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Author(s):	
Editor(s):	Kai Tullius

Project Co-ordinator:	**Maurizio Tomassini**
	Società Trasporti Automobilistici
	Via Ostiense 131/L
	00154 Roma Italia
	Phone: ++39-06-57118216
	Fax: ++39-06-57118547
	E-mail: m.tomassini@sta.roma.it

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Executive Summary

HEAVEN (Healthier Environment through Abatement of Vehicle Emission and Noise) is a research project co-funded by the Information Society Technologies Programme of the European Union. In the project consortium, valuable expertise in the field of transport and environment of research institutes, the private sector (leading industry and supporting consultants), and the public sector is combined.

It is the high-level goal of the project to demonstrate a Decision Support System (DSS) which can evaluate the environmental effects (air quality and noise quality - both emissions and dispersion forecasting) of Transport Demand Management Strategies (TDMS) in large urban areas. The EU cities of Berlin, Leicester, Paris, Rome, and Rotterdam as well as the CEEC city of Prague serve as the demonstration sites of the project.

The demonstration in these cities provides a concrete sustainable development perspective and improves the quality of life in European cities by reducing transport-related noise and air pollutant emissions through the innovative combination of efficient TDMS and integrated environmental Information Society Technologies (IST).

Workpackage 8 is the demonstration phase of the HEAVEN project. Within this workpackage, the partner cities aim to work together to meet three key objectives: the demonstration of the DSS for evaluating the mobility related pollution in relation to implemented and planned TDMS; the demonstration of noise emission forecasting related to mobility strategies; aid national-local pollution strategies in compliance with EU directives on air and noise pollution.

In this document the results of the demonstration period are summarized. It can be stated for Berlin that the demonstration was carried out according to

- the technical specifications given in WP 5 and 6
- the demonstration plan (D 8.3) under consideration of the results from WP 7.

In Berlin there are no deviation from the technical plans (WP 5 and 6). The system architecture as outlined in these deliverables was implemented according to the time schedule. The environmental models (IMMIS modeling chain) for calculating traffic emission, rooftop concentration and roadside pollution for air pollutants and noise were integrated to the system as planned. The accuracy of these models meet the previously defined quality standards. As demonstrated in different scenario analyses models have also proven to be sensitive to changes in the traffic input data. Results of the online calculation are presented on the Berlin HEAVEN website to professional users.

Next to the environmental modeling and information presentation on the internet, the traffic effects of different TDMS have been modeled. In a second step these TDMS have been implemented and evaluated in terms of traffic and environment. These TDMS consist of:

- Speed reduction to 30 m/h, introduced from 01.07.2002 – 27.08.2002
- Truck ban, introduced from 26.08.2002 – 15.09.2002

In addition also more long term scenarios related to a ban of diesel vehicles not complying with the Euro 3 Norm (2005) and Euro 4 Norm (2010) from the city centre were calculated for the years 2005 and 2010.

As a result pursuit of a "clean vehicle policy " is a vital but not sufficient a way forward towards full compliance with European air equality standards. Having successfully developed the tools within HEAVEN complementary traffic management measures can be designed for those hot spot areas where the technical emission control potential is not enough.

So, HEAVEN can be regarded as a successful project. The developed and improved tools will continue to operate and the city of Berlin plans to use these tools for its future environmental monitoring and planning of pollution control strategies.

Table of Contents

1 INTRODUCTION

1.1 Guide to the reader

In this document the results of the demonstration are presented. The demonstration was carried out according to the demonstration plan (deliverable D8.3). In this document the verification results and their impact on WP8 are briefly described (chapter 2). In chapter 3 the HEAVEN decision support system (DSS) system which was developed in WP 5 and WP 6 is described. In Berlin there are no deviations from the plan (WP 5 and 6). Based upon this information and Berlin's general objectives the Berlin demonstrator and especially the results of the demonstration are presented in detail (chapter 4). This refers to the following topics:

- Operation of the system during demonstration
- Accuracy of the environmental models used in the HEAVEN DSS
- Description of the internet based information platform
- Description of the different TDMS which includes the ex ante offline modelling, the implementation of the TDMS and the ex post evaluation of the TDMS in terms of traffic and environment
- Outlook of potential future use of the HEAVEN DSS

1.2 Project Objectives

The project objectives can be considered on varying scales- on a HEAVEN basis, on a workpackage basis and on a site basis and each of these will now be discussed briefly.

1.2.1 By project

The project's high-level goal is to demonstrate a decision support system (DSS) which can evaluate the environmental effects (air quality and noise quality - both emissions and dispersion forecasting) of Transportation Demand Management Strategies (TDMS) in large urban areas. This goal has been translated into a concise set of high-level project objectives:

- Improve the basis for decision-making through integrated and real time information on key pollution factors;
- Inform key actors (including the public) on the state of air and noise pollution levels;
- Test different TDMS and their impacts on traffic and the environment;

- Draw conclusions for the implementation of local noise and air action plans;
- Generate commercial value out of the project.

1.2.2 By workpackage

- To demonstrate the DSS for evaluating the mobility related pollution in relation to implemented and planned TDMS;
- To aid in achieving compliance with EU directives on air [and noise] pollution, and in developing national-local pollution strategies.

1.2.3 By site

Berlin wants to test new methodologies and systems for decision making to reduce transport related emissions to assist in achieving compliance with EU Directives on air quality and noise. In the framework of the HEAVEN project a system is demonstrated which permanently monitors the actual air and noise pollution in street canyons. This dynamic system permanently compares the actual environmental situation with threshold values. Based upon this information, different Transport Demand Management Strategies to reduce pollution and avoid exceedances can be developed, tested and evaluated. The project objective is to realise a system consisting of the following components:

Traffic Monitoring

Berlin's HEAVEN system is based on the Traffic Management Centre (TMC), which recently started its operation. The centre collects real-time traffic data from 158 measurement points in the city. The combination of data from the traffic management centre and use of the existing models allows for the modelling of pollution levels in near real-time at the street level, eventually, for each major street in Berlin.

Environmental Modeling

Based on actual traffic and meteorological data the near real-time air pollution (CO, NOx, PM 10, benzene) and noise-levels are calculated using the IMMIS model chain:

- IMMIS em for modelling traffic related emissions.
- IMMIS net for calculating regional and city background concentration.
- IMMIS cpb for calculating pollution concentration in street canyons.
- IMMIS lärm for calculating traffic induced sound emissions and noise levels for city streets.

The TMC delivers data on the number of vehicles and traffic flow that is used as input to all models. The emission calculation model IMMIS ^{em} calculates the emission from the detected / modelled traffic. IMMIS ^{net} then calculates the rooftop pollution concentrations caused by the emissions from traffic, area sources, and point sources as influenced by the meteorological conditions. Finally IMMIS ^{cpb} calculates the total pollution concentration for network links caused by traffic as influenced by background pollution and current meteorological conditions.

Impacts of T(D)MS on the environment

The information on actual pollution levels shall form the basis for implementing Transport Demand Management Strategies (TDMS) anticipated to reduce these levels. In the HEAVEN project, different measures will be tested regarding their effectiveness to reduce pollution in the Beusselstrasse, a small area in Berlin characterised by heavy truck traffic. These measures consist of:

- introduction of a speed limit of 30km/h;
- introduction of a truck ban;

The modelling of the effects have shown that the introduction of a truck ban can reduce air pollution by up to 13% and noise levels by up to 2,5 dB(A) while a speed limit can reduce air pollution by 3 - 4 % and noise levels by up to 3,5 dB(A). In real life tests – which were carried out in summer/autumn 2003 - it was investigated if the predicted reductions can be achieved and if reallocated traffic will lead to higher pollution in adjacent areas.

Impacts on transport policy

The results of these tests will be of high significance for the future transport policy in Berlin. In a few areas it will be difficult to meet environmental standards, especially threshold values for PM10 and NO2. The TDMS tested in the HEAVEN project (Speed limit, truck rerouting, variation in traffic signalling) will become a reference case for similar measures to be introduced in other parts of the city. Combined with the HEAVEN system it will then be possible to develop optimal, individual transport strategies for different areas. Those strategies can consist of long term measures but also of dynamic measures which are introduced when certain limit values are exceeded.

Information Platform

The results of the online pollution monitoring are available to professional users at authorities and the general public via the internet. During the demonstration phase the results are presented in the following way: A digital map street map of Berlin forms the basis of the information platform. On this map the receptors are indicated for which online results of the environmental modelling are available. In total 6 different, zoomable maps can be selected on which the annual average pollution levels are indicated: one for each pollutant (PM 10, CO, Benzene, NO2), one for noise and one for traffic.

During demonstration, the Berlin system only calculates online pollution for those road segments where online traffic data is available. As soon as online traffic data is available for the whole network, pollution levels for all road segments on the main street network in Berlin can be calculated online. Based on this data, dynamic maps can be produced, showing the actual roadside pollution on all segments of the main street network.

1.3 Project structure

1.3.1 Project Level

The management structure of HEAVEN, as depicted in the figure below. includes the following roles:

- The Steering Group is formed by executive level representatives of the principal contractors and is responsible for providing strategic guidance and in charge of steering of the project.
- The Technical Management Committee is formed from all Local Site and Workpackage Managers and the Project Manager. The Committee meets regularly to review technical progress on overall and site level and identify needs for corrective actions; reports regularly to the Steering Committee via the Project Manager.
- The Project Manager (STA) is the single contact point for the European Commission Project Officer and has overall responsibility for the day-to-day management and all regular reporting according to the contract (e.g. tri-monthly progress reports, Annual reports, Annual Review Report), representing the Co-ordinating Contractor The Project Manager has specific responsibility for administrative and financial management and quality control and assists the Steering Committee and prepares and follows up on its decisions. The project manager is in charge of the organisation of frequent partner

meetings and discussion forums, as well as continual communication via email, fax and telephone conferences in order to ensure the necessary flow of information.

- The Technical Manager (Heich Consult) is responsible for the day-to-day management of the project, co-ordination of the various tasks and work between the sites and WP Leaders according to an overall project workplan, organisation of frequent technical meetings and information exchange between sites and partners via e-mail, fax, in order to ensure the necessary flow of information. The Technical Manager's responsibilities encompass workpackage supervision, interfacing with workpackage leaders, and overall co-ordination of deliverable production. Additionally, the Technical Manager is in charge of co-ordinating the participation in programme level clustering and ensuring a high level of evaluation.
- The Workpackage Leaders have the key task to co-ordinate activities on site and at project level for the duration of a workpackage, assist the Technical Manager during the active period of their workpackage and co-ordinate production of the deliverables of the workpackage.
- The Local Site Managers co-ordinate all contributions to the project from their respective local partners (especially during the demonstration and exploitation phase). They are the single contact point for their sites towards the project consortium.

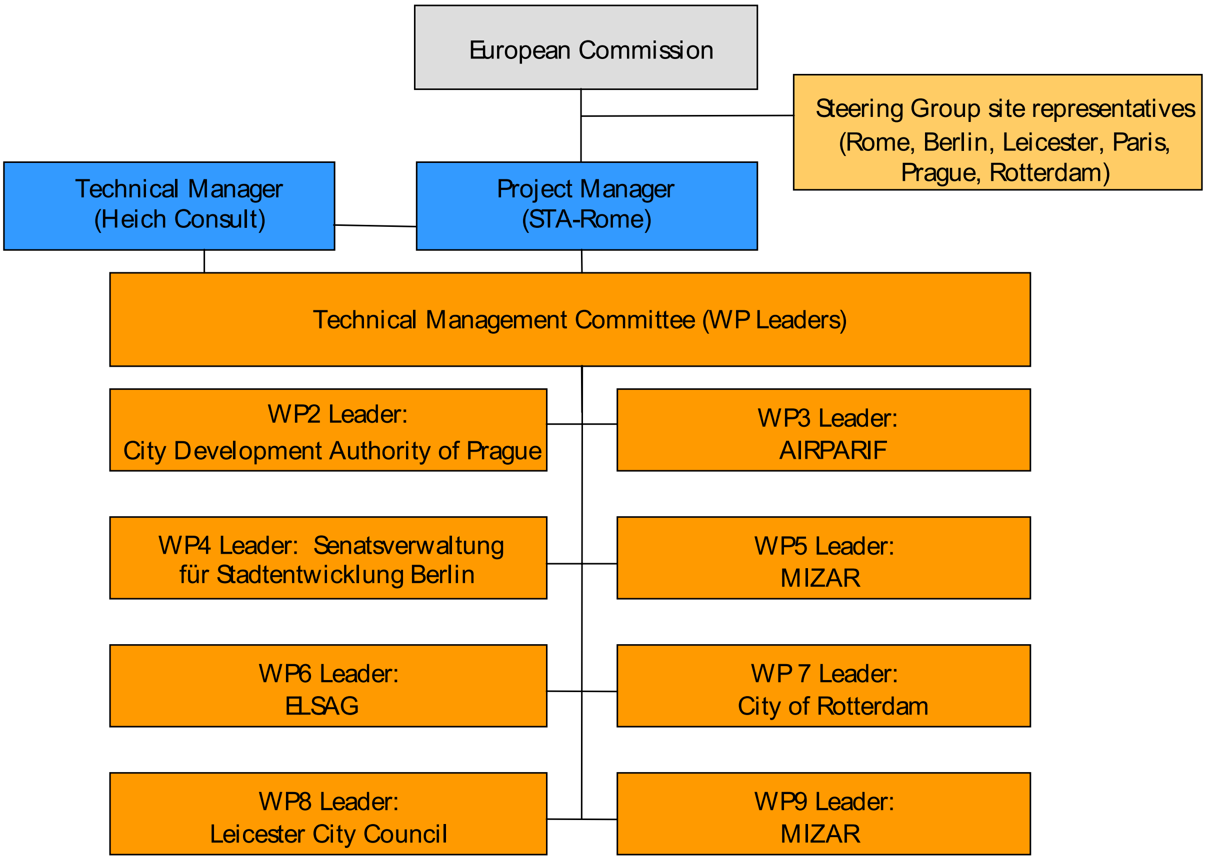


Fig. 1 Management Structure of the HEAVEN project

1.3.2 Site Level

The local workpackage leader in Berlin is the Senate Department for Urban Development – Transport Section.

The Senate is responsible for any practical measures which have influence on traffic conditions, because the Berlin transport division also obtains the transport authorities for individual and public transport. So the co-ordination of measures which effect different local authorities (local district administration, road authority, trade associations, transport companies, stake holders, NGOs, etc.) can be done most effectively under the leadership of this department.

The pilot study in the area of Beusselstraße also offers good opportunities to improve institutional co-operation among the transport and the environmental divisions of the Senate

Department for Urban Development. Such co-operation is essential, given the responsibility of the environment division for developing the abatement plans required by European legislation in order to attain the EU's air quality limit values within the next five to ten years.. On the other hand, it is the transport division's role to assist in the aim of reducing pollutant emissions from traffic given the predominant contribution of this sector to the excess of air and noise thresholds in Berlin.

IVU Traffic Technologies AG supports the Senate in carrying out the workpackage. Thus running the online monitoring system and evaluating the impacts of the different TDMS in terms of their effects on the environment.

1.4 Summary of other WPs

1.4.1 WP1: Project Management

The project management consists of the continuous co-ordination and monitoring of the project's progress, paying attention both to end goals and interim goals. Because of the complexity of the project, the management will be divided into administrative management and technical co-ordination.

1.4.2 WP2: Dissemination

The goal is to disseminate the outcomes of the project and form consensus on the approach used in HEAVEN. The major milestones are an interim technical workshop and a final conference both to be organised at the European level. Contribution to Key events organised by the Commission and to European and World conferences dealing with the HEAVEN research will be ensured. The outcomes of the project will also be made available through a project website. The feasibility of organising a temporary web site for user group consultation and discussion will be examined.

1.4.3 WP3: Validation Co-ordination

WP3 will assist both the verification and the demonstration stages of the project. Firstly, a draft validation plan will be developed, in close co-operation with the local evaluation managers, who are responsible for performing the actual evaluation in WP7 and WP8. Secondly, the local evaluation work, both for the verification and the demonstration phase, will be guided through advice and direct assistance. Verification of systems will be done in WP7, evaluation of the demonstration's impacts in WP8. WP3 is responsible for co-ordinating the results from the verification and demonstration phases and for incorporating them into a Final Evaluation Report.

1.4.4 WP4: User Requirements and Implementation Framework

This WP focuses on a detailed analysis of the needs of the different DSS and Information system users: decision makers, system operators and end-users. The draft user requirements will form an input to WP5 for the design of the DSS and Information system and to WP3 for the preparation of the draft validation plan.

1.4.5 WP5: Functional Specifications/System architecture

WP5 will develop the specifications for DSS and Information systems on the basis of the requirements captured by WP4. The work will be performed in each site according to local particularities and constraints, and following a common and structured approach, which help to identify commonalties between sites. The underlying purpose of this work package is to design the functions and architectures suitable to support tasks presented above.

1.4.6 WP6: Build Integrated Systems

Starting from the functional architectures and the systems design provided by WP5 and based on the actual existing implementations, WP6 will identify the set of components and actions to be undertaken in order to grant the implementation of the DSS and Information System. WP6 will include the identification of the components required to fulfil the specifications provided by WP5; the selection, validation and improvement of the environmental models; and the detailed specification of the central Decision Support System (DSS).

1.4.7 WP7: System Verification

At first, the operating performance of the system will be assessed by focussing on indicators like number of breakdowns, log-files and speed of the system.

Secondly the acceptance by users interviewed in the context of WP3. Users will be asked if the system meets their requirements and if the information supplied is clear.

Thirdly, a user panel consisting of a small group of citizens will give its opinion on the information provided to the general public.

In this stage, some changes to be made to the systems before the large-scale demonstration within work package 8 can be indicated.

1.4.8 WP 8: Large Scale Demonstration

The on-site implementation and real-life operation of the systems of both the DSS and the information platforms occurs in Workpackage 8. All the system component integration also occurs (traffic monitoring, environmental monitoring, emissions and dispersion models, etc.). The demonstration reflects modifications made in response to the verification phase (WP7), both in terms of technical performance and in terms of the outputs (content and form). Additional minor adjustments proceed during the demonstration period, according to the milestone schedule.

1.4.9 WP9: Exploitation and Business Plan

This workpackage will assess the added value and the exploitation possibilities of the suite of HEAVEN end products, in particular the DSS for evaluating TDM strategies, the information integration platform, and any of the refined models incorporated into these end products. This workpackage will provide a detailed Exploitation and Business Plan for the industrial partners, identifying what market possibilities they identify for the developments completed in this project.

The following diagram displays how each work package inter-relates with the others

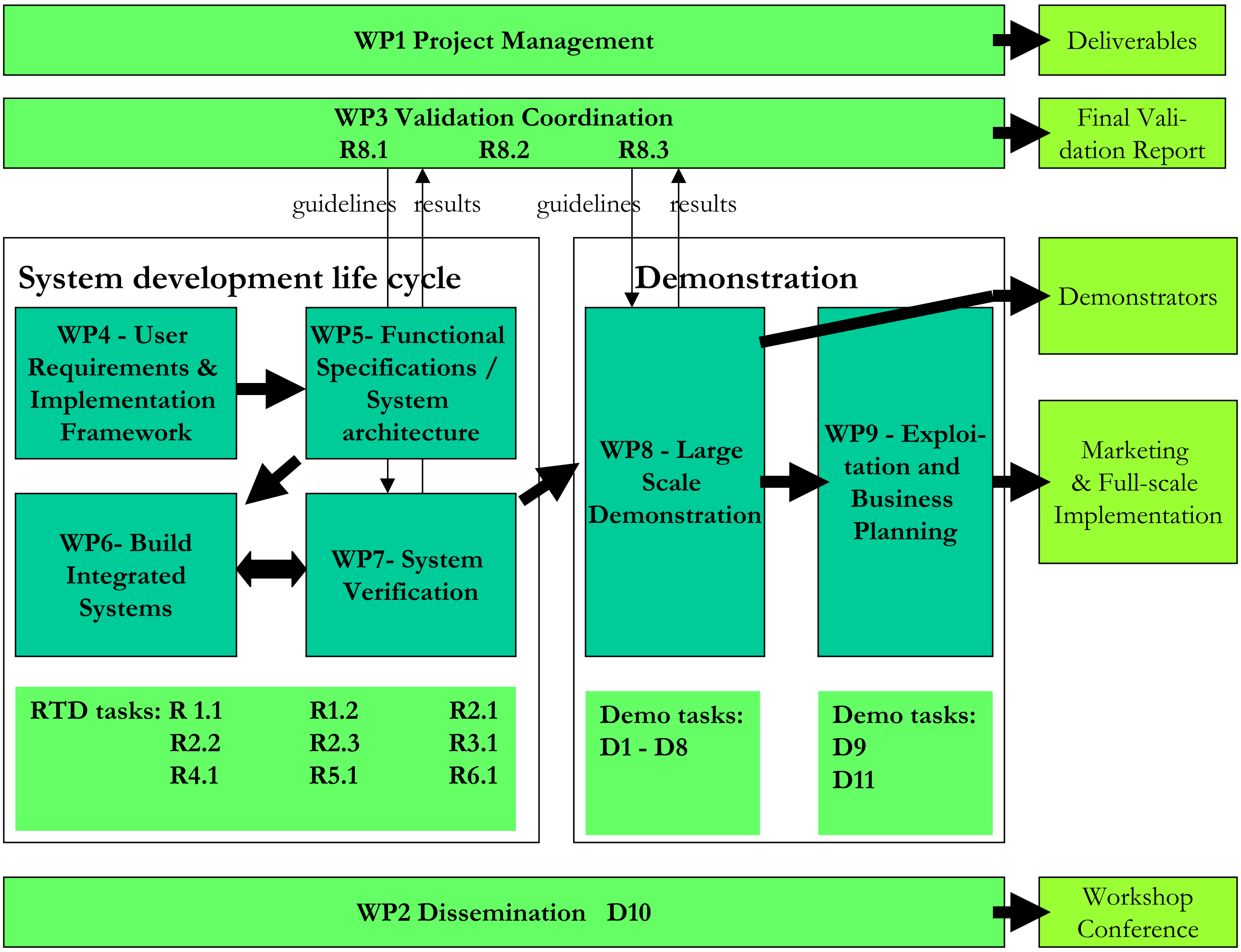


Fig. 2 Interrelations between workpackages and RTD and demonstration tasks

1.5 HEAVEN System Concept

The HEAVEN DSS combines near real-time traffic flow information into emission and dispersion models so as to analyse the contribution of mobile sources to air quality and noise. In order to estimate emissions based on current traffic levels and on planned demand management scenarios, the system can operate on-line, based on current traffic and environmental information, and off-line, based on planned traffic and environmental conditions and pre-defined TDMS.

The diagram in Figure 2 shows the dynamic data processing and modelling chain that supports the on-line operation of the system. The near real-time input information concerning traffic, air quality, noise and meteorological conditions is processed and archived for use during off-line operation.

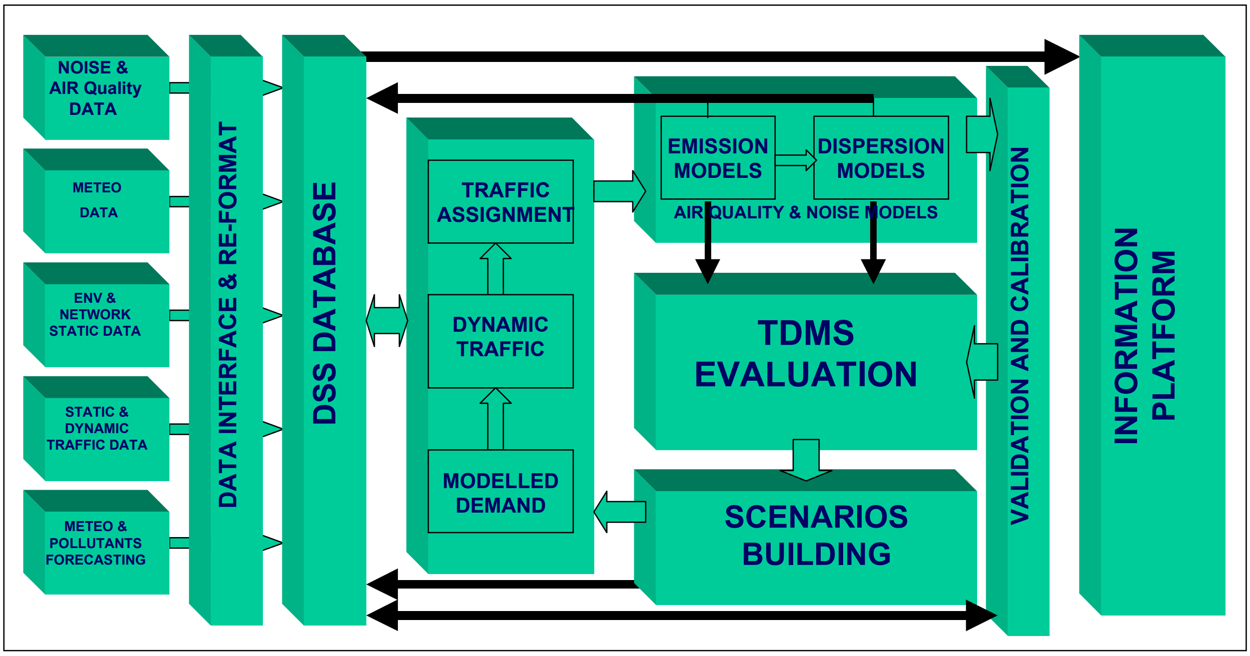


Fig. 3 The dynamic Data Processing and Modelling Chain of the HEAVEN DSS

The main operational characteristics of the HEAVEN DSS emerge from the processes drawn in the diagram above.

i. Data exchange from external sources to the DSS models

The input data for the DSS come from several external sources:

- Near real-time dynamic Traffic, Air Quality, Noise and Meteorological data come from specific infrastructures and monitoring systems. Type of data, spatial and time resolution, accuracy, etc, depend on the features of the monitoring systems. The data exchange is performed on-line to ensure near real-time data processing.
- Static and infrequently updated data - such as data representing the traffic network, the land use, the built environment, statistics and forecasts concerning traffic, pollution and meteorological conditions, the model configuration parameters, etc – are provided by specialised institutions, bodies and data bases. This data exchange is performed off-line.

In general, specific interfaces are required to interact with the different data sources and to hide the possible complexity of the on-line connection with the monitoring systems. The storage of data in the HEAVEN data base is normally performed after manipulation, pre-processing and reformatting of raw data. Dynamic data are fed into the DSS modelling chain only after validation.

ii. Dynamic traffic data processing

- Traffic data from near real time detection of the Traffic Management Centre is used as data input.
- Near real-time traffic data is then fed into the environmental models for emission and dispersion estimation.
- Finally, the monitored traffic conditions contribute to the evaluation of the impact of the TDMS under analysis and constitutes one component of the TDMS application scenario.

iii. Dynamic Air Quality and Noise data processing

- *The (validated) dynamic air quality, noise and meteo data are employed to compute the traffic related emissions in near real-time, and so to feed the pollutant dispersion estimation and the noise levels computation. Concentration of pollutants and noise levels are then computed for key points and areas in the network taking care of background dispersions modelled through specific models.*
- Also the output of the Air Quality and Noise models undergo validation procedures both to ensure consistency of the information produced, and to contribute to the environmental models calibration and tuning.
- Finally, modelled emissions and measured and modelled Air Quality and Noise levels are the main information for the evaluation of the impact of the TDMS under analysis.

iv. Information exchange between the DSS Data Base and the Information Platform

- All the input information and DSS model results are stored in the system data-base. The entire or a part of this set of information can be transferred to the Common Information Platform and disseminated according to user related access restrictions.
- Dissemination is performed through several format (tables, maps, etc)

v. Scenarios building

- Through the scenarios building, the operator can define the context for the off-line evaluation of new TDMS in the view of optimising the environmental impact of the traffic.

vi. TDMS Evaluation

- The evaluation of the performance of a TDMS in the context of a planned or actual scenario is made through the comparison between the traffic, emissions, air quality and noise modelled output based on this scenario and the traffic, emissions, air quality and noise modelled output based on a reference situation.
- This process bases on manual procedures for data collection, selection and computation but the system operator plays a key role to set the operational conditions to perform the evaluation. The system operator steers the evaluation process through a specific Operator Interface.

The characteristics of the site DSS' reflect the general characteristics of the HEAVEN DSS, although duly customised according to the peculiarities of the site (availability and type of the data sources external to the system, models adopted, operational constraints, etc).

2 DECISION SUPPORT SYSTEM IN BERLIN

The Berlin DSS was implemented according to the plans already outlined in deliverables D5.1, D5.2, D6.1, D6.2. No changes to this specification incurred during the demonstration phase. The system concept is summarised in the chapter

2.1 General System Architecture

The following diagram represents the on-line processing chain for the DSS in Berlin and it is derived from the Top Level Data Flow Diagram of Deliverable 5.2, integrated with the set of components described in Deliverable 6.1.

For the processing purposes, in the Berlin case:

- Interfaces with existing/external systems
- Air / Noise Pollution Modelling Module

are shown.

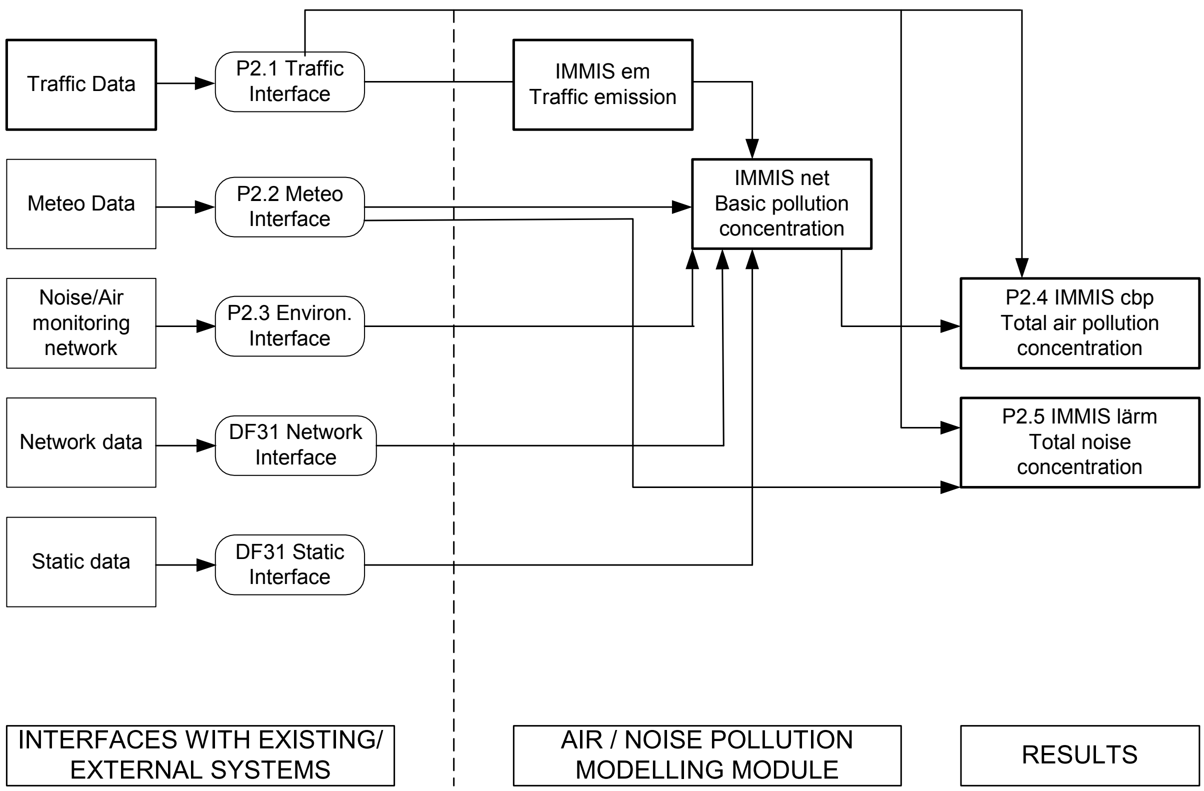


Fig. 4 Berlin DSS Processing chain

2.2 Interfaces with external and/or existing systems

In the Berlin DSS, the following external systems provide input data for the HEAVEN DSS:

- traffic monitoring and modelling system
- meteo services
- air pollution measurements for background pollution purposes
- noise and air pollution measurements for verification purposes
- static data

2.2.1 Traffic Modelling Module

The traffic-modelling module is operated as an external system of the DSS. The T(D)MC provides traffic information for the main road network in Berlin. Near real time traffic data from detectors and forecast for the rest of the network are provided by the T(D)MC and are imported to the HEAVEN DSS and stored in the database for future use. This Management Centre collects online traffic data and provides other relevant information on transport such as time tables for public transport. The traffic management centre produces an overview on the current traffic situation of Berlin's road network and at public transport operations. In addition, forecasts are produced for the expected traffic situation in the next hours, the next day, the next weekend. Such forecasts will facilitate traffic planning.

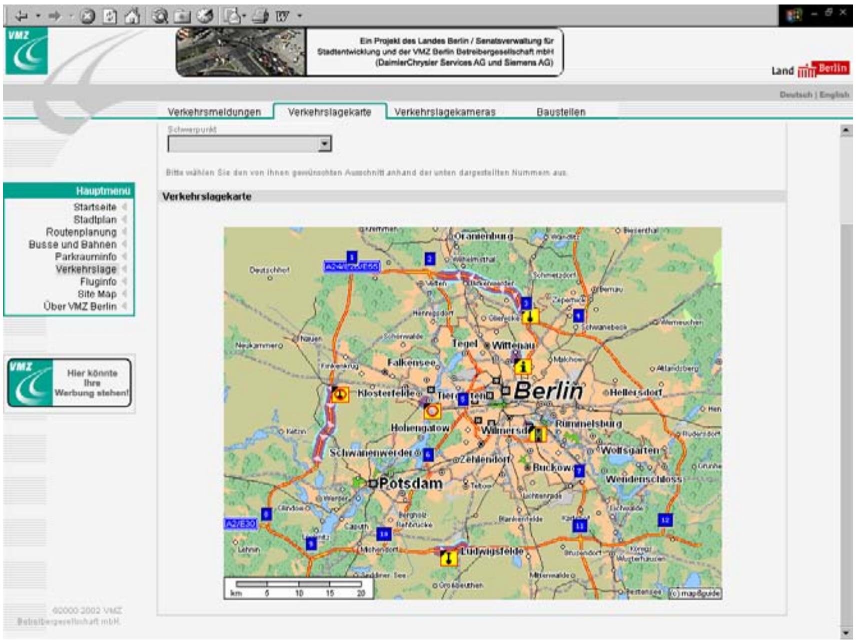


Fig. 5 Traffic Management Centre Berlin

The VMZ monitors traffic with 158 detectors which are spread on the main road network in Berlin. The detectors deliver data on number of cars/trucks and their speed on hourly basis. This data is sufficient to model the whole traffic situation on the main road network and to identify any changes from the expected traffic situation.

For the HEAVEN project, this traffic data is used to calculate the roadside pollution at the road segments where detectors are located. In the future, such a modelling shall be possible for the complete main road network on an hourly basis.

2.2.2 Meteo Services

Near Real Time Meteorological data is taken from the meteorological station of the environmental authority of Berlin. Meteorological data serves as model-input for the calculation of the spread and the actual concentration of air-pollutants in streets. The following data is used as input data for the environmental modelling:

- wind direction,
- wind speed,
- dispersion class.

2.2.3 Air pollution monitoring network

Since 1975 an automatic air monitoring network has been under operation in Berlin. The current status of the network consists of more than 20 sites, each equipped with several instruments for measurements of various pollutants. The measured data is routinely transmitted every 5 minutes to the central processing unit, where the data is aggregated to 30 minute and hourly averages. Figure 7 shows the spatial distribution, while the table below provides further detail on the equipment in each site.

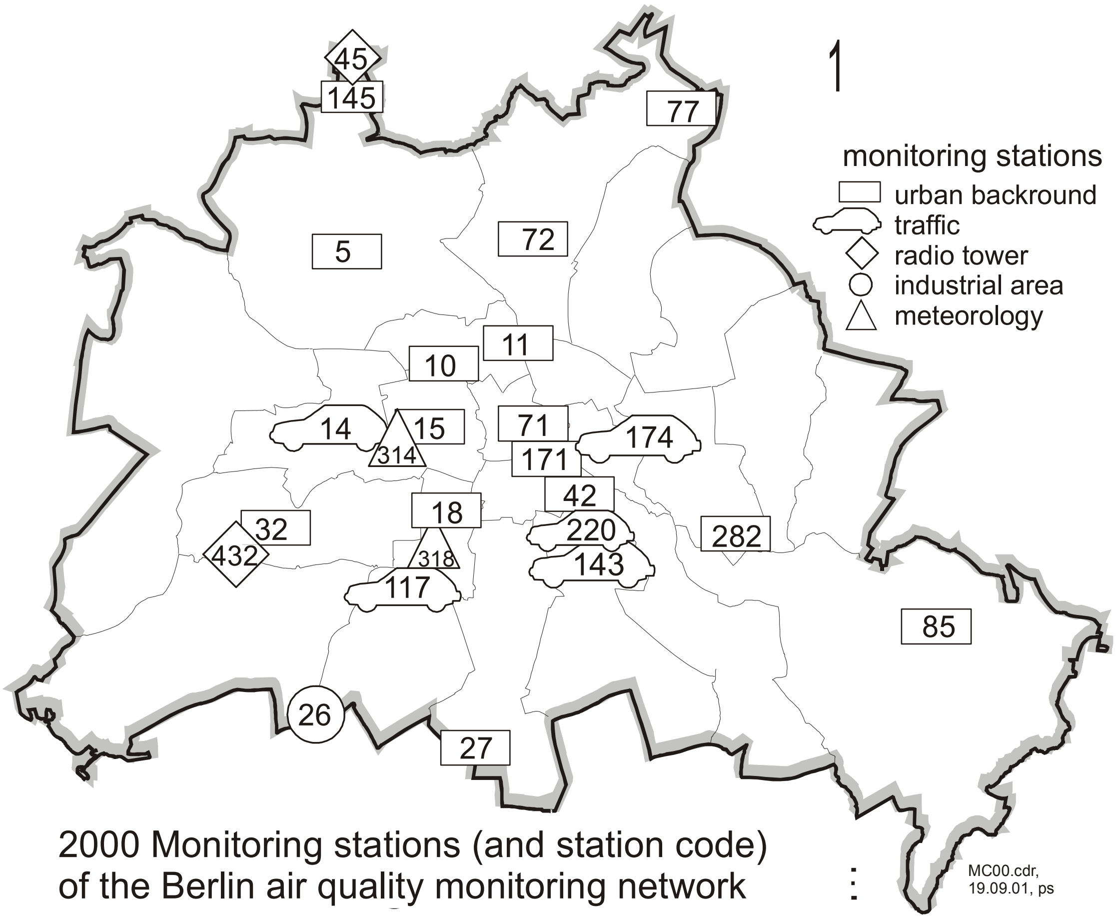


Fig. 6 Air pollution and meteorological stations in Berlin

As a supplementary source of information around 40 small monitoring devices are under operation which allow active sampling of soot and benzene, as well as passive sampling of nitrogen dioxide. The samples are collected and analysed in the laboratory once a week, so that a time series of weekly averages have been obtained. One of these devices records the air pollution in the Beusselstraße since 1998. Hence, it enables comparison with and assessment of the representativity of the levels measured during the verification and demonstration phase in relation to the long-term pollution load in the Beusselstraße.

	Name	SPM	SO2	NOx	CO	O3	BTX	Meteo
residential sites								
005	Tegel	a	x	x	x			
010	Wedding	b	x	x	x	x	x	
011	Wedding	a	x	x	x			
015	Tiergarten	b	x	x	x			
018	Schöneberg	a	x	x	x			
042	Neukölln	bcdfg	x	x	x	x	x	
071	Mitte	b	x	x	x	x	x	
072	Pankow	b	x	x				
282	Karlshorst	a	x	x	x			
traffic sites								
014	Stadtautobahn, Lerschpfad	b	x	x	x	x	x	
117	Schildhornstraße	b	x	x	x		x	
143	Silbersteinstraße			x	x			
174	Frankfurter Allee	bcdefg	x	x	x		x	
220	Karl-Marx-Straße			x	x			
industrial sites								
026	Lichterfelde	a	x	x	x			
sites on the periphery								
027	Marienfelde	bc	x	x	x	x		
032	Grunewald (forest, 3m above grnd)	a	x	x	x	x		x
432	Grunewald (forest,27m above grnd)		x	x	x	x		x
077	Buch	bc	x	x		x		
085	Friedrichshagen	b	x	x		x		
145	Frohnau (near ground)	b	x	x	x	x	x	x
045	Frohnau, radiotower (324 m above grnd)		x	x		x		x
meteorology								
314	Schöneberg							x
318	Charlottenburg							x

Suspended Particulate Matter (SPM)

a automatic TSP radiometric
b automatic PM10 radiometric with optical soot analysis
c PM10 Digitel DHA80
d PM10 Kleinfilter
e PM2,5 Digitel DHA80
f PM 2,5 Kleinfilter
g PM 1.0 Kleinfilter

BTX: monitoring of benzene, toluene and xylene

Tab. 1 Air Pollution Monitoring Stations in Berlin

For the purpose of measuring the pollution concentration in the demonstration area in the Beusselstraße a mobile unit with automatic devices of PM10, CO, NO, NO_2, NOx and benzene has been used, which records values with a time resolution of 30 minutes. Two different locations have been chosen in order to account for different traffic loads in the northern and southern part of the Beusselstraße. In order to allow a more sophisticated evaluation of the contribution of traffic and exhaust emissions to the total PM10-concentration in the demonstration area, an additional PM10 sampler has been deployed at the northern site. The main components (carbonaceous compounds, ions) of the obtained 24h samples will be analysed and evaluated in conjunction with a series of similar measurements performed elsewhere in the city.

Emission inventories

With regard to the modelling system, the emission database includes information on a variety of pollutants, namely NO_X, PM_{10}, CO, and Benzene.

Modelling tools (air, emissions, noise, traffic)

The following table provides a list of the tools used in Berlin

Type of modelling	Type of model
Air quality modelling	• Emission Modelling: IMMIS ^{em} • Rooftop concentration modelling: IMMIS ^{net} • Canyon dispersion / roadside description: IMMIS ^{cpb}
Noise modelling	IMMIS Lärm

Tab. 2 Air and noise pollution models used in Berlin

2.2.4 Noise pollution monitoring

According to German legislation assessment and mapping of motor traffic noise is to be based only on calculations with a standardised model, which has once been calibrated against measurements and which serves as the basis for the noise modelling tool developed for the HEAVEN DSS. So, as there is no need to perform measurements of traffic noise there are no permanent noise monitoring sites in Berlin. However, noise measurement have been performed for the purpose of validating the HEAVEN noise modelling tool, which has been derived from the standardised approach prescribed by German legislation, in order to allow calculation of hourly noise levels from on-line traffic data. Two locations for measurements of air and noise pollution have been chosen in the Beusselstraße (see map), because the amount of traffic is larger in the northern section (27.000 vehicles per working day, incl. 1700 HDV) than in the southern section (19.000 vehicles, incl. 1300 HDV).

The data produced from this noise monitoring programme is used in HEAVEN to assess the accuracy of the noise model.

2.3 Environmental Modelling

In this chapter the modelling chain of the environmental online modelling is outlined.

2.3.1 Air Pollution Modelling Modules

In the Berlin DSS, the following modelling processes are involved:

- Traffic Related Emission Modelling (IMMIS em)
- Background Concentration (roof top) Modelling (IMMIS net)
- Dispersion Modelling (IMMIS cpb)

On the basis of near real-time traffic and near real-time meteorological data the near real-time air pollution (CO, NOx, PM 10, benzene) and noise-levels are calculated using existing models IMMIS em (emission modelling), IMMIS net (background pollution modelling), and IMMIS cpb (dispersion modelling).

Before HEAVEN these models calculated the mean air pollution and noise levels for a 24-hour period. The models were enhanced in order to be capable to use directly the information from the EM database and calculate automatically air pollution and noise levels per link in the network on an hourly basis. The models were chosen because the offline models are already used with good results in Berlin and because these models are relatively easy to adjust for dynamic online modelling processes. In detail the following functions are fulfilled by the models:

- **Traffic Related Emission Modelling (IMMIS em)**
  has the objective to supply a modelling of traffic pollution emissions based on the different types of data available from the Traffic Monitoring and forecast function. This function runs hourly according to the update of traffic data.
- **Background Concentration (roof top) Modelling (IMMIS net)**
  has the objective to model local background pollution.
- **Dispersion Modelling (IMMIS cpb)**
  has the objective to evaluate the pollutants dispersion providing a value of concentration in pre-defined receptors. This function runs every hour based upon the calculated traffic emissions and other emission sources inside Berlin.

The following figure depicts the general architecture of the environmental modelling process. The T(D)MC delivers data on number of vehicles and traffic flow that is used as input to all models. The emission calculation model IMMIS em calculates the emission from the detected / modelled traffic. IMMIS net is then calculating the background pollution concentration caused by the emissions from traffic, area sources, and point sources under consideration of meteorological conditions. Finally IMMIS cpb is calculating the total pollution concentration for network links caused by traffic under consideration of background pollution and current meteorological conditions.

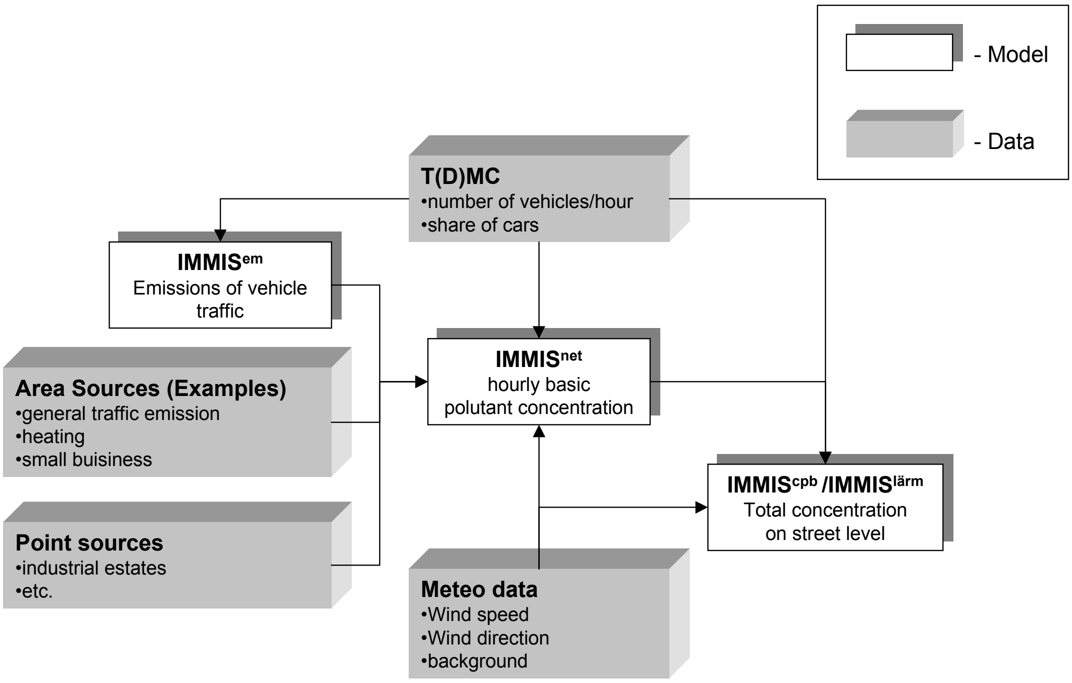


Fig. 7 Environmental Modelling Chain

The modelling is described in two steps. In the next chapter, only the emission modelling is described while in chapter 2.3.1.2 the background pollution and dispersion modelling is described. The modelling of noise is described in chapter 3.3.2.

2.3.1.1 Emission Modelling

For the calculation of the traffic emissions an enhanced version of the model IMMIS em is used for the HEAVEN DSS. The model IMMIS em is based on the current handbook for emissions in road traffic (INFRAS 1995, 1999). In this handbook emission factors and other data related to traffic volumes are specified for different types of vehicles until the year 2020.

Input
Traffic data from T(D)MC
emission factors

→

Output
emission of vehicles for PM10, Benzene, CO, NOx

Fig. 8 Input and output of emission modelling

2.3.1.2 Dispersion calculation module

In cities two different concentration areas can be divided:

- roof top concentration level
- ground level in street canyons

The roof top concentration is influenced by emissions from point, area and line sources. A smaller share is coming from regional background pollution emitted outside the city.
The roof top concentration can be modelled by IMMIS net. This roof top concentration can be regarded as background pollution for modelling ground level concentration. However, the most relevant concentrations can be found in street canyons, where the highest emissions are emitted by traffic. This additional concentration can be modelled by IMMIS cpb. Total concentration is the sum of roof top and ground level concentration, this is also the concentration affecting the population in the street canyons.

Modelling of roof top concentration

For modelling the background air pollution - on the basis of Gauß formulas - the model IMMIS net is used which uses emission input data - divided by different sources - from:

- line sources,
- area sources,
- point sources

Area sources include the general/total emissions from traffic that are not calculated by IMMISem, emission from households and commercial activities, while point sources are related to industrial activities or other relevant emission from one single source.

The input data for these sources can be taken from the Emissionskataster Berlin. This source provides the following data:

- Traffic emissions based on the year 1999
- emissions from households, based on the year 1999
- emissions from industry. updates for the year 1999 will be available shortly
- emissions from commercial activities, based on the year 1993/94

Measured air pollution (regional background pollution) data from the city borders are used to estimate the impact of pollution coming from outside Berlin. Emission profiles (over time) are needed for all 11 source groups and the pollutants NOx, CO, Benzene and PM10

Modelling of ground level concentration

To calculate the total air pollutant concentration, next to the background pollution from area and point sources, the detected emission caused by traffic on street level (as provided by the T(D)MC) has to be taken into account. The model IMMIS cpb calculates the air pollutant concentration of traffic in street canyons. It is generally designed to calculate half-hour values of pollutant concentration for points in street canyons in dependence of the building heights and the effects of the buildings on wind direction and speed. The IMMIS cpb model is a two-dimensional, analytical-empirical model that can be used to compute half-hourly traffic induced air pollution immissions at any points (receptors) along a street canyon using easily obtained measured quantities.

The model can accommodate a wide variety of canyon geometries, including differing building heights on opposite sides of the streets and semi-open or “porous” buildings (e.g. open parking garages). The street being analysed may be of arbitrary length and may terminate at either or both ends with an intersection. IMMIS cpb computes averages and percentiles for each receptor and it is used for computing traffic-induced pollution concentrations.

The model essentially consists of three elements:

- a flow model which provides the wind fields needed to transport the pollutants along the street canyon,
- an empirical turbulence model which provides the quantities required to disperse the pollutants in the street canyon by means of turbulence,
- a dispersion model that consists of a vortex model for flow across the street and a model for flow parallel to the street. The criteria for the choice of model are the intensity of turbulence at the bottom of the canyon.

Modelling of total concentration values

The two dispersion models IMMISnet and IMMIScpb are used to calculate the total pollution concentration on street level by using the results of the IMMISem modelling, meteo and static data.

Input
emission of vehicles
reference network
network parameter
area, point sources
hot spot measurements
built environment
meteorological data

Output
polution concentration of PM10, Benzene, CO, NOx

Fig. 9 Input and output of dispersion modelling

Interface with the HEAVEN system

All input data for the environmental monitoring is imported from the EM database via ASCII Interfaces to the IMMIS models. The results of the modelling will be stored in the EM database from where they taken for the result presentation. The following figure depicts that process.

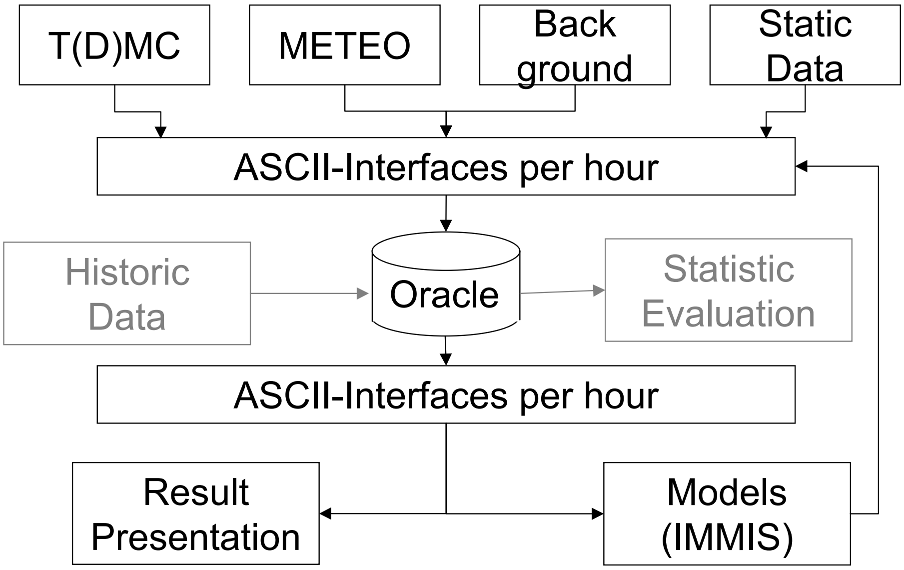


Fig. 10 Data Flows in the modelling chain

2.3.2 Noise Modelling Module

In the Berlin DSS, the following processes are involved:

- Traffic Related Emission Modelling
- Roadside concentration modelling

2.3.2.1 Introduction

For modelling noise in the HEAVEN DSS the model IMMIS lärm was chosen which fulfils the following functions:

- **Traffic Related Emission Modelling**
  has the objective to supply an estimation of traffic noise emissions based on the different types of data available from the Traffic Monitoring and forecast function. This function runs hourly according to the traffic data available.
- **Attenuation Modelling**
  has the objective to evaluate the noise dispersion. This function runs every hour.
- **Additional input**
  next to road traffic also tram traffic plays important role in determining noise pollution levels. The tram schedule is added to the calculation in order to integrate this noise source to the modelling.

2.3.2.2 Noise pollution modelling process

The model IMMIS lärm calculates noise emission and dispersion caused by vehicle traffic on urban streets. The model works according to German legislation. For modelling noise emissions the following input data is needed:

- traffic load separated by cars and trucks from the T(D)MC
- number of trams per hour
- average length of trams and share of wagons with special breaks
- road conditions/surface (network parameters from T(D)MC)

In addition, the following input is needed to calculate the noise dispersion

- built environment (reflections in street canyons)
- ground and meteo influence

Input		Output
traffic data from T(D)MC	→	noise emissions in db(A)
reference network		noise pollution leves db(A)
network parameter		number of residents affected
tram schedule		
population		
hot spot measurements		
road surface parameters		
built environemnt		
noise levels		

Fig. 11 Input and output of noise modelling

The model provides hourly updated noise levels for the main road network in Berlin. This noise data is stored in the database from where it is taken in order to be presented to the users. The way this information is provided to the users is described in detail in chapter 4.

2.4 HEAVEN DSS Database

The HEAVEN database forms the core of the HEAVEN DSS. All relevant input and output data is stored in the database. Such data consists for example of traffic data from the TMC, other relevant input data for environmental modelling, all outputs of the environmental models, etc. The Berlin database was established according to the specifications presented in D6.1 and D6.2.

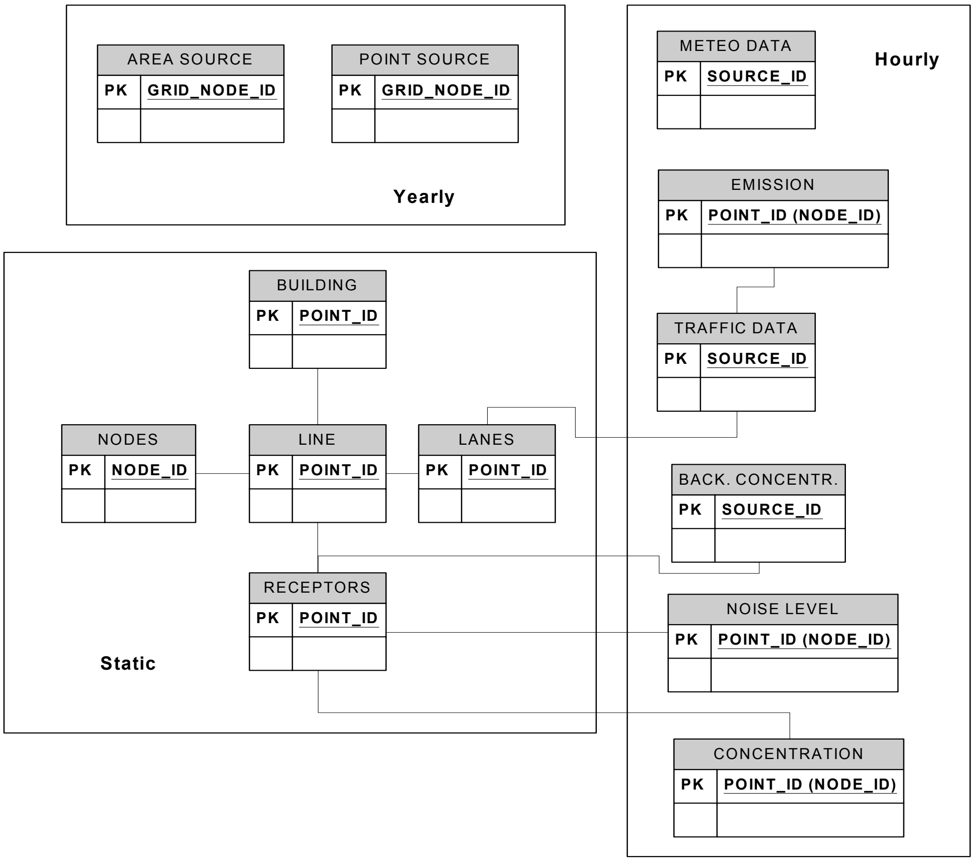


Fig. 12 Berlin DSS database

2.5 Functionalities of the HEAVEN DSS

2.5.1 Scenario Analysis

The main focus of the scenario analysis lies on the evaluation of different traffic demand management strategies (TDMS). The simulation of traffic impacts of TDMS can is carried out using the traffic models available at the T(D)MC where traffic profiles can be changed according to the investigated measures. The generated traffic output can be evaluated regarding the environmental effects of the TDMS under consideration of meteorological and background pollution forecasts.

The off line scenario management for modelling air and noise pollution consists of the following steps:

- The user defines the characteristics of the scenario to be simulated, i.e. he defines the day type of the scenario, the meteo conditions, the hourly range;
- Successively, he will choose one or more TDMS to be simulated, e.g. introduction of a truck ban;
- These scenario assumptions are then translated for the modelling process. The effects of the defined scenario measures on the transport demand are modelled. These simulated O/D matrices are then used as input for the scenario simulation
- The same processing chain of the on-line information processing is applied, i.e. the simulated traffic situation, meteo conditions, static data are used as input for the environmental modelling.
- The results of the simulation (noise levels and air pollution concentrations) can be presented on a map basis and in tables.

In the framework of the HEAVEN project different T(D)MS were tested on the regional level in the area Beusselstraße. These local measures in the demonstration area Beusselstraße to be tested in a scenario analysis consist of:

- speed limit (speed limit of 30 km/h)
- truck ban

The scenario analysis was carried out off line. The traffic effects of the different TDMS were to be simulated for the area Beusselstraße in Berlin. This new traffic assignment was then to be used to model the environmental situation after the implementation of the TDMS. A comparison with the reference case allows for an evaluation of the environmental effects of the different TDMS. The results of these simulations and real life tests are reported in chapter 4.

2.5.2 System Management

The operator of the HEAVEN system has access to the system via a Windows-based graphical user interface. Via this client, the operator can retrieve statistics from the system (direct access to historical databases) and can request forecasts when pollution concentration is likely to raise above previously defined limits.

The operator can also start a scenario analysis, i.e. modelling the effects of TDMS and other transport policies on the environmental situation. The operator can also change other input parameters such as traffic conditions and meteorological conditions.

Next to retrieving statistics from the HEAVEN DSS and running analyses the system operator also monitors the technical performance of the system. He is able to monitor the data flows and can control if near real time data is delivered on an hourly basis. The user will have none of these access rights.

2.5.3 Information Presentation

The Man Machine Interface provides the user of the Heaven system with a friendly instrument for monitoring the near real time environmental situation along the main road network in Berlin. In addition, the user has access to statistical and historical environmental data through a website. In addition, the HEAVEN project is presented in detail on this website and links to external systems are provided. All users have access to the system via the internet.

3 VERIFICATION

In the HEAVEN project, workpackage 7 (WP7) was responsible for the verification procedure and concentrates on the physical functioning of the system and the preliminary user acceptance proving that the integration of models works and meets the requirements of the end users. In addition, the workpackage dealt with the calibration of models aiming to give an indication about the adequacy of the models. The full verification of environmental models is out of the scope of the IST project HEAVEN. WP7 has developed a common verification concept, co-ordinated detailed local verification planning, analysed local results across sites, and made recommendations on system modifications before the start of the demonstration stage.

HEAVEN verification is based on a common verification concept necessitating that indicators are measured in the same way, or at least yield comparable results across the sites. In close co-operation with Workpackage 5 "Functional Specifications/System Architecture" and Workpackage 6 "Build Integrated Systems", a list of common verification indicators has been defined, which took account of the main processes, data flows and data stores. The indicators have been grouped into the three main themes of verification a) Testing physical functioning of the system, b) Preliminary user acceptance and c) Accuracy of roadside modelling and monitoring

The approach and methodologies applied in WP7 have been closely tuned with the overall evaluation process (WP3) to avoid disproportional overlap between the Evaluation and Verification. The WP3 Evaluation Indicator 1.3 Accuracy of Roadside Description was also in operation as part of the verification process. All other indicators in the verification stage were specific for verification.

The tests on the *physical functioning of the system* showed that in general the different components are functioned very well. No inadequate level of system failures occurred and the systems were over 95% operational. In general the interfaces to external systems and data sources work properly and the operational speed of the system is high enough to make the necessary updates on an hourly basis.

The investigations on the *preliminary user acceptance* were in general very positive. The users are satisfied, very supportive and enthusiastic. Recommendations for changes were made and are incorporated in the design where possible.

Within verification the results for *accuracy of modelling and monitoring for roadside description* in the cities were also very positive. The results showed that the different models used at the sites had been carefully selected and adjusted sufficiently for the specific situation at each site.

Results of the verification phase on the project level are reported in the "Final Verification Phase" (D7.1); in this chapter main results regarding the verification activities in Berlin are reported.

In this chapter both the general verification results of the overall project as well as the outstanding verification results and any resultant changes to the system are reported.

3.1 Results of the Berlin verification

In Berlin all verification indicators have been completed except the verification of the noise indicator. The results of the verification and their impact on the demonstration can be summarised as follows:

Indicator 2: Accuracy of roadside description, air models
For the purpose of initial verification the pollution was modelled during the period Nov 1 - Nov 7 2001 and was compared with the measured values on an hourly basis (168 values per pollutant). The success criterions were fulfilled for all evaluated substances PM10, CO, NO2, NOx, benzene. The deviation of the modelled values ranges between 27 % for PM 10 and 51 % for NO2. The target value of $C < 50\%$ was met for all pollutants.
However, improvements to the system have been realised during the demonstration phase. The improved modelling chain was evaluated again with a longer reference period in summer 2002. The results are reported in detail in chapter 4.

Indicator 3: Accuracy of roadside description, noise models
Due to technical difficulties no verification of the accuracy of noise models was carried out during the verification phase. Instead, a thorough evaluation of the model results in relation to measured noise values was undertaken within the demonstration phase of the project. The results of these tests are reported in chapter 4.

Indicator 4: Testing processes of DSS interfaces
Indicator 5: Testing DSS modelling and forecast processes

Indicator 6: Testing DSS operator interface and scenario definition process

Indicator 7: Testing the functioning of the main system components and their interaction

Throughout the testing in November 2001 for indicators 4, 5, 6 and 7 (when applicable), the number of system failures, the operational time, correct data in and out and speed of the system met the success criterion. Tests were carried out under the following conditions:

- Only static offline tests were carried out
- Static and infrequently information has been installed on the database only once

Further tests for indicators 4, 5, 6c, 7 are not necessary, because the results are very good. Indicators 6a and 6b can only be tested in an online situation. This - as well as the demonstration of the dynamic processes - was performed during the demonstration phase and is reported in chapter 4.

Indicator 8: User acceptance by professional users

The HEAVEN system was presented to the professional users and the general public in November 2001, at a time when the web-site was not yet ready. This is one reason why for some questions of the questionnaires no detailed answer could be given.

In general it was stated by the professional users that the system meets the requirements as described in WP 4 in terms of traffic information and air quality modelling. In terms of traffic management it was however stated that the system seems more suited to support short term planning than long term planning and long term scenarios which demonstrate the traffic shifting through measures influencing the traffic circulation are not possible.

Concerning user friendliness of the information provided, the users stated that presentation seems OK, however no dynamic maps were provided during demonstration. The information output is rated positively.

Indicator 9: User acceptance by the general public

In general the public rated the information provided by the system as understandable. However, some improvements were requested especially in terms of background information which have been implemented during demonstration.

The input from the users was taken into account when the final version of the heaven website was produced (As outlined in chapter 4). In the evaluation phase additional workshops and interviews with professional users and the general public were carried out. These interviews have shown a positive reaction to the system. The results of these additional interviews are presented in detail in the WP 3 deliverable.

4 EVALUATION

The HEAVEN project has considered evaluation as a very important horizontal activity throughout the whole project lifetime. The evaluation was geared to establish the benefits which all stakeholders, i.e. internal and external users, operators, and content providers can gain from the developed system. In order to determine and quantify the impacts, the project performed evaluation in a rigorous and systematic way. To do so, a formal evaluation process has been established. In the first year of the project lifetime, the evaluation has been carefully planned. A comprehensive validation plan (Deliverable 3.1) and a toolbook has been developed, which further define the expected impacts, related indicators, reference cases, success criteria and the methods for measuring the indicators. During the second year, the ex-ante evaluation has been performed and in the third year the ex-post evaluation took place. Despite the fact that the HEAVEN Decision Support System (DSS) was implemented and applied at six different European cities, its evaluation process is based on commonality. The challenge to reach commonality lies in the range of technical and institutional framework conditions, in the variety of existing methods and statistical considerations, as well as in the formulation of different reference cases and success criteria across the sites.

The impacts of HEAVEN are:

Impact 1:	Enhanced description of current environmental situation
Impact 2:	Enhanced environmental scenario analysis
Impact 3:	Improved access and quality of environmental information for professional users and for public users
Impact 4:	Improved institutional co-operation
Impact 5:	Increased support of urban planning on an environmental basis

For each impact, clear assessment objectives and a series of operational indicators have been identified and described. Throughout these exercises, an effort was made to reach the highest degree of commonality in defining these key elements of evaluation.

State-of-the-art evaluation ensured that the project was able to establish the extent that HEAVEN has met its objectives, what impacts it has generated on the city level and what its European added value is. The results from the evaluation process provided important input to the definition of the business case, exploitation and marketing plans and will therefore be instrumental for decisions on the direction of any future investments of the final product. The final evaluation report (Deliverable 3.2) describes the results of the evaluation in details and clearly outlines the lessons learnt and results gained by using IST to contribute environmental protection in the area of advanced transport strategies.

This chapter concentrates on the work undertaken and results gained in the field of calibration and model sensitivity.

4.1 Technical Operation

The operation of the real time emission, rooftop and dispersion modeling started in November 2001. From May 2002 on, the results have been presented on an online information platform, which is described in detail chapter 4.3. At the beginning of the operation, some failures incurred due to incorrect data import. However, these problems were solved by the start of the demonstration phase. Since May 2002 the system is running stable.

4.2 Quality of the models

4.2.1 Air Pollution Modeling

4.2.1.1 Results of the Modeling

The set quality criteria of the modeling were already met during the verification phase. No further actions have therefore been necessary. However, after the verification phase improvements to the system have been realized, especially what concerns data import and the quality of input data.

During demonstration additional air pollution measurements have been carried out from July till November in the northern part of the Beusselstraße. The improved system has been evaluated for the period during the demonstration phase July to September in terms of model accuracy by comparing the modeled values with the hourly measured values.

In addition to this comparison of average values also more detailed investigation on model accuracy has been carried out based on the hourly times series of measurements and calculations. For PM10 and CO we calculated also series of hourly running averages over 24 h or 8h hours, respectively, which reflect the format of the limit value. Using these hourly time series the regression coefficient R^2, and the nominal difference and the absolute difference between modelled and measured values was calculated. Those discrepancies are higher than the average difference as calculated above. These calculation was also done for the relevant limit value categories: mean 24 hour values for PM 10 and mean 8 hour values for CO. The average discrepancies in % per pollutant are presented below.

In addition to this comparison of average values also more detailed investigation on model accuracy has been carried out. This more detailed investigation refers to the calculation of the regression coefficient R^2, and the calculation of the discrepancies per hour for both the nominal difference and the absolute difference. Those discrepancies are higher than the average difference as calculated above. These calculation was also done for the relevant limit value categories: mean 24 hour values for PM 10 and mean 8 hour values for CO. The average discrepancies in % per pollutant are presented below. These results are based on approximately 1800 single hourly values.

	PM 10 (1 hour)	**CO (1 hour)**	**Benzene (1 hour)**	**NO2 (1 hour)**	**PM 10 (24 hour)**	**CO (8 hour)**
Modeled Pollution	37,6 µg/m³	0,49 mg/m³	2,67 µg/m³	46,6 µg/m³	37,2 µg/m³	0,48 mg/m³
Monitored Pollution	41,9 µg/m³	0,61 mg/m³	2,58 µ/m³	56,0 µ/m³	41,4 µg/m³	0,61 mg/m³
Minimum Difference	0	0	0	0	0,2 µg/m³	0
Maximum Difference	174 µg/m³	2.3 mg/m³	4.4µg/m³	128 µg/m³	17 µg/m³	1.1 mg/m³
Correlation (R^2)	0,61	0,17	O,32	0,1	0,87	0,18
Average Difference in % (C)	-7.5%	-10%	+9,3%	-4,3%	-10,3%	-14%
Average absolute Difference in % (Delta C)	21,3%	30,0%	40,0%	40,9%	13,6%	26,0%

Tab. 3 Statistical Analysis of modelled and monitored pollution (July – September) on an hourly basis

The following figures depict the correlation between modeled and monitored data in scattered diagrams.

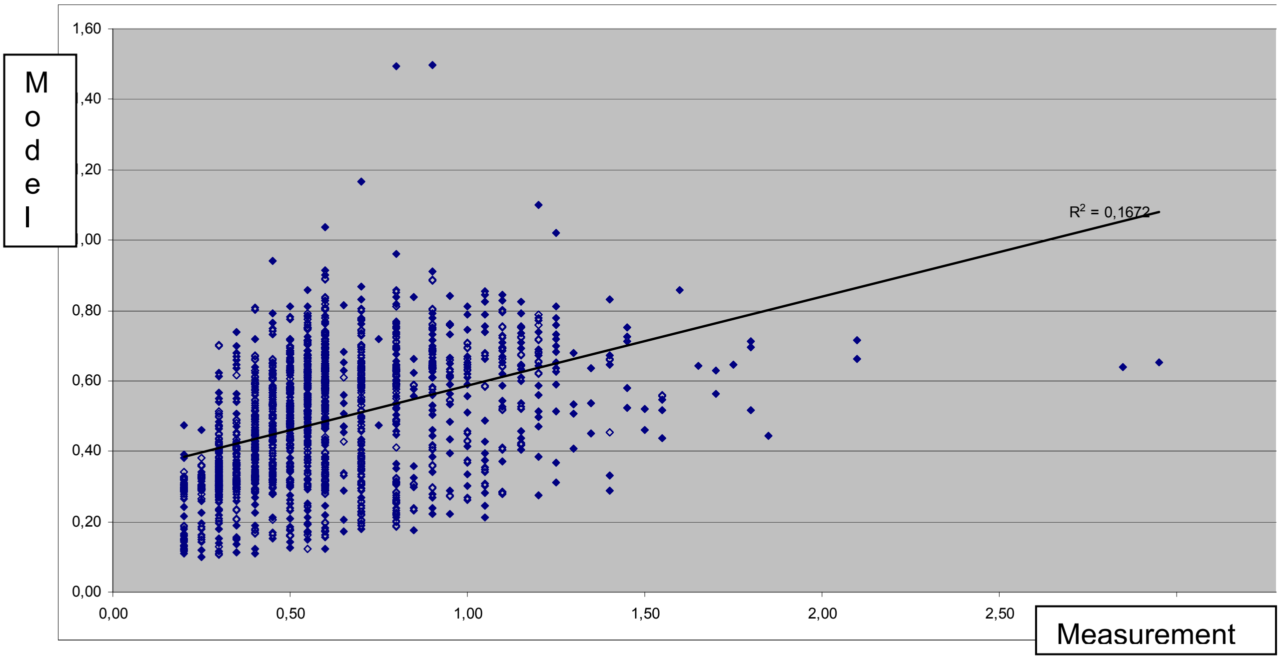


Fig. 13 Correlation of modelled and monitored data for CO (1 hour)

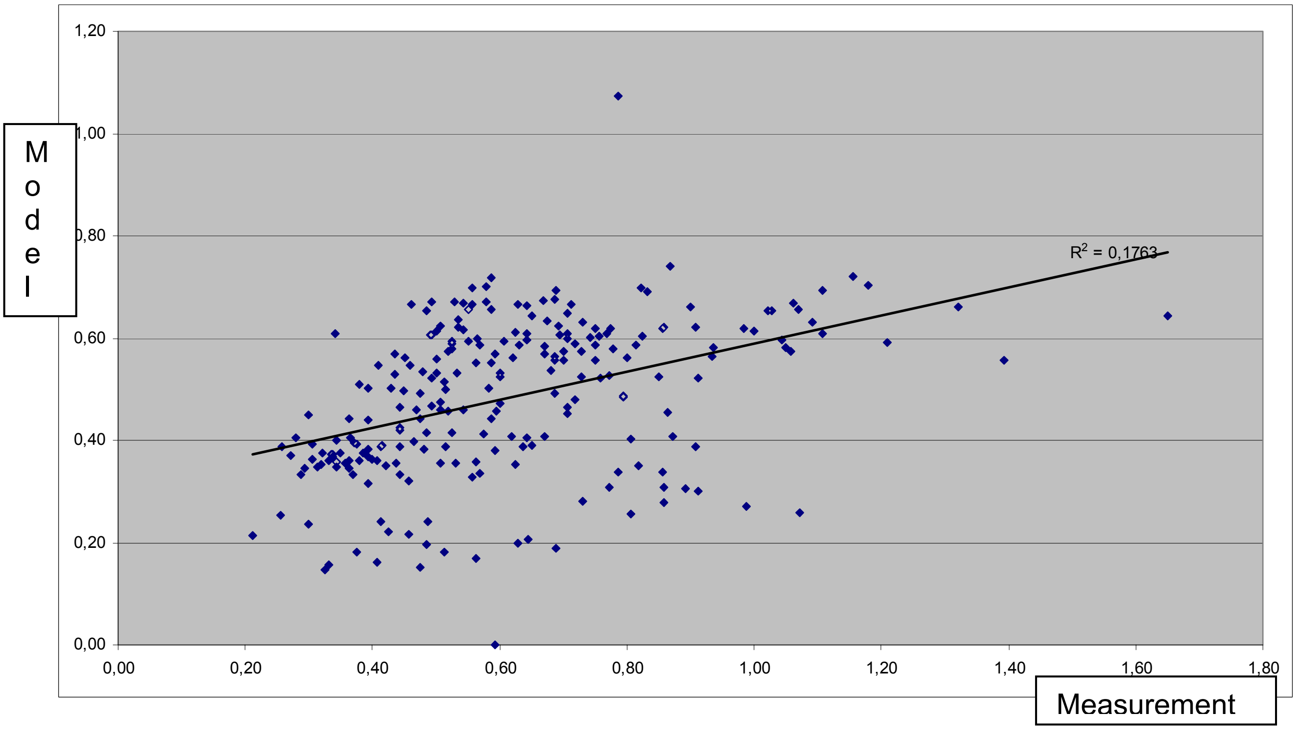


Fig. 14 Correlation of modelled and monitored data for CO (8 hour average)

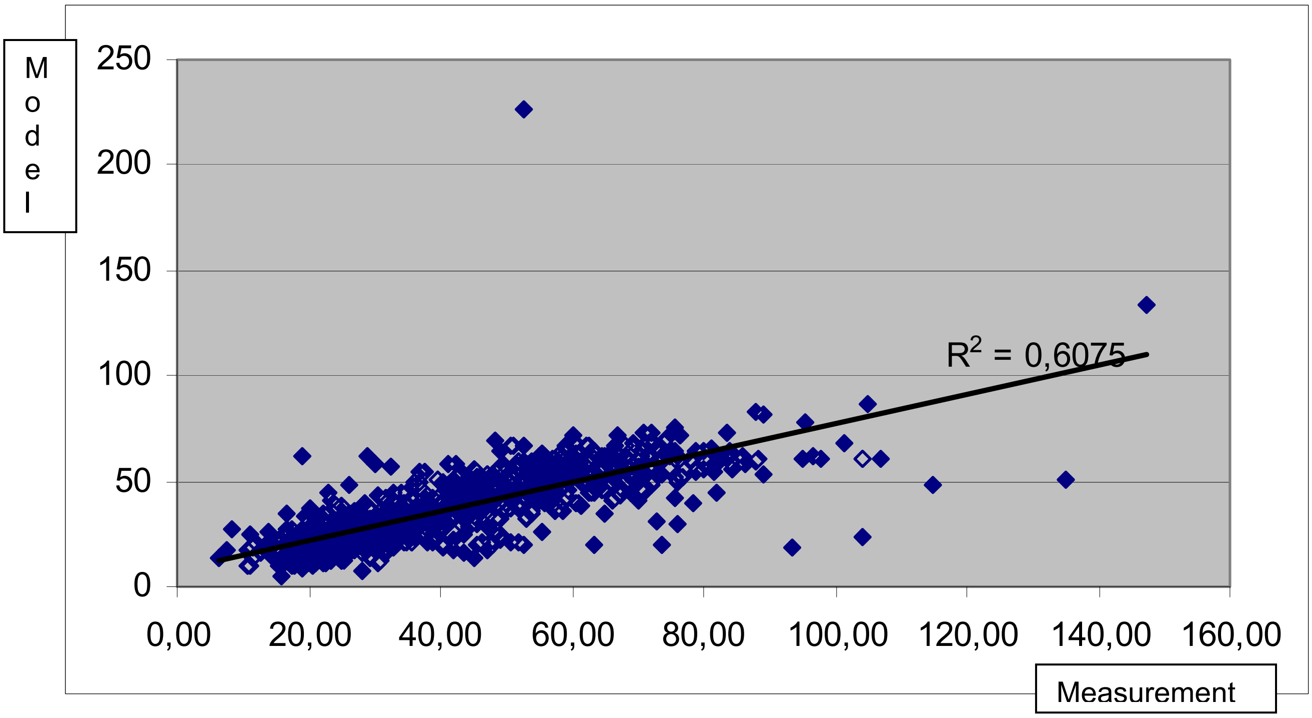


Fig. 15 Correlation of modelled and monitored data for PM 10 (1 hour)

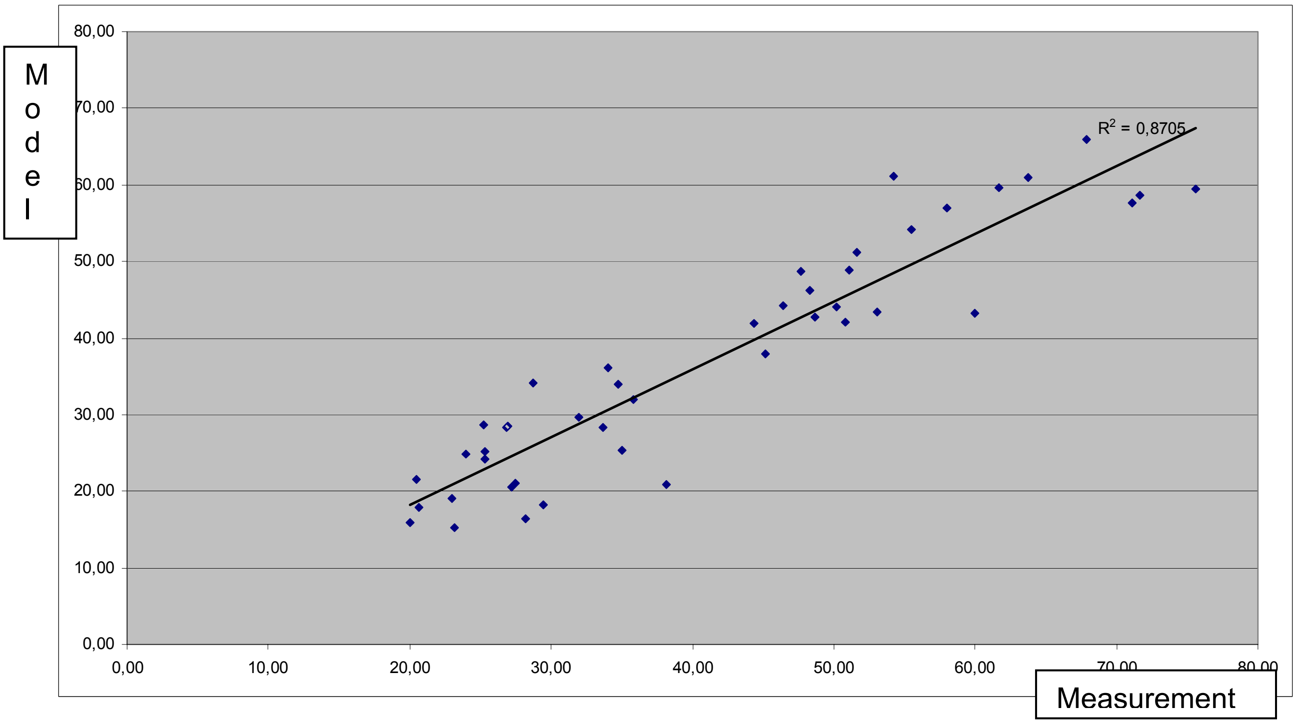


Fig. 16 Correlation of modelled and monitored data for PM 10 (24 hour average)

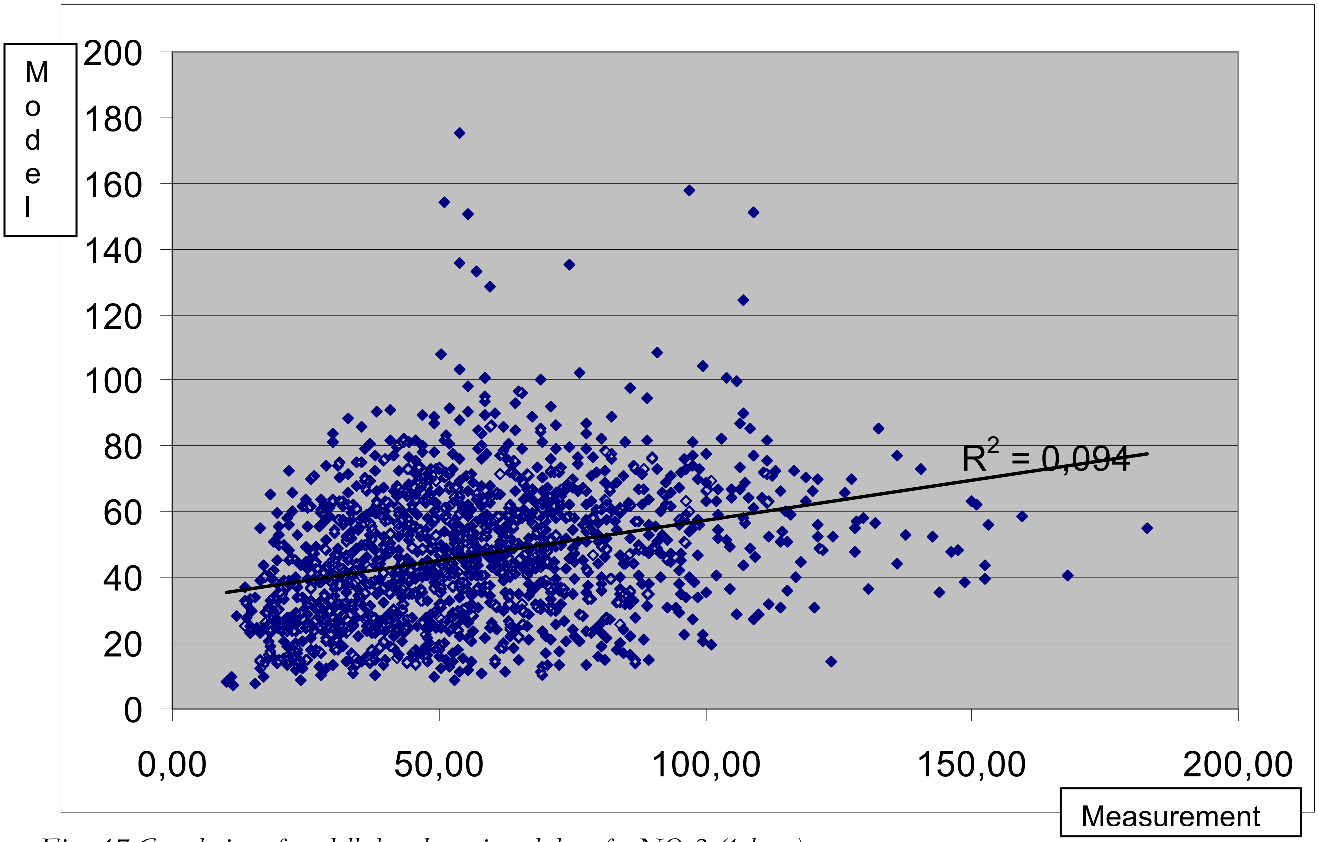


Fig. 17 Correlation of modelled and monitored data for NO 2 (1 hour)

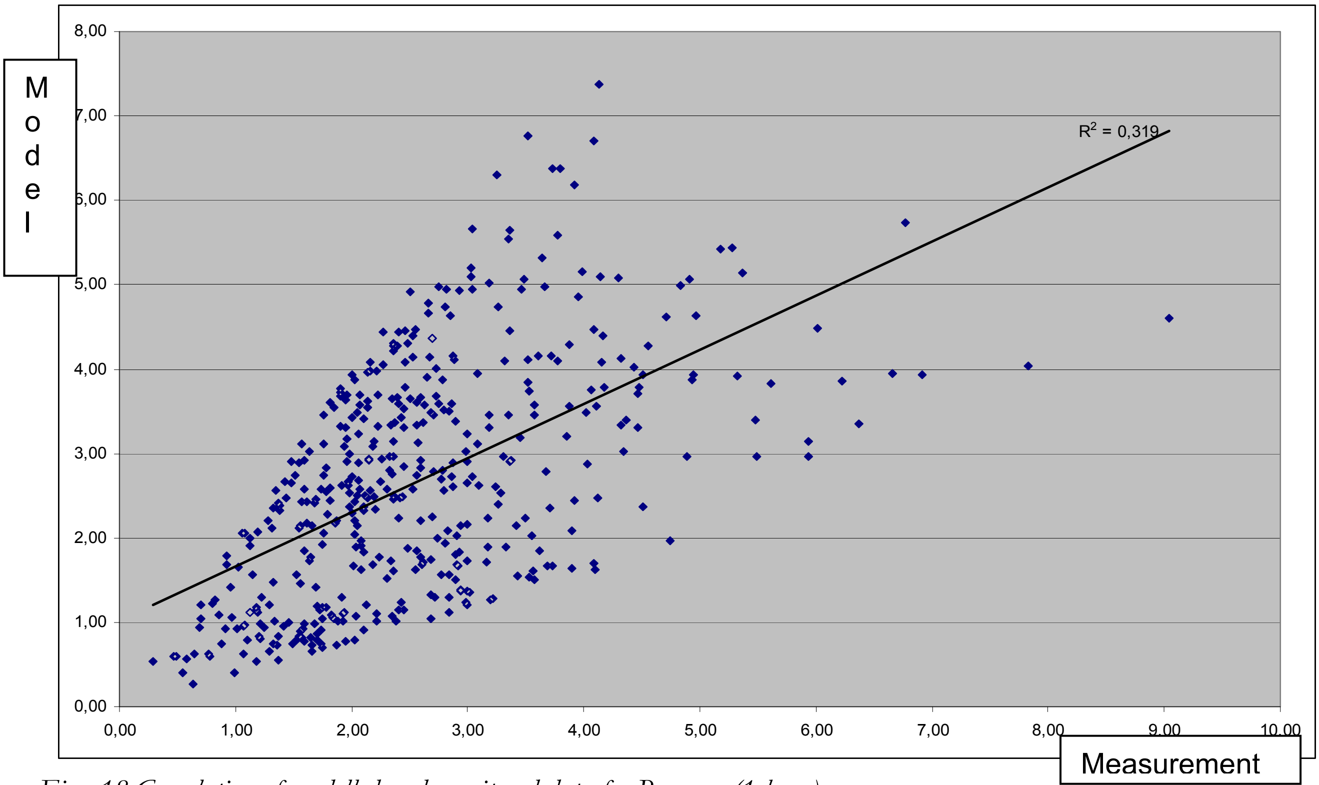


Fig. 18 Correlation of modelled and monitored data for Benzene (1 hour)

4.2.2 Noise Pollution Modeling

In WP 7 the noise model evaluation was not carried out because no noise monitoring was possible. In order to gain measurements comparable with the noise levels simulated with the IMMIS model and which complies with the common standard for noise modeling in Germany certain requirements in terms of the exact position of the microphone in relation to height above ground, distance from building facades, distance from junctions, etc have to be met. Because of the complicated environment in the Beusselstraße with narrow pavements, high demand for parking slots, building activities, etc., it turned out to be more difficult than initially expected, to find an appropriate location for monitoring where to install the measuring equipment so that it meets the above specifications. It has therefore not been possible to undertake the noise measurements during the verification period.

During the demonstration these problems have been solved. In total 4 measurements have been carried out over a period of 24 hours each, of which 2 were used for the evaluation. So, ample opportunities exist to compare the measured noise levels with those calculated by the model.

Noise measurements have been carried out at

- Beusselstraße number 65
- Height above ground: 4 metres
- distance from façade: 2 metres
- distance from mid of street: 13 metres

For the evaluation a comparison between the modeled and the monitored data was carried out. On average, the modeled values were slightly higher than the ones measured. However, the modeled values react better to changes in traffic volume than the measured values.

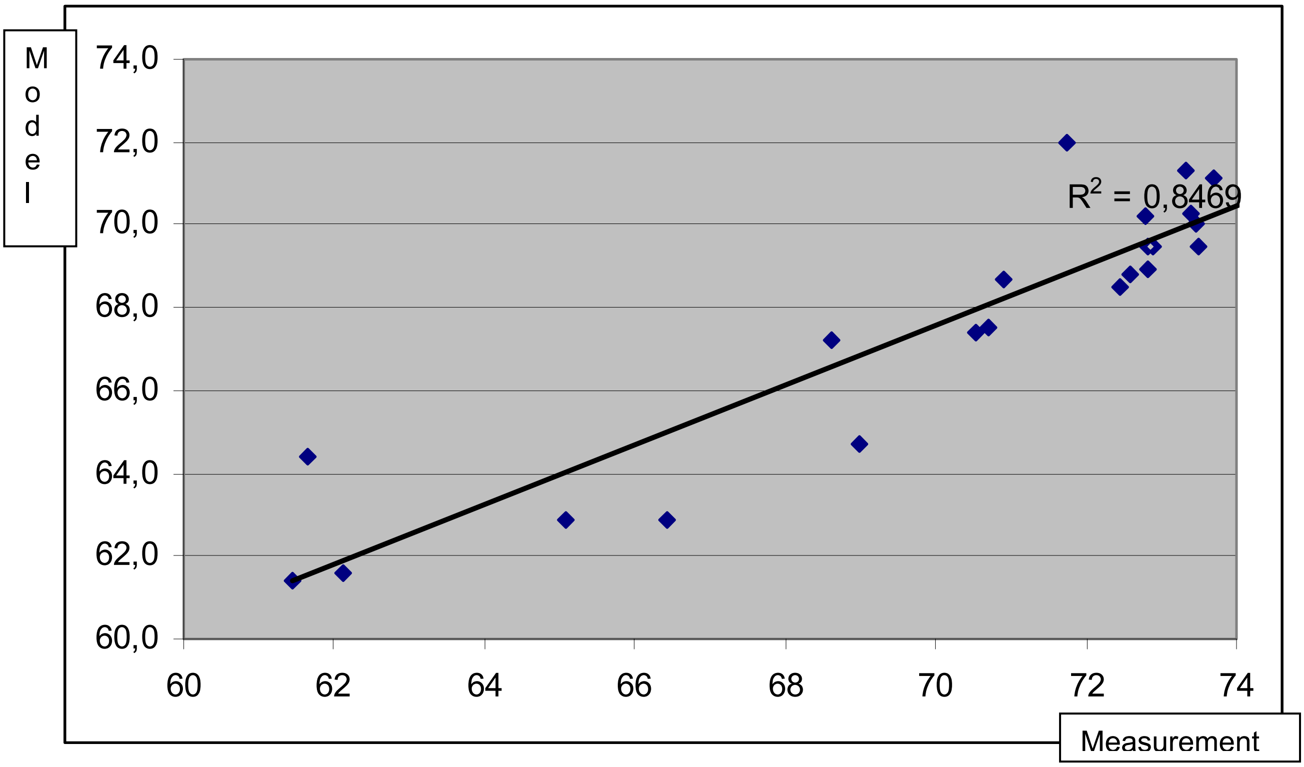


Fig. 19 Regression analysis: modeled and monitored noise data

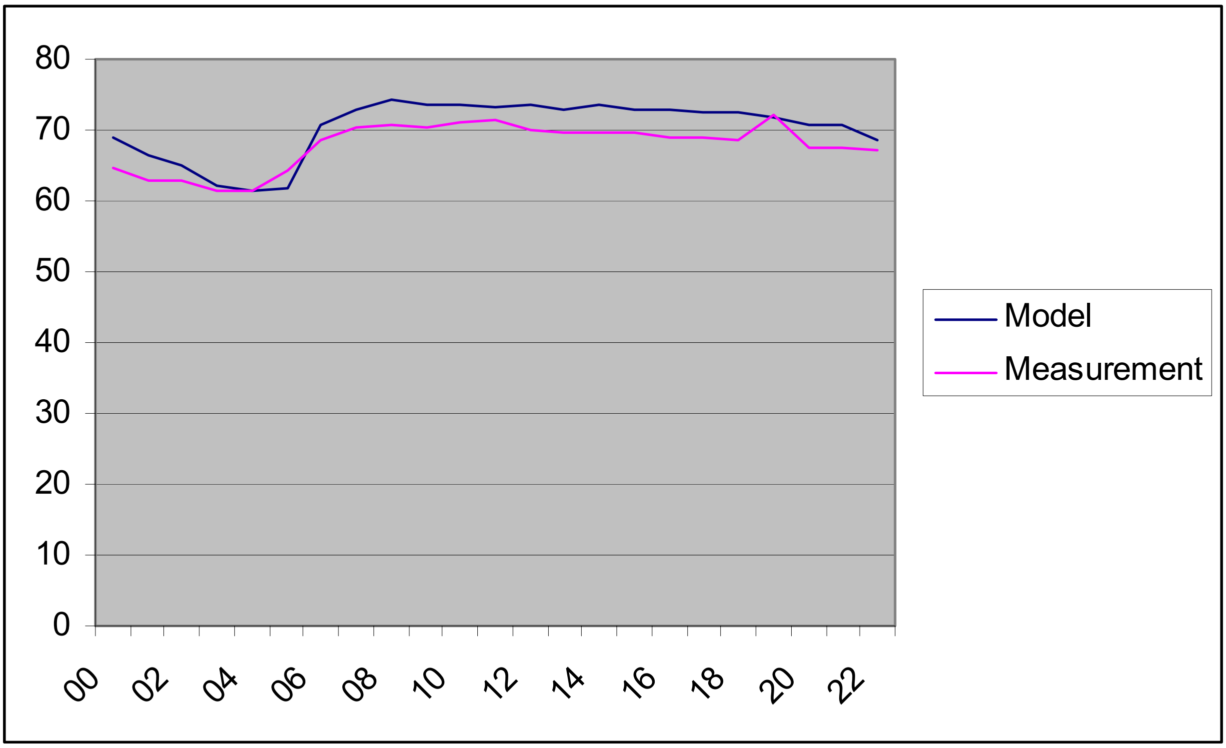


Fig. 20 Comparison of modelled and measured noise data over the day

4.2.3 Sensitivity of models

In the framework of WP3 Evaluation the HEAVEN project agreed to run a number of scenarios which are common to all project cities. These scenarios are quite simple “black and white” scenarios involving some basic crucial parameters with no direct link to the specific situation at each site. These scenarios have the aim to investigate the sensitivity of the applied model chain towards parameters such as fleet composition, emission standards, traffic volume and speed and can give decision makers an indication about the bandwith of possible emission reductions. In addition the scenarios are used to quantify the time which is needed to run scenarios before and after HEAVEN.

The common HEAVEN scenarios assume the following:

- **20 % speed reduction** : A homogeneous speed reduction of 20 % for the whole running fleet (passenger cars, light duty vehicles, heavy duty vehicles, buses, mopeds, motorcycles)
- **No heavy duty vehicles** : Vehicle fleet without heavy duty vehicles (> 3.5t). Heavy duty vehicles will not be reallocated among the other vehicle categories
- **No two-wheelers** : Vehicle fleet without mopeds and motorcycles. Two wheelers will not be reallocated among the other vehicle categories
- **No traffic** : Scenario without traffic related emissions
- **Euro IV legislation** : The scenario consists in anticipating for each type of vehicle fleet (passenger cars, light duty vehicles etc.) the implementation of one of the most advanced legislations (Euro IV) related to the emission factors.

These scenarios were calculated in an offline mode using the models used in Berlin’s online modeling. Berlin decided not to run the scenario without two wheelers since two wheelers are not significant in Berlin.

These tests have been carried out for the demonstration area Beusselstraße for one hour on Sept. 19., 2002, 6.00 – 7.00 o’clock, comparing the roadside pollution in the Status Quo situation to the pollution concentration when changes in traffic behavior have incurred as described in the scenarios. All other input parameters such as background pollution and meteorological conditions remained unchanged.

In Berlin the models reacted in a reasonable way to the changes of the traffic input data. In the following table the results of the scenarios are presented.

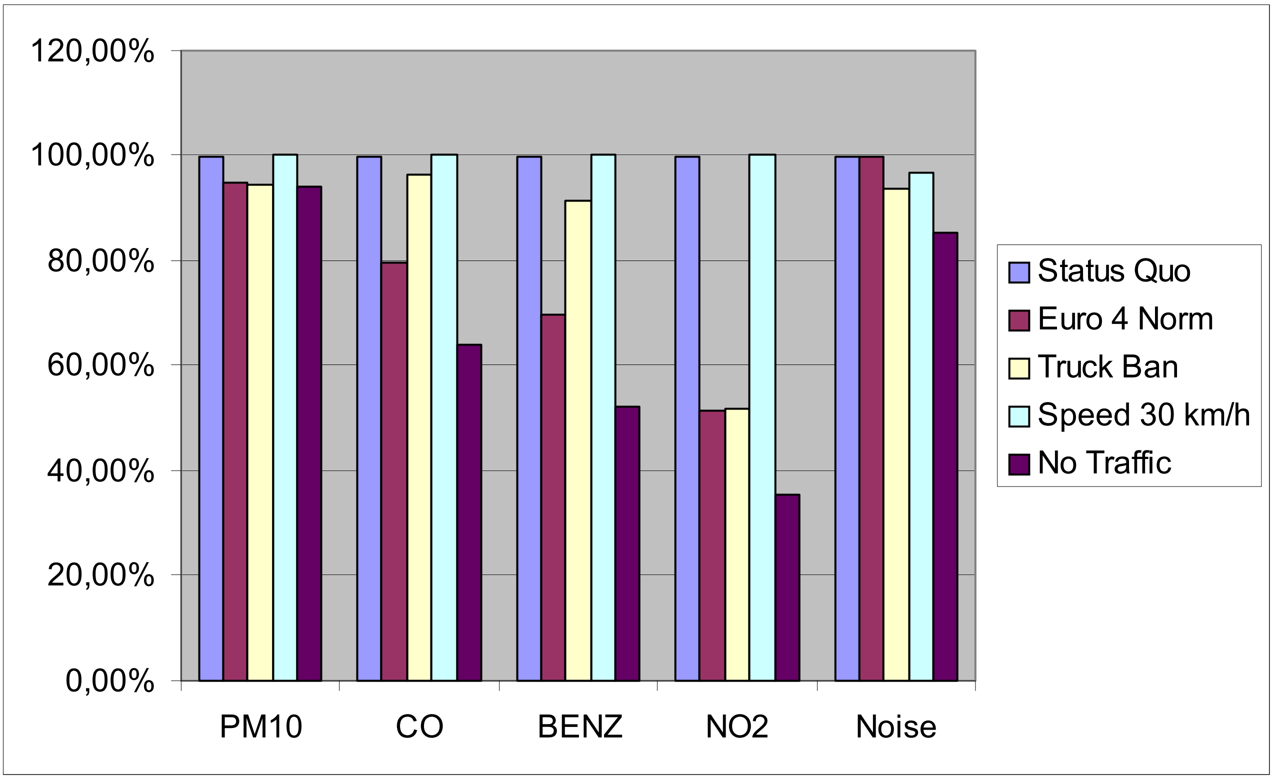
	PM 10	CO	Benzene	NO2	Noise
Status Quo	46,41 µg/m³	0,66 mg/m³	3,5 µg/m³	58 µg/m³	74,92 dBA
No Traffic	43,68 µg/m³	0,41 µg/m³	1,8 µg/m³	21 µg/m³	63,89 dBA
Truck Ban	43,92 µg/m³	0,63 mg/m³	3,2 µg/m³	30 µg/m³	70,11 dBA
Speed 30 km/h	46,42 µg/m³	0,66 mg/m³	3,5 µg/m³	58 µg/m³	72,50 dBA
Euro 4Norm	43,95 µg/m³	0,52 mg/m³	2,4 µg/m³	30 µg/m³	74,92 dBA

Tab. 5 Results of the sensitivity tests (absolute values)

When introducing a truck ban, the HEAVEN model calculated a significant reduction in NO2 pollution of 48% for the Beusselstraße. Also a significant reduction of 4.8 dBA was calculated. However, reductions in Benzene and CO are not that significant because trucks do not account for a great share of these emissions. The impact on PM roadside pollution is not as significant as expected, but this is probably due to a very high background concentration at this particular day. When all vehicles are replaced by Euro 4 standard vehicles, a reduction of NO2 pollution of also 48% could be achieved. Benzene pollution could be reduced by 30% and CO by 20%. Noise pollution will not be affected as the number of vehicles remain constant.

The introduction of a speed limit shows no effects on air pollution because speed is not an input factor for the IMMIS air pollution models. Instead, noise effects of a speed reduction can be calculated with the HEAVEN system. Introducing a speed limit would lead to a reduction of 2.5 dBA provided the limit of 30 km/h is being followed.

The greatest effect can of course be expected from a total traffic ban inside the demonstration area, then only background pollution remains and pollution can be reduced by up to 65% for NO2.



Tab. 6 Results of the sensitivity tests (relative values, Status Quo = 100%)

5 THE HEAVEN DSS DURING THE DEMONSTRATION PHASE

5.1 Summary of air pollution situation in Berlin

Over the last decade, in particular following the re-unification of Germany and Berlin, a remarkable progress has been achieved in controlling air pollution. Winter smog has become a phenomenon of the past. Most tangible progress has taken place in industry, small business and combustion, due to more stringent emission limit values in EU-legislation. Despite tightened emission standards for vehicles and requirements for cleaner fuels pollution from traffic has become more predominant.

In the meanwhile the revised air quality standards adopted by the European Community pose a new challenge for air quality management in Berlin. The table below gives a summary assessment of the air quality in Berlin with indications where additional efforts are deemed necessary:

pollutant	**most important pollution sources**	**situation in Berlin**	**need for action**	**score**
sulphur dioxide	imported sulphur dioxide, house heating (singel stoves), power plants, industry, by now traffic (especially Diesel cars)	no problem anymore	-	☺
carbon monoxide	traffic, single stove heating	no problem anymore	-	☺
benzene	traffic (gasoline cars)	**diminishing problem**: excess of the EU-limit value for 2010 in some major roads with decreasing trend	current measures deemed sufficient to attain limit values	😐
nitrogen dioxide	traffic, imported NOx, house heating, industry & large combustion plants	**serious problem:** excess of the annual EU-limit value for 2010 at all traffic-related monitoring sites; excess of the margin of tolerance	additional measures needed in Berlin and EU-wide, focused on the transport sector	☹
particulate matter	traffic, domestic sector (incl. house heating), imported secondary particulate matter, industry, construction, biogenic material (e.g. pollen)	**severe problem:** - numerous exceedances of the 24h EU-limt value for 2005 at traffic spots - widespread excess of the indicative limit value for 2010	additional measures in several sectors in Berlin and on national/EU level necessary	☹
ozone	ozone is barely emitted; is formed of NOx and hydro-carbons; sources: traffic, combustion plants, industry, domestic sector; more than one third of the ozone levels stem from natural sources, only a fraction is of local origin	**serious problem:** Excess of the future European target values and long-term objectives in residential areas and at the periphery of the city	additional measures on national and EU level necessary	☹

Tab. 7 Air Pollution Situation in Berlin

As an illustrative example for widespread exceedances of a European air quality standard, the figure below depicts the locations in the city, where NO2-concentration are measured and where the annual mean levels in 2001 exceeded the NO2- limit value.

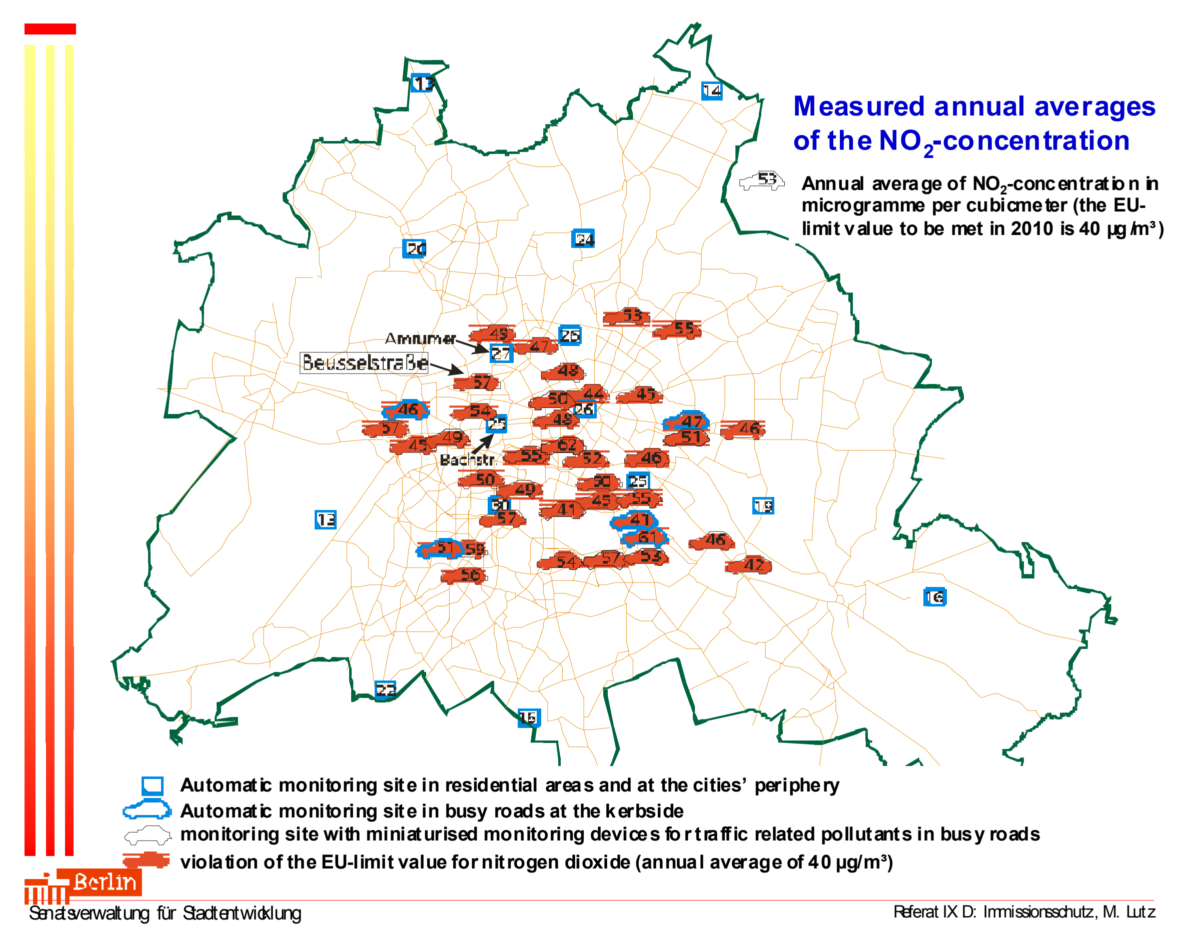


Fig. 21 NO2-concentration measurement stations in Berlin

5.2 Berlin's Objectives of the demonstration phase

The new EU Directives on air quality demand enhanced activities from the cities in terms of environmental monitoring, information provision to the public and setting up of action plans in order to reduce pollution, so that the new limit values will be met. In Berlin the specific focus of the Senatsverwaltung für Stadtentwicklung is to develop and implement strategies which will reduce air pollution of particulate matter (PM10) and nitrogen dioxide in the city in order to meet the limit values which must be attained by the year 2005 and 2010, respectively. Given the predominant share of the traffic emissions in the air pollution in the city measures to reduce air pollution will have to address especially the transport sector. Moreover, in anticipation of the forthcoming EU Directive on noise, work has just started to devise a noise abatement plan, thereby addressing the growing public attention of traffic noise as a major factor which badly effects the quality of life in the city.

In participating in HEAVEN Berlin aims at reducing noise and air pollution levels at hot spots - among other means, like technical control of vehicle exhaust emissions - by a more efficient management of traffic. In the framework of the project a system is developed and implemented in a demonstration area which allows on-line calculation of air and noise pollution in street canyons based on real-time traffic data. In using this information the objective is to modify traffic flows in a way that emissions would be minimised where exceedances of certain pollution levels occur. With such an approach it is intended to avoid traffic restrictions as the prevailing means to meet the EU limit values.

Within the demonstration phase, different Transport Demand Management Strategies (TDMS) to reduce pollution and avoid exceedances were developed, tested and evaluated. In the HEAVEN project, different measures were analysed and tested regarding their effectiveness to reduce pollution in the demonstration area "Beusselstrasse" , an area in Berlin characterised by heavy truck traffic. These measures consists of:

- introduction of a speed limit of 30km/h;
- introduction of a truck ban.

In addition, to the test of the above mentioned management strategies also long term scenarios were calculated within the HEAVEN project. Those scenarios refer to a ban of Diesel vehicles from Berlin's inner city which do not fulfil the Euro 3 norm for the year 2005 and which do not fulfil the Euro 4 norm in 2010.

The results of these tests will be of high significance for the future transport policy in Berlin. In some areas it will be difficult to meet future environmental standards, especially the limit values for PM10 and NO2. The TDMS to be tested in Berlin in the framework of the HEAVEN project (Speed limit, truck bans and rerouting) will become a reference case for similar measures to be introduced in other parts of the city. Combined with the HEAVEN system it will then be possible to develop optimal, individual transport strategies for different areas. Those strategies can consist of long term measures related to technical emission control or traffic planning, but also of dynamic traffic management measures which are introduced when certain limit values are exceeded. The modelling tools developed within HEAVEN are to facilitate the assessment of the impact of both type of strategies.

Next to testing different TDMS in order to improve knowledge about the effects of such measures on air and noise pollution, also two other important objectives are related to the Berlin demonstration:

- Development of an online Environmental Monitoring and Modelling system;
- Development of an environmental information platform accessible via the internet.

Also these objectives are in line with the EU directives where the information for the public on the actual environmental situation is an important topic. The results of the Berlin demonstration are reported in this chapter. The results refer to:

- The performance of the environmental modelling system in terms of both, the technical performance as well as the modelling results;
- The information platform which is accessible via the internet since spring 2002;
- The offline modelling chain and results of the modelling of TDMS in the Beusselstraße ;
- The calculation of long term scenarios for the ban of Diesel vehicles which do not fulfil Euro 3 (2005) and Euro 4 (2010) standards.
- An evaluation of the real measured effects of the TDMS implemented in the demonstration area on traffic and air pollution.

5.3 Information platform

The HEAVEN information platform has been available since April 2002 and is accessible via internet: http://heaven.ivu.de. However, access to the online pollution data has been restricted to professional users during demonstration. This was done because the accuracy of the results was not fully tested at the beginning of demonstration phase and it was decided not to confuse the general public by not 100% approved data.

In the following the general structure of the information platform and the available data is presented.

Start page

A general presentation of the project and the structure of the information platform is given

Fig. 22 HEAVEN Information Platform Start Page

Presentation of online modelling results

In the restricted section the modelled near real time dispersion data is presented. This data is presented on static maps where the average annual pollution (based on traffic data from 1998) is presented. In total 6 different maps are accessible: for traffic, noise and the following pollutants:

- PM 10
- CO
- NO2
- Benzene

The road segments for which near real time pollution data is available are marked by a red dot on the maps. At the beginning of the demonstration phase online data was only available for the demonstration area Beusselstraße. Additional street segments – where online traffic data is available – was added to the online modelling system at the end of the demonstration phase in November 2002.

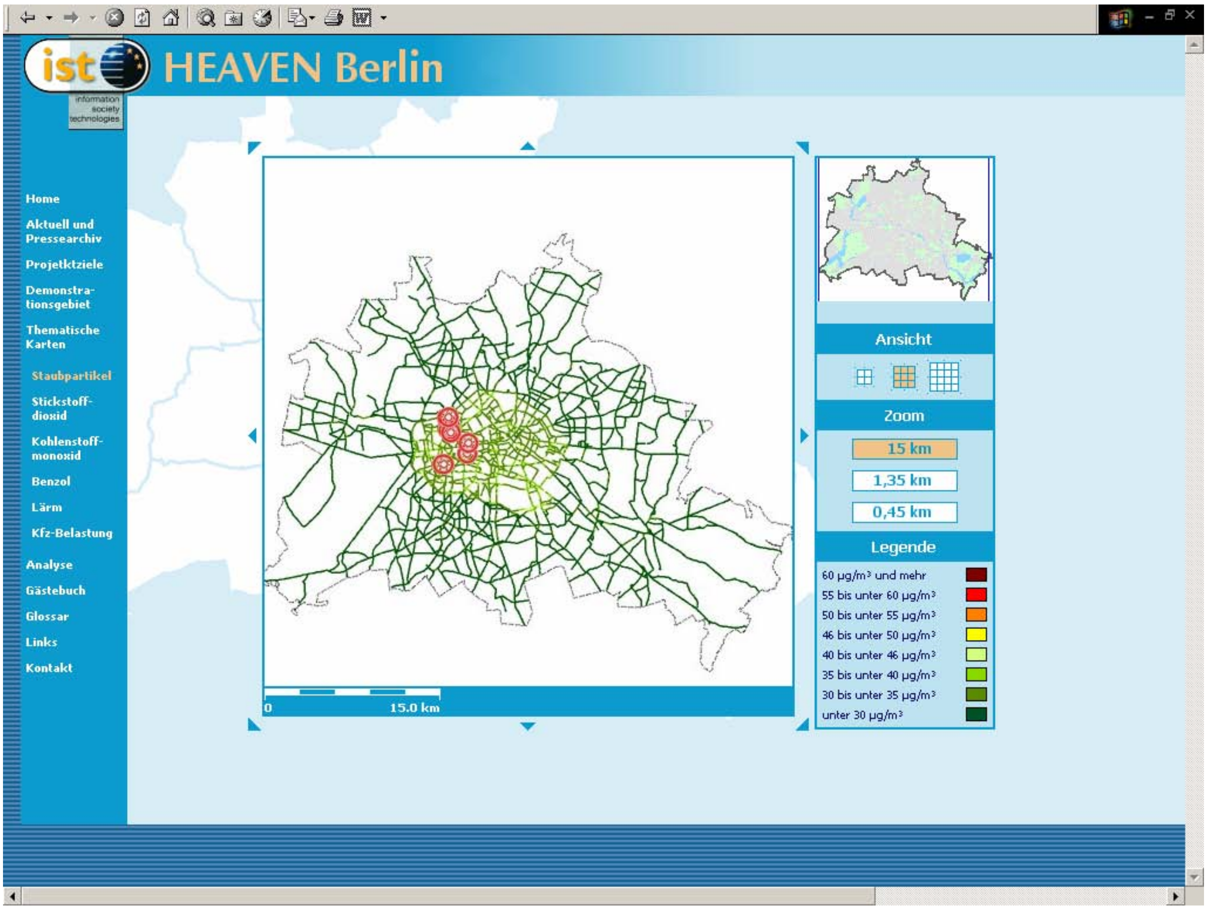


Fig. 23 HEVEN Information Platform: Monitored Sites

Different zoom functions are available, which allow the user to navigate on the maps and investigate the situation on street level.

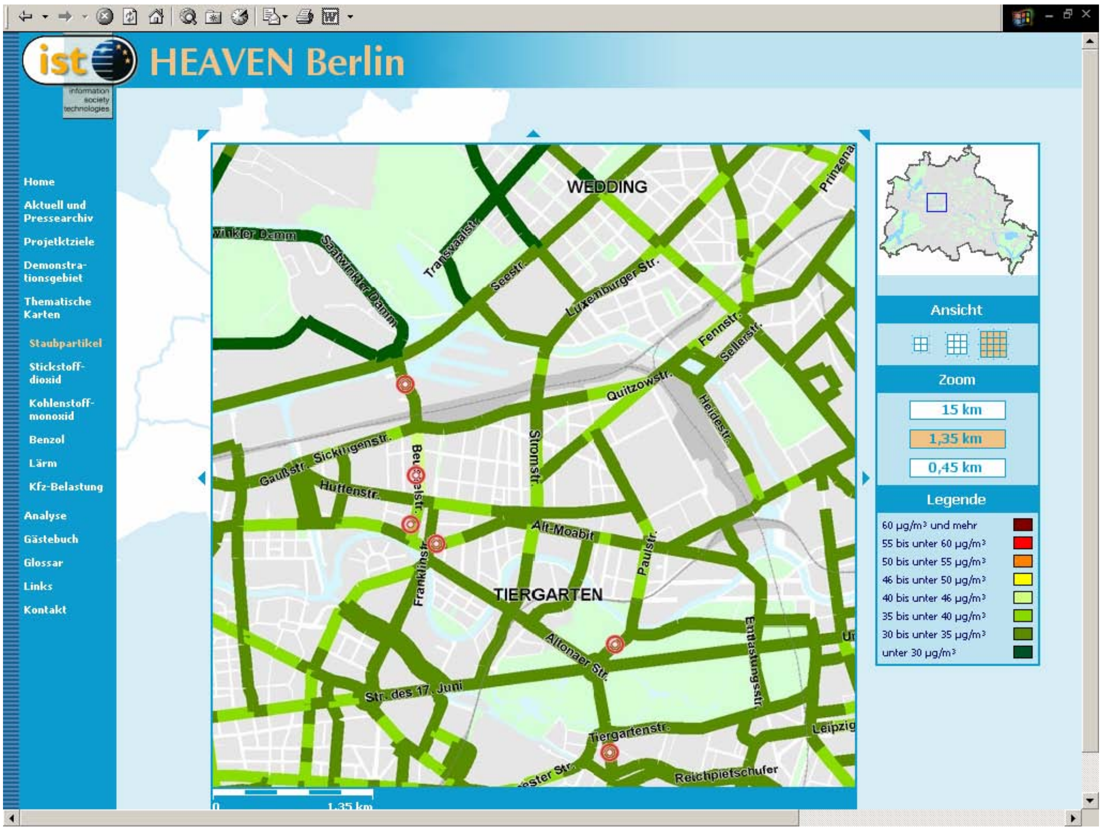


Fig. 24 HEAVEN Information Platform: Zoom

By clicking on the dots the near real time pollution situation for the selected street segment is presented on a table.

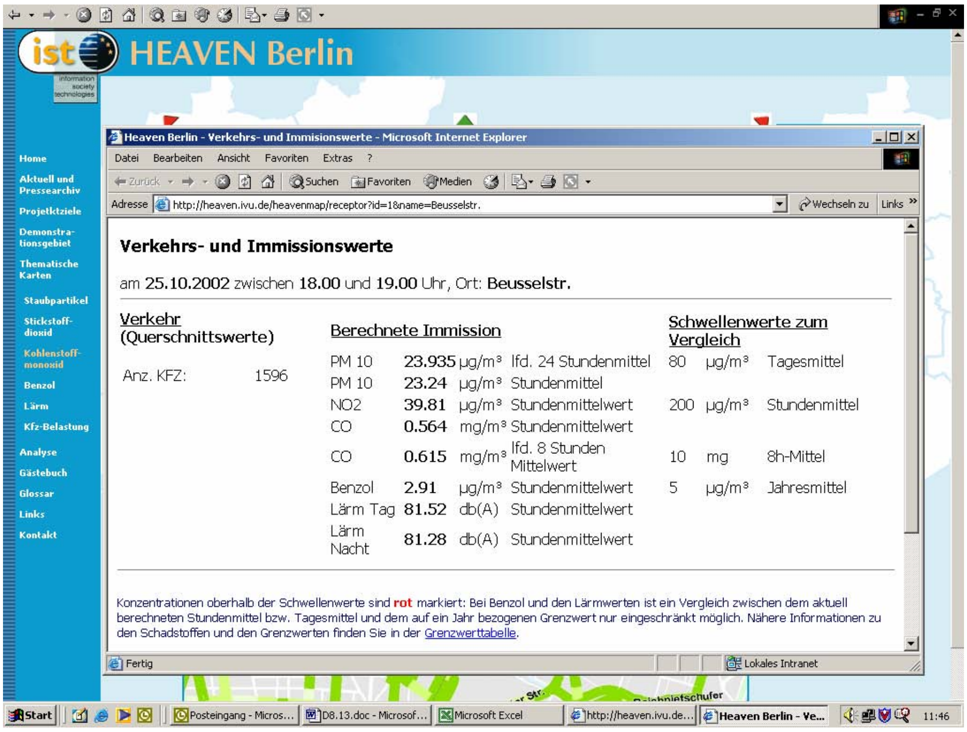


Fig. 25 HEAVEN Information Platform: Presentation of online modelling results

Via this interface also average, minimum and maximum values for the last week, as well as for the current month and year can be retrieved.

Fig. 26 HEAVEN Information Platform: Presentation of general statistics

Database Access

In addition, a database access is granted to the professional users, where all in- and output data stored in the HEAVEN database can be accessed. This consists especially of roadside pollution concentration, but also on number of limit value exceeding, traffic data, etc. Data can be retrieved for one specific hour or for a time period which can be chosen individually. For this function, a specific request form was created which is also available via the internet.

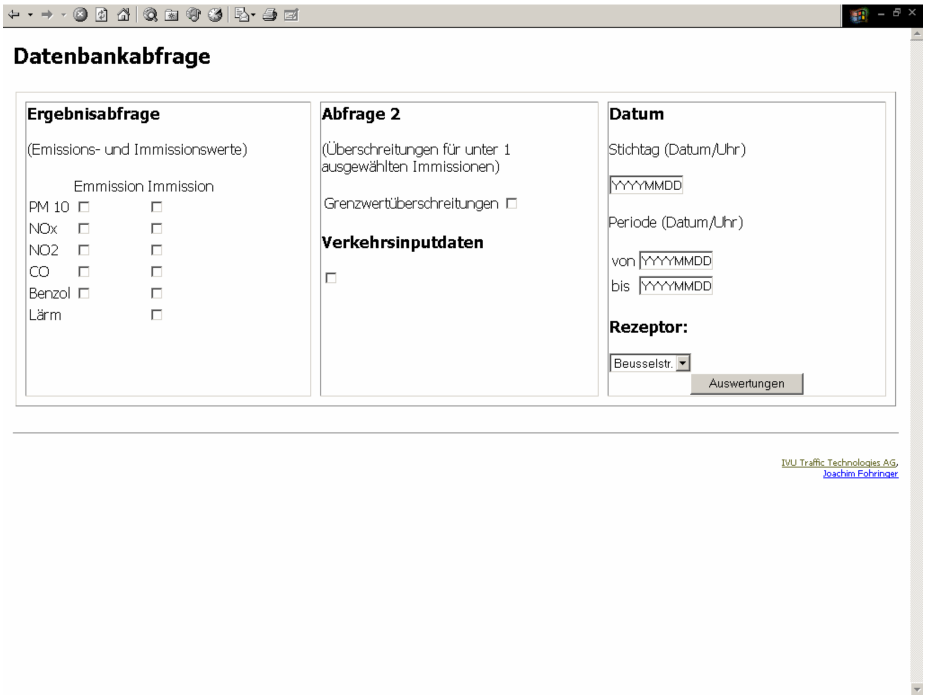
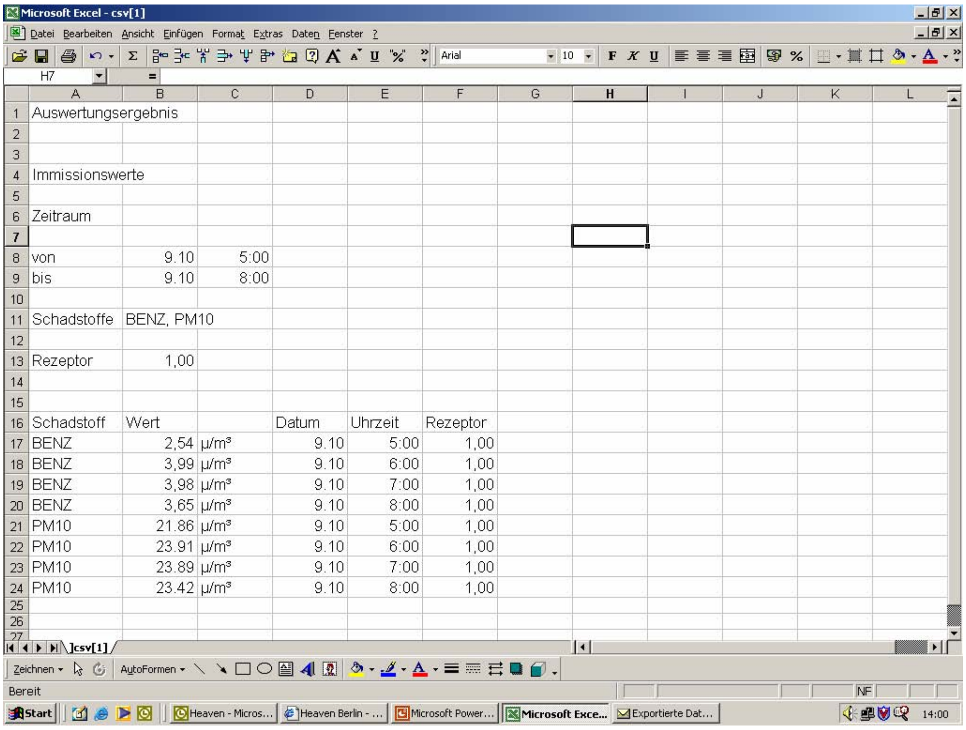


Fig. 27 HEAVEN Information Platform: Interface to retrieve statistical data

Such a request is than processed in the HEAVEN database and a file containing the requested information is send back to the user.



Auswertungsergebnis					
Immissionswerte					
Zeitraum					
von	9.10	5:00			
bis	9.10	8:00			
Schadstoffe	BENZ, PM10				
Rezeptor	1,00				
Schadstoff	Wert		Datum	Uhrzeit	Rezeptor
BENZ	2,54	µ/m³	9.10	5:00	1,00
BENZ	3,99	µ/m³	9.10	6:00	1,00
BENZ	3,98	µ/m³	9.10	7:00	1,00
BENZ	3,65	µ/m³	9.10	8:00	1,00
PM10	21.86	µ/m³	9.10	5:00	1,00
PM10	23.91	µ/m³	9.10	6:00	1,00
PM10	23.89	µ/m³	9.10	7:00	1,00
PM10	23.42	µ/m³	9.10	8:00	1,00

Fig. 28 HEAVEN Information Platform: Results from a database request

Demonstration area

In addition to the near real time roadside pollution presentation and the database access, also general information is provided at the HEAVEN information platform. This consists in particular of information on the Beusselstraße and on the effects the TDMS had in terms of traffic and environment.

User input

The users or invited to give their comments to the HEAVEN information platform. Either by directly contacting one of the project representatives or by leaving a message in a public guest book.

Additional information

Also additional information especially on environmental topics are available. This consists in particular of information related to air pollutants and to legislative issues such as limit values for pollutants, etc.

5.4 Traffic Demand Management Strategies

5.4.1 Ex ante Modeling of TDMS

In a first step, the expected effects of Traffic Demand Management Strategies (TDMS) were modelled for the demonstration area Beusselstraße in Berlin. These TDMS were:

- Introduction of a speed limit of 30 km/h in the Beusselstraße
- Implementation of a truck ban in the Beusselstraße

The effects of these different measures were modelled regarding their impact on the environment and on the number of people affected.

Introduction of a speed limit of 30 km/h:
In this case a reduction of the allowed speed for all kinds of vehicles in the Beusselstraße was modelled. In terms of traffic such a measure will not only lead to a speed reduction but also to some reallocation effects, as some vehicles will look for a faster route. In total this measure can lead to a reduction in noise pollution by 3.5 dB(A) and to a reduction in air pollution by 3 - 5% in the Beusselstraße. However, due to the reallocation effects the NO2 and Soot pollution will increase on some side streets by 2 - 3%. In total, the positive effects definitely outweigh the negative effects in the side street and the number of positively affected people will be much higher as those affected negatively.

Implementation of a truck ban
By this measure all trucks >3.5 t shall be forced to use other routes (preferably the motorway) and only those trucks with their source or destination in the Beusselstraße are allowed to enter the street. It is expected to achieve a reduction of trucks by approx. 1,100 trucks/workday in the Beusselstraße, whereas other streets will face a slight increase. The expected traffc shifts are depicted in the following figure.

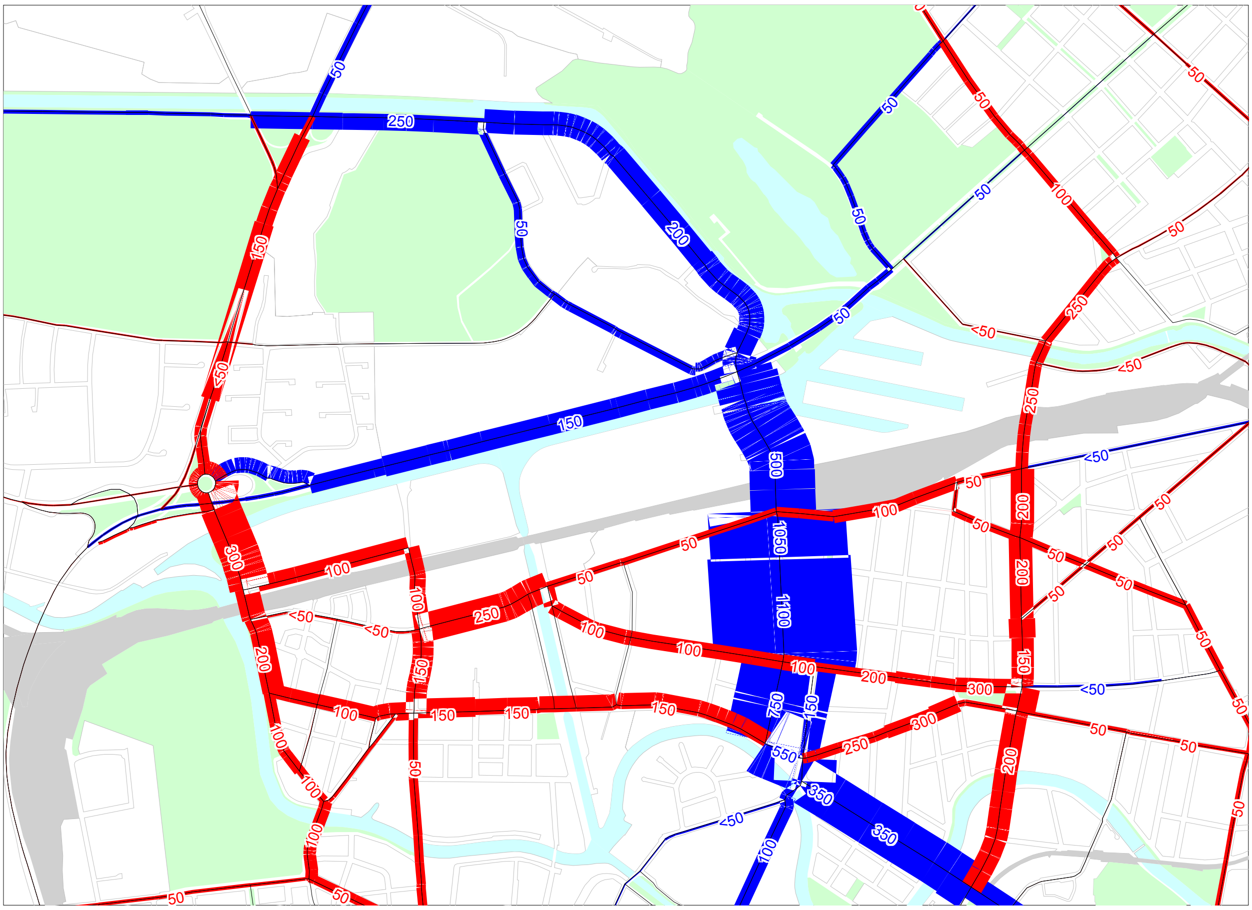


Fig. 1 Reallocation effects of a truck ban

From an environmental perspective noise pollution in the Beusselstraße can be reduced by approx. 2.5 dB(A) during the day and by 2 dB(A) at night. Air pollution can be reduced by up to 11 - 13%. Negative effects at side streets can also be encountered, but these increases will only add up to approx. 2 - 4% and fewer people are affected negatively than positively.

Summary

Traffic as well as air/noise pollution in the Beusselstraße can be significantly reduced when the described measures are implemented. These measures are therefore suited to help the city to meet the new environmental threshold values. The reductions expected from these measures and from a combination of these measures are depicted in the following tables. In these offline scenario calculations only the pollutants PM10, NO2 and Soot as well as noise were calculated. This was due to the fact, that these are the critical pollutants in the Beusselstraße, while Benzene and CO are far below threshold values. For a more detailed description of the modelled results please refer to D 8.3.

Reduction Air Pollution (in %)

	Truck Ban	Speed 30	Combi
Soot	- 13,0 %	- 4,4%	- 15,6 %
PM 10	- 11,4 %	- 3,4 %	- 13,1 %
NO2	- 13,0 %	- 4,2%	- 16,3 %

Reduction Noise Pollution (in dB(A))

	Truck Ban	Speed 30	Combi
Noise day	- 2,6 dB(A)	- 3,5 dB(A)	- 5,7 dB(A)
Noise night	- 2,1 dB(A)	- 3,5 dB(A)	- 5,3 dB(A)

Tab. 8 Calculated Air and Noise Pollution reductions in an ex ante analysis

However, due the reallocation effects, some adjacent streets will face an increase in traffic and in air/noise pollution. These increases will be lower than the reductions in the Beusselstraße and the number of people negatively affected will also be lower than the number of people who will face an improvement in air quality.

5.4.2 Implemented TDMS and their effects

In the previous chapter the modeled environmental effects were described. Thus these results refer to offline modeling before the TDMS were implemented and they only describe the expected effects. In this chapter "real life" traffic and environmental effects which were monitored while the TDMS were in force are described.

5.4.2.1 Introduction

In the framework of the demonstration project the following TDMS were implemented:

- Speed reduction to 30 m/h from 01.07.2002 – 27.08.2002
- Truck ban from 26.08.2002 – 15.09.2002

In the initial phase of the project it was also planned to modify the signaling in the demonstration area in order to optimize dynamically traffic flows coming into the demonstration area. Due to some technical problems it was not possible to implement this TDMS to its full extent. Instead, the signaling inside the demonstration area was changed during the phase of the speed reduction in order to allow a steady traffic flow inside the Beusselstraße when traveling with a speed of 30 km/h.

The TDMS where implemented in the Beusselstraße between Kaiserin Augusta Allee and Sickingenstraße (for details on the demonstration area see fig. 31). However, the analysis in this chapter concentrates on the effects on the northern part of the demonstration area (Turmstraße – Sickingenstraße) as more reliable and comparable results were achieved in this part. This is due to the fact that speed measurements in the southern part had to be carried out close to traffic signals. In addition, construction works in the southern part were carried out which lead to restrictions in the use of traffic lanes. These construction works also had a direct impact on the roadside pollution which makes it hard to calculate the environmental impacts of the TDMS in this area.

The reference period for comparing the traffic and environmental situation was the time after the end of the tests until Mid November (16.09. – 11.11.). In addition, traffic volumes in the months of May and June were used to compare the traffic situation after and before the implementation of the TDMS. This was done in order to evaluate if the TDMS had a long term influence on the traffic behavior.

5.4.2.2 Evaluation of TDMS

5.4.2.2.1 Speed Limit

In the period 01.07.2002 - 26.08.2002 a speed limit of 30 km/h was introduced in the Beusselstraße between Augusta Allee and Siemensstraße. In parallel, this speed limit was also introduced in a adjacent street Gotzkowskystraße in order to avoid a shift of traffic to this street. On August 21, speed measurements were carried out at No. 66 in the Beusselstraße in between the junctions (traffic signals) Beusselstr. – Turmstr and Beusselstr. – Wittstocker Str..

Traffic Impacts

Average speed was reduced by 10% in the period during the speed limit. This speed reduction was achieved despite the fact that the speed limit was in force during the summer holidays when in the Beusselstraße 20% less traffic was detected than in the reference periods in June and September/October. It can be assumed that this better traffic flow would have lead to an even higher average speed than in the reference periods if no speed limit had been introduced.

Nevertheless, especially in the southern direction the average speed was well above the allowed limit and reached 40 km/h. In the northern direction average speed was about 35 km/h.

Direction	Reference Period	Speed Limit 30 km/h
Southern	44 km/h	40 km/h
Northern	38 km/h	35 km/h

Tab. 9 Impact of the speed limit on average speed

Only during the official speed control on August 21 the speed was almost reduced to the allowed level. In the following figure the average speed during the speed limit and the speed during speed control are depicted.

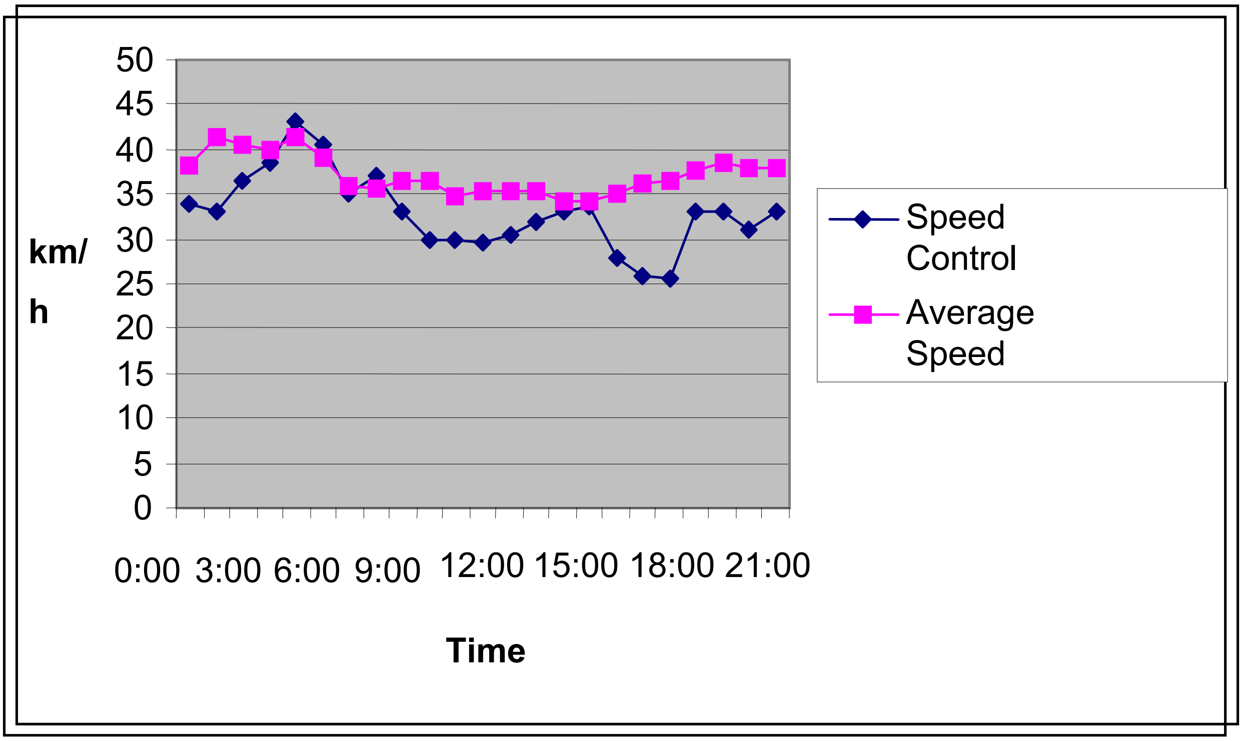


Fig. 29 Day course average speed during speed limit and during speed control (speed control between 7.00 – 9.00, 10.00 – 13.00, 15.00 – 18.00)

After the end of the speed limit the average speed of the reference period May/June of 44 km/h in southern and 38 km/h in northern direction was reached again.

Impacts on the environmental situation

The impact of the speed limit on the roadside pollution in the Beusselstraße is hard to evaluate. Due to the limited project lifetime the speed limit had to be introduced during summer holidays. In this period traffic volumes were approx. 20% lower than during the reference periods.

Segment	Reference Period		Speed Limit	
	Cars	Trucks + Busses	Cars	Trucks + Busses
Beusselstraße	25.797	1.295	20.548	1.112

Tab. 10 Average number of cars and truck per workday in the Beusselstraße

The impact on the environment is therefore a result of both, the overall traffic reduction and of the 10% speed reduction.

The online modeling for the respective time period correspond to the measured roadside pollution reduction for most of the pollutants. However, the measured effect on pollution concentration has to be evaluated in greater detail, because the calculation of NO_2 is rather complex and because external effects have to be excluded. NO emission is transformed into NO_2 pollution concentration. This transformation is dependent on the ozone concentration: the transformation rate is higher when the ozone concentration is also high. In summertime the ozone rate is high and therefore NO is transferred at a higher rate into NO_2 than in wintertime. Thus at a given constant NO emission the NO_2 pollution in summer is higher than in winter. The HEAVEN TDMS have been implemented during summertime while the reference period lies in autumn. In order to better compare the measured results, the following results for NO_2 are based on an equal transmission rate for the test and for the reference period. Another approach which turned out to be even more stable is to look at the NO_x concentrations. Being the sum of NO and NO_2, NO_x is therefore not affected by the seasonal dependency of the NO_2 formation rate. In the following table the roadside pollution during the speed limit and during the reference period are summarized:

Pollutant	Reference Period	Speed Limit	Changes %
NO2 µg/m³	58,3 µg/m³	40,9 µg/m³	-30%
PM10 µg/m³	34,3 µg/m³	35,2 µg/m³	+2%
Soot µg/m³	6,6 µg/m³	5,3 µg/m³	-20%
CO mg/m³	0,7 mg/m³	0,6 mg/m³	-14%
Benzene µg/m³	3,4 µg/m³	2,6 mg/m³	-24%

Tab. 11 Roadside Pollution (Measurements) in the Beusselstraße (Speed Limit)

For all pollutants but PM 10 a reduction could be measured while the speed limit was in force. One would expect that PM 10 would also be significantly lower during the speed limit, especially since overall traffic was reduced and PM 10 roadside pollution is dependent on traffic volume. This PM 10 increase is the result of two external sources:

- a higher background pollution which incurred during the speed limit.
- Relatively dry weather conditions which also lead to higher PM 10 pollution

Two additional calculation approaches were applied in order to delete the external effects (high background pollution, low traffic volumes). It was expected that that these approaches will help to better evaluate the impacts of the TDMS on the environment:

1. Comparison of the pollution situation in the Beusselstraße with other roads in Berlin (urban roads, street canyon) while the TDMS were in force and during the reference period. It can be expected that the decrease in roadside pollution was higher in the Beusselstraße (resp. the increase in PM 10 pollution was lower) than in the other roads in Berlin.
2. Subtraction of the background pollution from the total roadside pollution. By doing so the additional pollution caused by traffic can be quantified.

However these evaluations were not carried out for the pollutant CO, because not all relevant data was available from other streets for CO.

By applying the comparison methodology (1) it becomes obvious that – with the exception of PM 10 - the reduction in roadside pollution was indeed higher in the Beusselstraße than in the other roads (see table below).

Pollutant	Reference Period		Speed Limit		Changes %	
	Beussel	Other	Beussel	Other	Beussel	Other
NO2 µg/m³	58,3 µg/m³	60,1 µg/m³	40,9 µg/m³	44,1 µg/m³	-30%	-26%
PM10 µg/m³	34,3 µg/m³	35,2 µg/m³	35,2 µg/m³	36,0 µg/m³	+2%	+2%
Soot µg/m³	6,6 µg/m³	6,4 µg/m³	5,3 µg/m³	5,6 µg/m³	-20%	-13%
Benzene µg/m³	3,4 µg/m³	5,0 µg/m³	2,6 mg/m³	3,9 mg/m³	-24%	-22%

Tab. 12 Pollution situation at Beusselstraße and other roads during speed limit

This calculation shows that the roadside NO2, Soot and Benzene pollution reduction in the Beusselstraße during the speed limit was higher than on the other roads.

In order to precisely quantify the pollution reduction in the Beusselstraße during the speed limit the absolute difference of the pollution concentration at the Beusselstraße and the other streets during the reference and during the speed limit were calculated. Then the absolute difference between the differences in pollution concentration between Beusselstraße and other roads for the speed limit and the reference period are calculated. When this value is negative the pollution reduction during the speed limit was higher in the Beusselstraße than in other roads and vice versa. In a final step the pollution reduction in % was calculated by referring the absolute difference to the total pollution concentration in the Beusselstraße in the reference period. This reduction can be seen as the real effect of the speed limit in the Beusselstraße excluding external effects and the overall traffic reduction.

Pollutant	Reference Period			Speed Limit			Absolute difference	**Pollution Reduction**
	Beussel	Other	Difference	Beussel	Other	Difference		
NO2 µg/m³	58,3 µg/m³	60,1 µg/m³	-1,7 µg/m³	40,9 µg/m³	44,1 µg/m³	-3,2 µg/m³	-1,5 µg/m³	-2,5%
NOx µg/m³	184 µg/m³	209 µg/m³	-25 µg/m³	129 µg/m³	157 µg/m³	-28 µg/m³	-3,0 µg/m³	-1,6 %
PM10 µg/m³	34,3 µg/m³	35,2 µg/m³	-0,9 µg/m³	35,2 µg/m³	36,0 µg/m³	-O,8 µg/m³	0,1 µg/m³	+0,2%
Soot µg/m³	6,6 µg/m³	6,4 µg/m³	0,2 µg/m³	5,3 µg/m³	5,6 µg/m³	-0,3 µg/m³	-0,5 µg/m³	-7,1%
Benzene µg/m³	3,4 µg/m³	5,0 µg/m³	-1,6 µg/m³	2,6 mg/m³	3,9 mg/m³	-1,4 µg/m³	0,2 µg/m³	+5,4%

Tab. 13 Pollution reduction at Beusselstraße during the speed

It should be noted, that CO has not been considered here and in the following evaluation, because the recorded levels of around 0.6 mg/m³ were very low (the limit value is 10 mg/m³) and hence quite close to the detection limit of 0.1 mg/m³ of the monitoring devices. So, the uncertainty range due to monitoring sensitivity is higher than any expected change of CO concentrations during the speed limit period resulting from the above approach.

A variant of the above approach was also performed. Instead of comparing the **absolute** difference of the Beusselstraße and other traffic sites we compared the **ratio** of the pollution in the Beusselstraße and the other sites within the speed limit and the reference period, respectively. The results are similar to those shown in Table 10.

Methodology (2) looks at the additional pollution in the Beusselstrasse. This is the measured roadside pollution minus the urban background pollution measured at measurement points in adjacent residential areas in Berlin's city centre where the traffic burden is low. These urban background values are considered to reflect the roof top concentration around the Beuselstrasse. Hence, additional pollution levels obtained here should not be influenced anymore by the variation of the background levels. In the following table the additional pollution is depicted for the reference period and for the speed limit:

Pollutant	Reference Period	Speed Limit	Changes Absolute	Changes in% of total pollution
NO2 µg/m³	20,9 µg/m³	21,5 µg/m³	+0,6 µg/m³	+1%
NOx µg/m³	122, 7 µg/m³	95,7 µg/m³	-27,0 µg/m³	-15 %
PM10 µg/m³	11,3 µg/m³	7,9 µg/m³	-3,4 µg/m³	-10%
Soot µg/m³	3,4 µg/m³	2,7 µg/m³	-0,7 µg/m³	-10%
Benzene µg/m³	1,6 µg/m³	1,5 mg/m³	-0,1 µg/m³	-3%

Tab. 14 Additional pollution at the Beusselstraße during speed limit without windspeed and traffic volume correction

The percentage reduction shown here are higher than the results obtained with method (1); except for NO2. This is due to the fact that this approach does not take into account the reduction in the overall traffic during the speed limit period. Assuming a linear relationship between traffic intensity, emissions and additional pollution by traffic in the Beusselstrasse, the values of the additional pollution during the reference period were weighted by the ratio of the traffic counted during the speed limit and during the reference period, i.e by 0.75%. Moreover, a more thorough scrutiny of the weather data revealed that the average wind speed was lower by 0.4 m/s during the speed limit compared with the reference period. Given that higher wind speed correlates with lower pollution, a supplement derived from the data was added to concentration of the reference period in order to compensate the effect of higher wind speed.

Pollutant	Windspeed correction: supplement added to the levels during the reference period	Resulting Changes in% of total pollution
NO_2 µg/m³	none	not applied
NO_x µg/m³	+ 9 µg/m³	-3 %
PM10 µg/m³	+1 µg/m³	-5%
Soot µg/m³	0,22 µg/m³	-10%
Benzene µg/m³	0,13 µg/m³	-3%

Tab. 15 Resulting changes in pollution after windspeed correction and adjustment due to traffic volume

Summary:
Results of the various evaluation methods described above are summarised below by providing a single reduction percentage figure averaged over the single results of each methods and a span reflecting the variation of the results obtained by the different approaches.
It can be concluded that the overall reduction of pollution achieved by the speed limit was slightly below the forecasted decrease. This can be due to the fact that not all drivers reduced their speed to 30 km/h while the speed limit was in force and that the expected deviation of traffic flow happened to be smaller.

Pollutant	Forecast	Measurement
NO_2	- 4%	- 3% (+/- 2%)
PM10	- 3%	- 2% (+/- 2%)
Soot	- 4%	- 3% (+/- 3%)
Benzene		0 (+/- 5%)

Tab. 16 Expected and measured pollution reduction

Impact on noise

The effects on noise pollution were monitored on one day while the speed limit was in force and while the police was controlling this speed limit. However, average speed was still higher than 30 km/h thus the expected noise reductions of 3.5 db8A) were not fully reached. Instead an average reduction of 2.0 dB(A) during daytime and 1.2 db(A) during nighttime was measured.

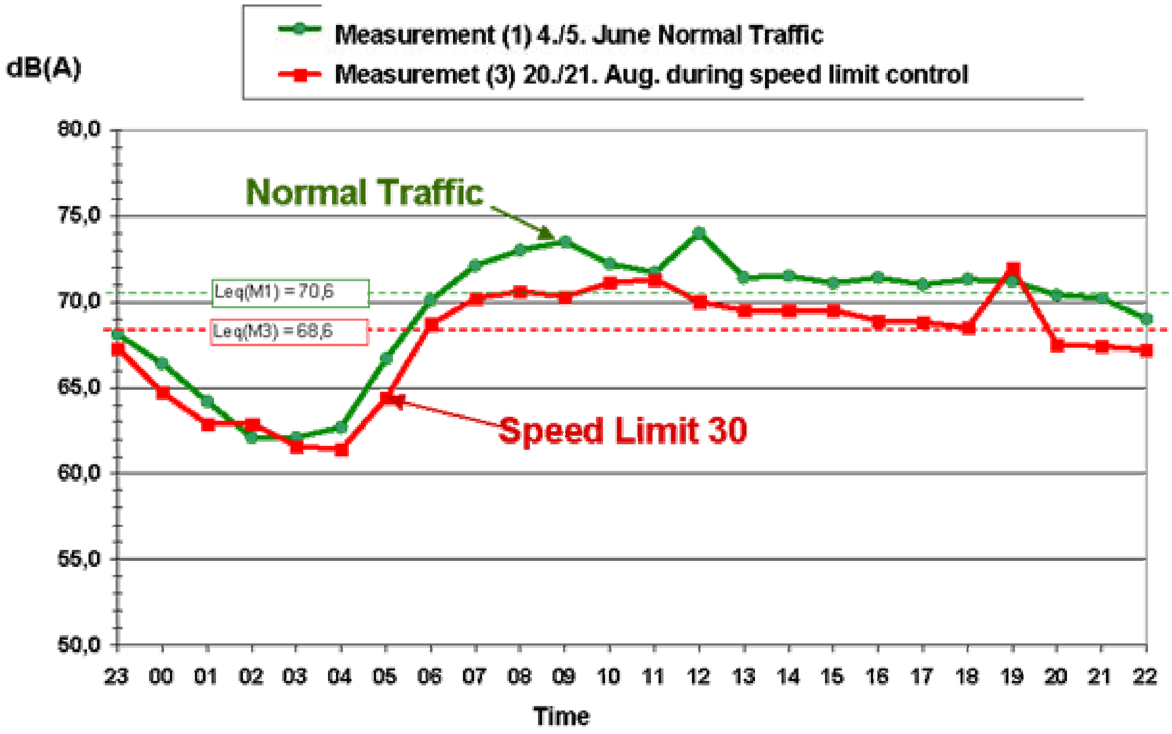


Fig. 30 Noise Pollution during demonstration

The reduction modeled during the speed limit was even lower than 2 dBA due to the fact that the average speed was higher than 30 km/h. The following table provides a comparision of the predicted and measured improvement in noise levels:

Time	Forecast	Measurement
Day	-3,5 dB(A)	-2,0 dB(A)
Night	- 3,5 dB(A)	-1,2 dB(A)

Tab. 17 Expected and measured noise reduction

5.4.2.2.2 Truck Ban

During the truck ban – which was in force between 26.08. – 15.09.2002 – only those trucks were allowed to enter the demonstration area, which had its origin or destination directly in the Beusselstraße. All other truck traffic had to use alternative routes which were recommended by traffic signs:

- traffic which had its origin / destination in the area of the Beusselstraße (especially inland port and market) had to use the detours via Stromstraße (Eastern detour) , or Tegeler Weg, Neues Ufer, Turmstraße, Kaiserin-Augusta-Allee und Alt Moabit (western detour) (see also green lanes in the following figure)
- detours via the motorway (see also red lanes in the following figure)

In the following figure these detour recommendations are shown. Next to the traffic signs also additional information on the TDMS and the recommended detours has been given to the local transport operators before the truck ban was implemented.

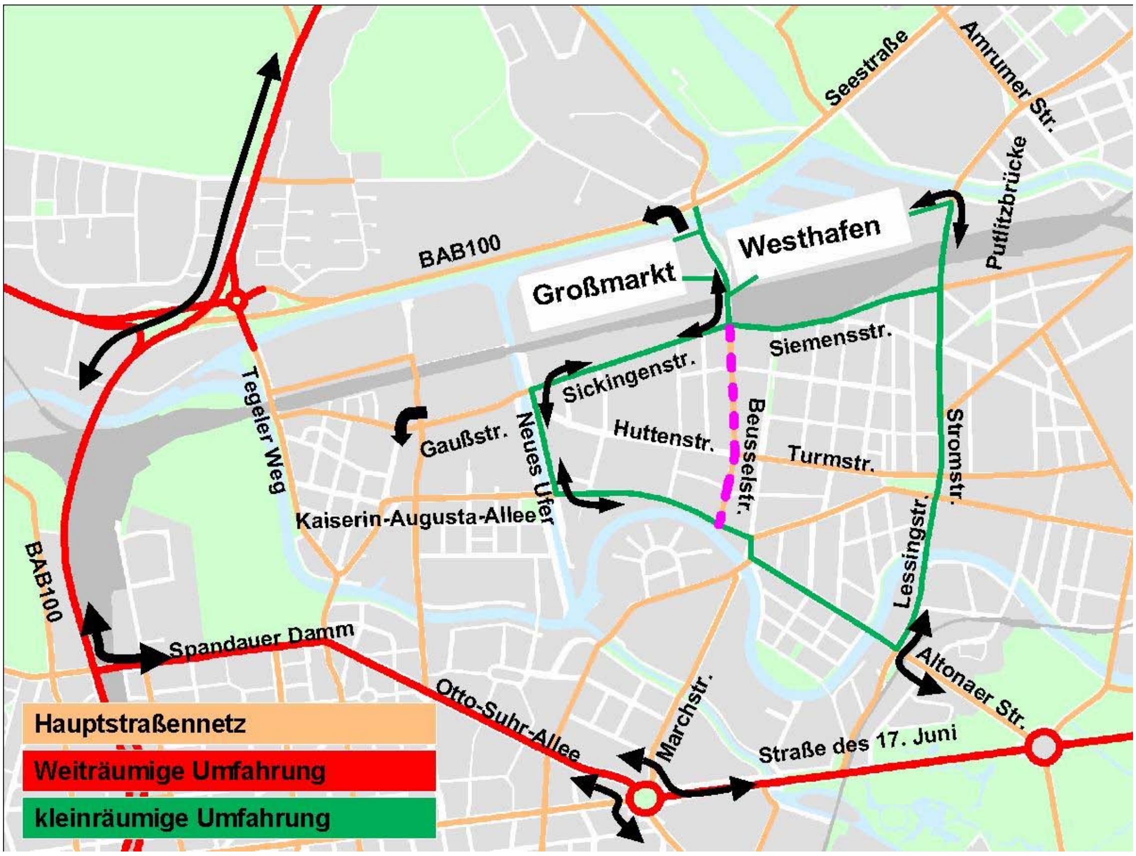


Fig. 31 Detour recommendations during the truck ban

The truck ban was implemented after the end of the holiday season. From the start of the ban, total traffic on Berlin's road network reached approx. the volume of June. A comparison of the effects of the truck ban with the situation before the ban would not be useful, due to the lower traffic volumes in July and August. Instead, the same reference period was used as for the speed limit: 15.09. – 11.11.

Traffic Impacts

The traffic impacts were analyzed by using traffic monitoring data from the Traffic Management Centre. The traffic detectors (sensors) monitor two vehicle groups: cars and trucks/busses. This is done by the length of the vehicles. All vehicles of length of more than 7 metres are classified as trucks. In this group also busses are included of which approx. 400 pass the Beusselstraße per workday. Busses do not fall under a truck ban and were allowed to use the Beusselstraße during this ban.

During the truck ban a reduction of total heavy traffic (trucks and busses) of 20% was monitored. This equals a reduction of truck traffic (excluding busses) by 28%.

The reduction of truck traffic in southern direction (32%) was substantially higher than in northern direction. This can be explained by the fact that detailed information on the truck ban was distributed in the inland port and market in the north of the demonstration area. Therefore drivers from these origins were prepared to follow the detours.

Vehicle	Reference Period	Truck Ban	Changes %
Truck + Bus	1.295	1.041	-20%
Truck (excl. Bus)	895	641	-28%
Cars	25.797	24.696	-4%

Tab. 18 Average amount cars and trucks per workday in the Beusselstraße, reference period September

Comparison with truck traffic in June

In comparison to the month of June (before summer holidays) a reduction of truck traffic of 44% (or 33% of heavy traffic incl. buses) was monitored. This means, that after the end of the truck ban, total truck traffic in the Beusselstraße only increased by approx. 250 trucks. Thus, total truck traffic after the end of the ban was 300 trucks/workday lower than before the ban was in force. However, on average, Berlin's truck traffic in June had about the same level as in autumn. It can be concluded that some of the trucks which were using the motorway detour have continued doing so even after the end of the truck ban.

Vehicle	Reference Period June	Truck Ban	Changes %
Truck + Bus	1.584	1.041	-33%
Truck (excl. Bus)	1.184	641	-44%
Cars	23.640	24.696	+4%

Tab. 19 Average amount cars and trucks per workday in the Beusselstraße, reference period June

From a traffic point of view the introduction of a truck ban was only partly successful as only about 44% of all trucks followed this ban. This resulted in the fact that approx. 650 trucks/workday used the Beusselstraße despite of the truck ban. In a modeling analysis before the introduction of the ban it was calculated that approx. 30% of the trucks passing the Beusselstraße have their origin/destination in the neighborhood while 70% of the traffic is through traffic going to or coming from the motorway. Only 100 trucks/workday have their destination in the Beusselstraße and would have therefore been excluded from the truck ban.

This behavior had of course an impact on the roadside pollution in the Beusselstraße during the demonstration phase which would have been considerably lower if all trucks had followed the ban.

Effects on adjacent roads

During the planning of the truck ban a lot of emphasis has been paid to analyze the effects of the truck ban in the Beusselstraße on adjacent roads. In a rough analysis of the traffic situation on these adjacent roads during the truck ban no considerable increase in truck traffic could be monitored on any of the roads which were marked as detour routes. This can be explained by the different detour recommendations given which lead to the fact that a large number of streets had to cope with only a very minor increase in traffic.

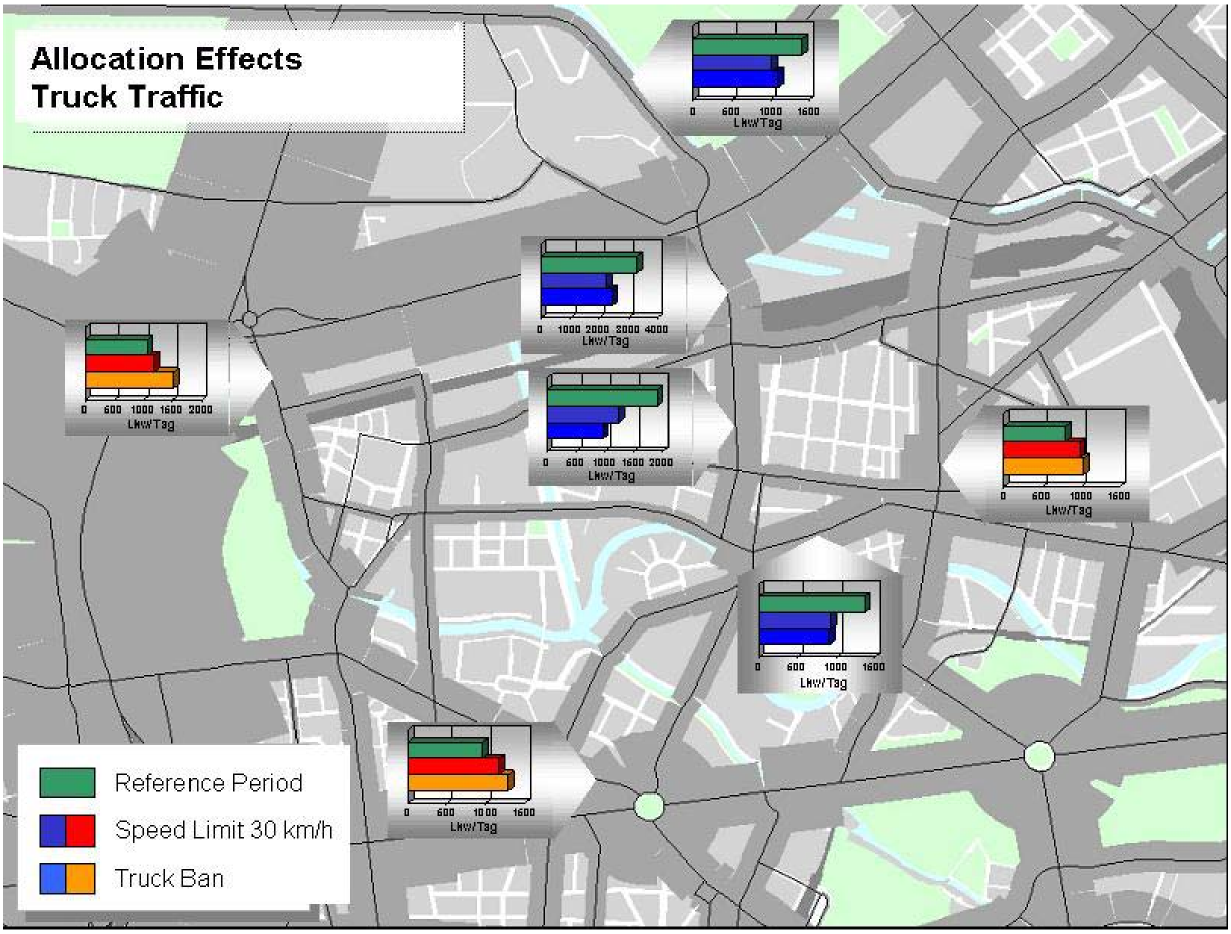


Fig. 32 Allocation of truck traffic during demonstration in the Beusselstraße area

Impact on the environmental situation

Car traffic was not impacted by the truck ban. As explained in the previous chapter this car traffic reached the June level during the demonstration phase. Thus the monitored and calculated pollution reductions can be regarded as a result of the truck ban.

For all pollutants but PM 10 a reduction could be measured while the speed limit was in force. These results correspond to the modeled roadside pollution reduction calculated by the heaven online modeling. In the following table the roadside pollution during the truck ban and during the reference period are summarized, using the same corrected values for NO2 as during the speed limit analysis:

Pollutant	Reference Period	Truck Ban	Changes %
NO2 µg/m³	58,3 µg/m³	36,4 µg/m³	-38%
PM10 µg/m³	34,3 µg/m³	52,4 µg/m³	+53%
Soot µg/m³	6,6 µg/m³	5,7 µg/m³	-14%
CO mg/m³	0,7 mg/m³	0,6 mg/m³	-14%
Benzene µg/m³	3,4 µg/m³	2,5 µg/m³	-26%

Tab. 20 Roadside Pollution in the Beusselstraße (measurement) (Truck Ban)

For all pollutants but PM 10 a reduction could be measured while the truck ban was in force. This PM 10 increase is the result of two external sources:

- As for the speed limit, the PM 10 increase is the result of a very high background pollution which incurred during the truck ban. In this period the average background pollution added up to an average of 39 to 49 µg/m³ (depending on the measurement station) which is 90 to 180 % higher than the background pollution measured during the reference period.
- Relatively dry weather conditions which also lead to higher PM 10 pollution

In order to eliminate these external factors we pursued the same approach as described above in the section on the evaluation of the impact of the speed limit

By applying the comparison methodology (1) the PM10 pollution increase could also be monitored on other roads in Berlin at an even higher level. However, the reduction in roadside pollution was higher in the Beusselstraße during the truck ban than in the other roads (see Table 17 below).

Pollutant	Reference Period			Truck Ban			Absolute Changes	Pollution Changes
	Beussel	Other	Difference	Beussel	Other	Difference		
NO2 µg/m^3	58,3 µg/m^3	60,1 µg/m^3	-1,7 µg/m^3	36,4 µg/m^3	44,2 µg/m^3	-7,7 µg/m^3	-6,0 µg/m^3	-10,3%
NOx µg/m^3	184 µg/m^3	209 µg/m^3	-25 µg/m^3	115 µg/m^3	158 µg/m^3	-43 µg/m^3	-18 µg/m^3	-9,8 %
PM10 µg/m^3	34,3 µg/m^3	35,2 µg/m^3	-0,9 µg/m^3	52,4 µg/m^3	54,7 µg/m^3	-2,2 µg/m^3	-1,4 µg/m^3	-4,0%
Soot µg/m^3	6,6 µg/m^3	6,4 µg/m^3	0,2 µg/m^3	5,7 µg/m^3	4,2 µg/m^3	-0,1 µg/m^3	-0,3 µg/m^3	-4,8%
Benzene µg/m^3	3,4 µg/m^3	5,0 µg/m^3	-1,6 µg/m^3	2,5 µg/m^3	3,9 mg/m^3	-1,7µg/m^3	-0,1 µg/m^3	-3,1%

Tab. 21 Pollution reduction in the Beusselstraße during the truck ban

Summary

In accordance with the approach used for the assessment of speed limit methodology (1) was also applied on the ratio of the pollution between Beusselstrasse and other traffic sites, as well as methodology (2) with a correction of the effect of lower wind speed during the truck ban.

All results yield a reduction of the air pollution in the Beusselstrasse during the truck ban, with methodology (2) resulting in more significant reductions of NOX or NO2, respectively. As in the previous section results of the various evaluation methods are summarised below by providing a single reduction percentage figure averaged over the single results of each methods and a span reflecting the variation of the results obtained by the different approaches.

Slight modifications to the calculation methodology described above have lead to similar results. It can be concluded that the overall reduction of pollution achieved by the truck ban was slightly below the forecasted ones. This can be due to the fact that the truck ban was only respected by less than 50% of all trucks.

Pollutant	Forecast	Measurement
NO2	- 13%	- 20% (+/- 10%)
PM10	- 11%	- 8% (+/- 5%)
Soot	- 13%	- 7% (+/- 3%)
Benzene		-9% (+/- 6%)

Tab. 22 Expected and measured pollution reduction

Effects on Noise Pollution

During the truck ban noise pollution was reduced by 1.3 dB(A) during daytime and by 1.0 dB(A) during nighttime, instead of 2.6 and 2.1 dB(A) as forecasted. This difference can be explained by the fact that only approx. 50% of all trucks drivers followed the ban.

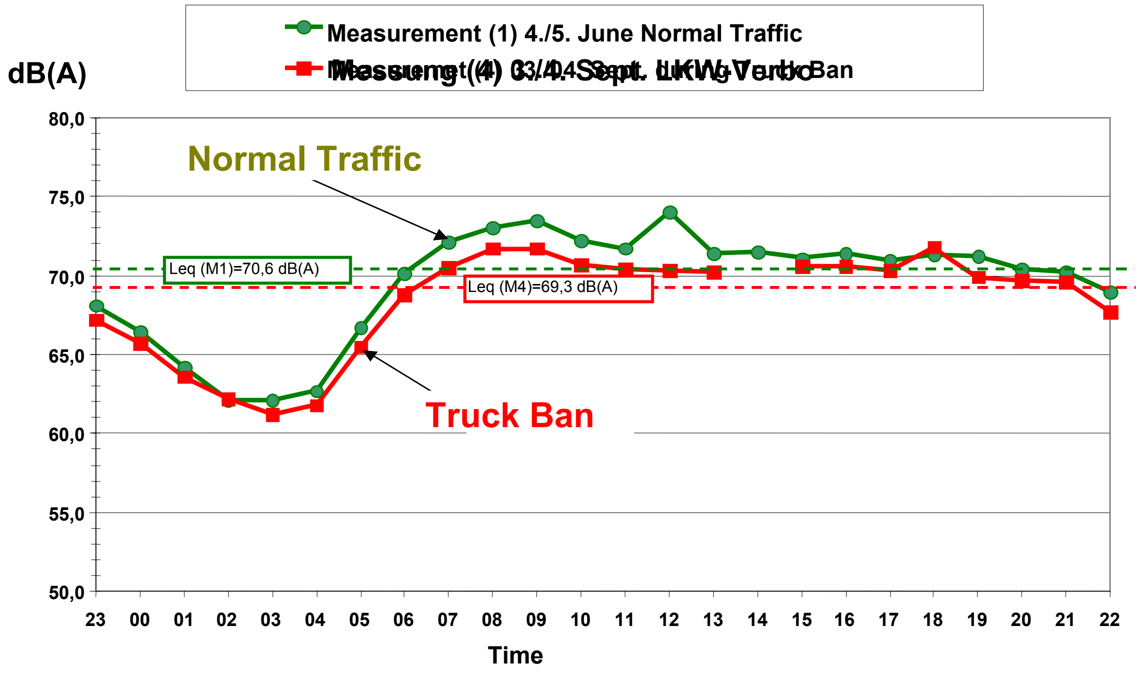


Fig. 33 Noise Pollution During Truck Ban

The following table provides a comparison of the predicted and measured improvement in noise levels during the truck ban:

Time	Forecast	Measurement
Day	-2,6 dB(A)	-1,3 dB(A)
Night	- 2,1 dB(A)	-1,0 dB(A)

Tab. 23 Expected and measured noise reduction

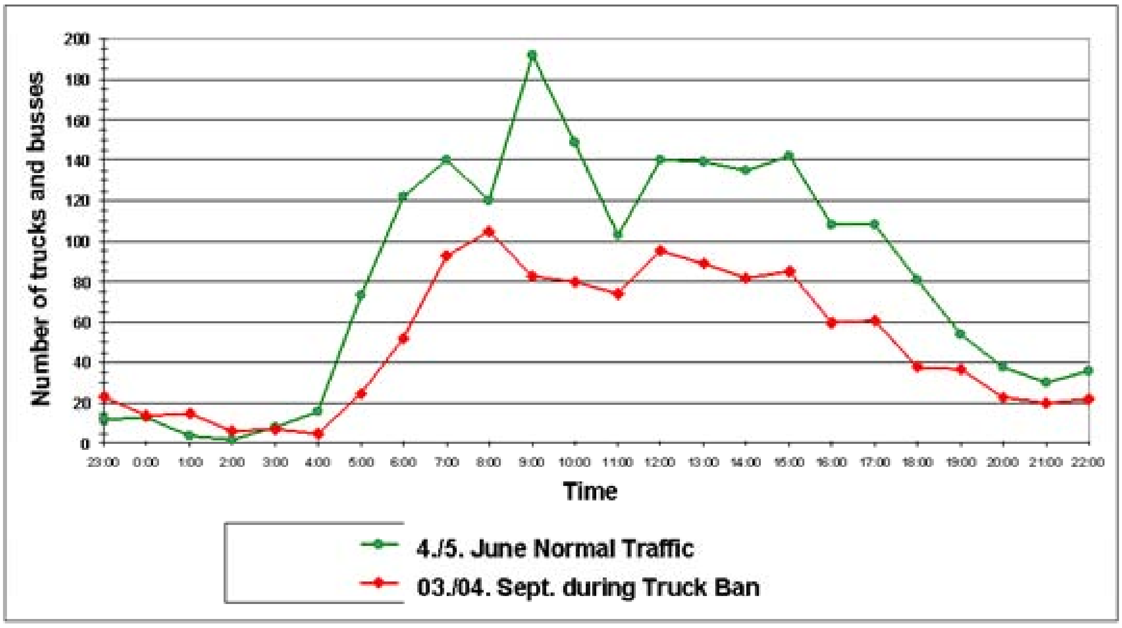


Fig. 34 Truck Traffic during noise pollution measurement

5.5 Calculation of long term scenarios

In addition to the traffic management scenarios also long term scenarios were calculated using the HEAVEN tools. For this purpose the effects of the following two scenarios were calculated:

- scenario 2005: ban all diesel vehicles from the inner city which do not fulfill the Euro 3 or better
- scenario 2010: ban all diesel vehicles from the inner city which do not fulfill the Euro 4 emission standard

For both scenarios the expected traffic volumes and the expected background pollution for the respective year was calculated. On this basis the total roadside pollution for the pollutants NO2 and PM10 were calculated for both scenarios. These scenarios were then compared to the situation in 1998 in order to evaluate what effects can be expected from such measures.

5.5.1 Data input for long term scenario calculation

In the context of the HEAVEN project, impacts of traffic on air pollution were calculated. This was done on the basis of existing studies for the emission register of Berlin using available procedures and groundwork.

The air pollution impact was computed with the program system $IMMIS^{luft}$. $IMMIS^{luft}$ contains among other models the emission model $IMMIS^{em}$, which is based completely on the current "manual for emission factors of the traffic" (HB-efa). Bases for the emission computations are

- the traffic volume
- the traffic conditions on the individual road sections,
- the vehicle fleet composition
- the specific emission factors.

For the computation of the traffic volume, the following traffic matrices were taken from the STEP (City development plan: Transport)

- for 2005 the matrix for the year 1998 without modification, but with adjustments in the road infrastructure
- for 2010 the prognosis matrix for the year 2015 (scenario 3 without modification)

The portion of heavy truck and penalties was projected from actual count values for 2015.

The classification of Berlin's road system is done as follows:

- urban motorway (with appropriate speed limit) and
- other major roads, which are partitioned again by traffic conditions (see HB-efa).

In addition for each road section the hourly capacity must be indicated for computation the stop & Go-portions and the function for the determination of the cold weather starting impacts.

The vehicle fleet composition for the prognosis years can be selected in IMMIS. It corresponds to the average German vehicle fleet as suggested in HB-efa of the Federal Environment Agency (UBA).

For the computation of the air pollutant emissions the newest emission factors issued by the Federal Environment Agency were used in IMMIS^{em}. These factors are also used also in HB-efa.·

- 2005 - fleet according to UBA, within central Berlin area all diesel engine vehicles fulfil at least euro III standard
- 2010 - fleet according to UBA, within central Berlin area all diesel engine vehicles fulfil at least euro IV standard

The computation of the pollution concentrations depends on

- the height of the emissions,
- the land development situation (closed/open land development, elevator width relationship),
- the meteorological conditions,
- the situation of the road longitudinal axis in correspondence to main wind direction and
- the background concentration.

A substantial basis of the computation of the roadside pollution is the respective background pollution for the different road sections, which can be caused by a lot of different sources. By using IMMIS^{net} the background pollution was determined as annual average value for NO2 and for PM10 in 1 km x 1 km receptor raster. This was done on the basis from emission land registers "other sources but road traffic" and the emissions of the traffic determined by IMMIS^{em}.

5.5.2 Results of the long term scenario calculation

In this chapter the results of the analysis for the 2005 scenario in comparison to the situation in 1998 are described for PM10. All described figures refer to the 90.41 percentile value. For NO2 the simulated situation for 2010 is compared to the one in 1998.

The following figure depicts the expected PM10 pollution when the ban of non Euro 4 Norm vehicles will be in force. In this case the main pollution will not occur in the inner city but rather on the roads around the inner city where vehicles which do not comply with the Euro 4 Norm are still allowed. However, the PM10 pollution will remain very high and will exceed the forthcoming limit values on a high number of street segments in Berlin.

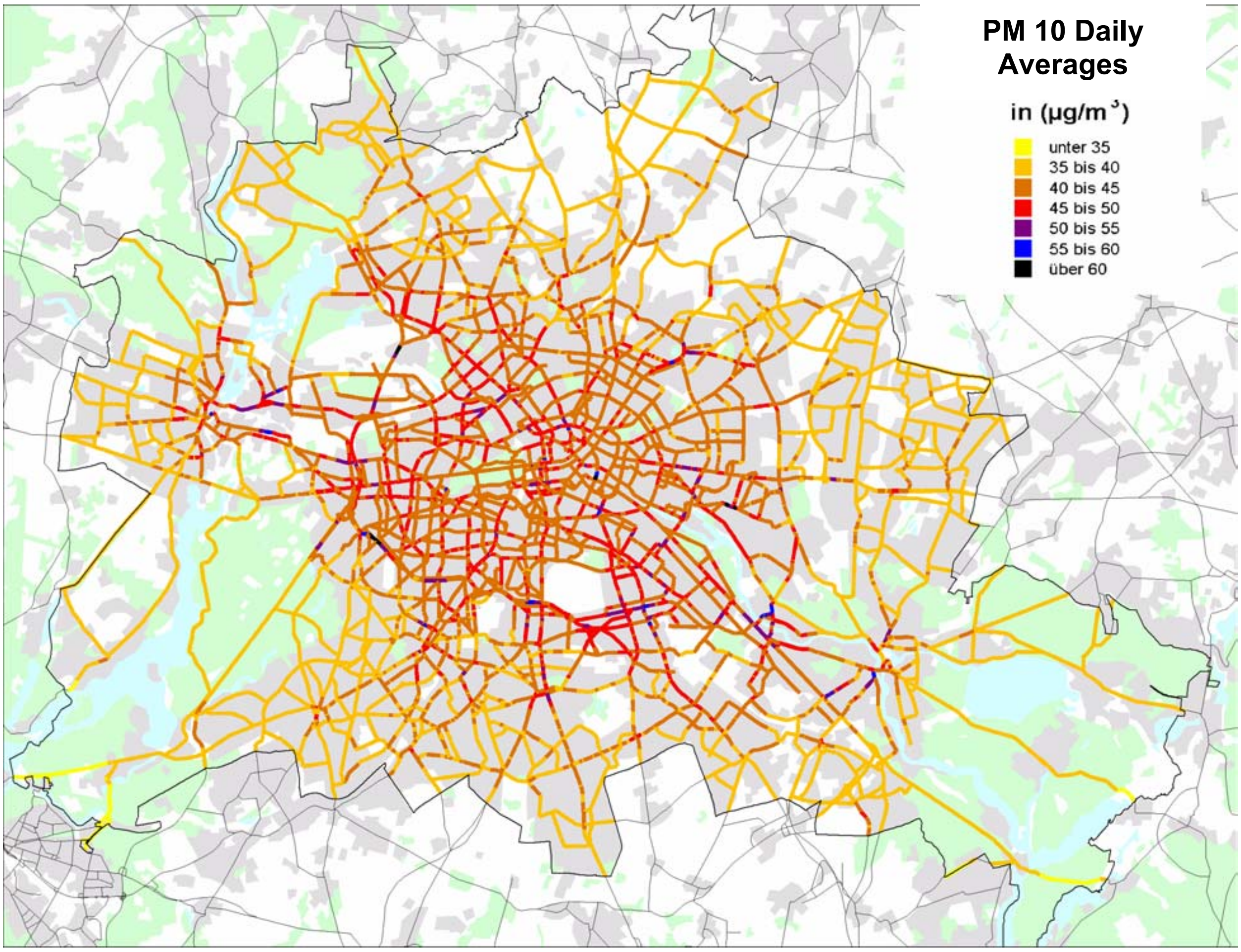


Fig. 35 Scenario 2005 – PM 10 pollution

When this situation is compared to the PM 10 pollution situation in 1998 it can be seen, that the PM 10 pollution will be reduced all over the city by up to more than 16 µg/m³. This reduction is the result of the lower emission and the resulting background pollution. The highest reductions can be expected in the inner city where the ban on high emission vehicles will be in force.

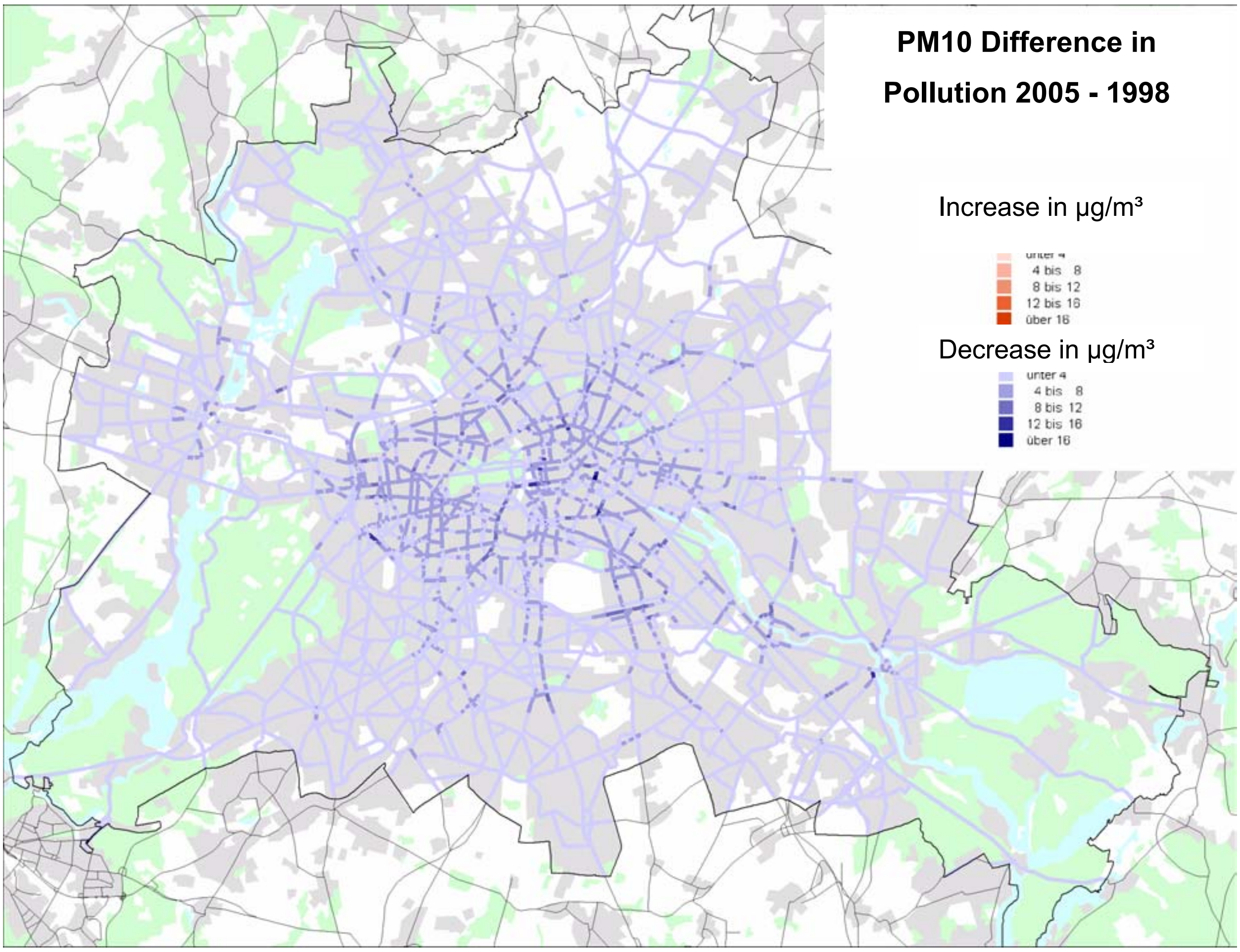


Fig. 36 Scenario 2005 – comparison PM 10 pollution 1998 – 2005

The situation for N02 will be similar to the one for PM10. In certain areas in the inner city the NO2 roadside pollution can be decreased by more than 20 µg/m³. However, the pollution situation remains critical on certain streets in the city of Berlin, where high emission vehicles will be allowed to drive. However, by introducing a ban in the inner city it can be expected that the limit values which will come into force in 2010 can be met in the inner city of Berlin, except at a limited number of hot spots.

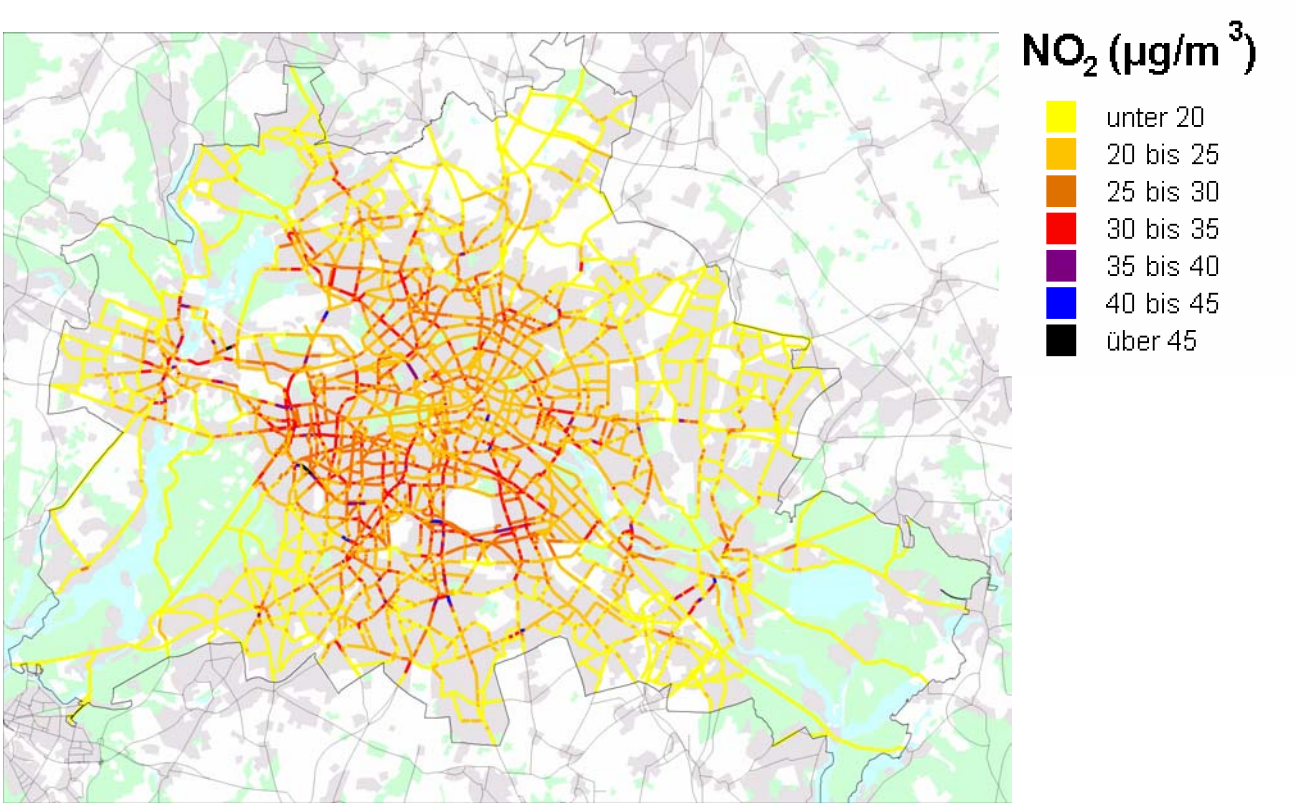


Fig. 37 Scenario 2010: NO2 pollution

Fig. 38 Scenario 2010 – comparison NO2 pollution 1998 – 2010

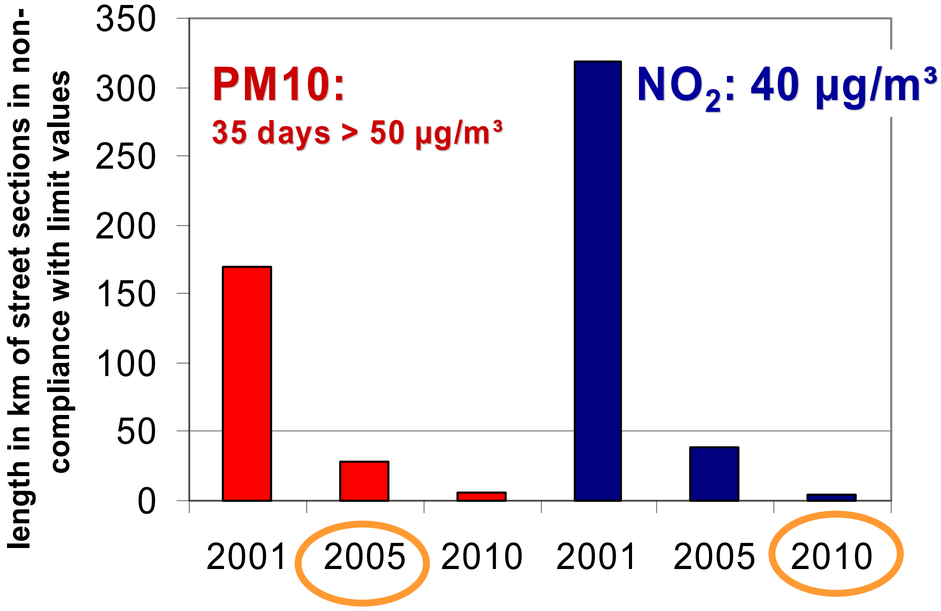


Fig. 39 Length of street section with pollution above the limit values as a result of the scenario 2005 and 2010

Figure 39 illustrates a summary of the expected improvement of the air quality as a result of the two scenarios for 2005 and 2010 in the form of the lenght of raod section where the PM10 and NO2 concentration still exceed the limit values. While the non-attainment area shrinks drastically, the aim of fully complying with the PM10 limit value by 2005 may not be achieved. This is even true for NO2 where the attainment period only ends in 2010. So, given that even such a tough "clean vehicle policy" may not be sufficient, complementary traffic management measures could help to ultimately attain the limit values at the remaining hots spots. The HEAVEN tools will allow to design such traffic management strategies more efficiently.

5.6 Future Adaptions to DSS

In Berlin the specific focus of the Senatsverwaltung für Stadtentwicklung is to develop and implement strategies which will reduce air pollution of particulate matter (PM10) and nitrogen dioxide in the city in order to meet the limit values which must be attained by the year 2005 and 2010, respectively. Given the predominant share of the traffic emissions in the air pollution in the city measures to reduce air pollution will have to address especially the transport sector. Moreover, in anticipation of the new EU Directive on noise, work has just started to devise a noise abatement plan, thereby addressing the growing public attention of traffic noise as a major factor which badly effects the quality of life in the city.

The results of HEAVEN are of high significance for the future transport policy in Berlin. In some areas it will be difficult to meet future environmental standards, especially the limit values for PM10 and NO2. The TDMS tested in Berlin in the framework of the HEAVEN project (Speed limit, truck bans and rerouting, variation in traffic signalling) will become a reference case for similar measures to be introduced in other parts of the city. Combined with the HEAVEN system it will then be possible to develop optimal, individual transport strategies for different areas.

Those strategies can consist of long term measures related to technical emission control or traffic planning. The modelling tools developed within HEAVEN will assist the Senate by developing long term transport measures as it facilitates the assessment of the impact of those strategies on traffic and the environment.

The HEAVEN system might also be used for implementing dynamic traffic management measures. Those measures are introduced when certain limit values are exceeded, or – which is more likely – are introduced when exceedances are forecasted. The data gathered in HEAVEN will allow for a very a good prediction of pollution levels in dependence of the expected traffic volume and the expected meteorological conditions. Thus suited measures (such as changes in signalling but also speed limits and bans) can be introduced in order to avoid exceedances.

6 CONCLUSIONS

The objectives of introducing the HEAVEN system in Berlin was threefold

- Development of an online environmental monitoring and modelling system
- Development of an environmental information platform accessible via the internet.
- Modeling and practical implementation of different TDMS and evaluation of their impact on traffic and environment.
- Modeling of long-term scenarios with measures to attain the noise and air quality standards

Technical Tasks (Environmental Modeling System)

In the demonstration area roadside pollution is being modeled online since spring 2002. Additional road segments were added to the online modeling in November 2002. The update interval is one hour. The results of the modeling is presented on the online HEAVEN information platform on the internet since May 2002. In the future, the HEAVEN system will be capable to provide online environmental information for Berlin's main road network.

The environmental models (IMMIS modeling chain) for calculating traffic emission, rooftop concentration and roadside pollution for air pollutants and noise was used in HEAVEN as planned. The accuracy of these models meet the previously defined quality standards. Also models have proven to be sensitive to changes in the traffic input data as proven in different scenario analyses.

The development of a traffic monitoring and modeling system was not a task in the HEAVEN project Berlin. Instead the needed traffic data is imported from the Traffic Management Centre (TMC) in Berlin. The TMC monitors traffic by approx. 160 traffic sensors on the main road network in Berlin. Based upon this information the whole traffic for the main road network will be modeled in the near future. The TMC was supposed to be fully operational in the year 2002. Online traffic data from the TMC is currently only available for a few road segments. This is why the Berlin HEAVEN demonstration project focuses on a relatively small area where online traffic data has been available since the end of 2001. Due to the flexibility of the HEAVEN system it will be comparable easy to incorporate more road segments into the environmental modeling process as soon as more online traffic data will become available from the TMC.

It can be concluded that the aim of developing and running an integrated online monitoring system was achieved. Also the online information platform was set up which meets the requirements of the users. Until the end of the project the system will be further validated and the internet platform will be improved.

Information Platform

The results of the modeling is presented on the online HEAVEN information platform on the internet since May 2002 (http://heaven.ivu.de). Access to this data is currently restricted to professional users. However, the general information platform is accessible to the public and users can ask to have access to the data. By the end of the demonstration period also additional road segments where online traffic data is already available will be added. For these road segments online roadside pollution will be calculated on an online basis by the end of the year. In the future, the HEAVEN system will be capable to provide online environmental information for Berlin’s main road network. A condition for this is the online availability of actual traffic data from all segments of the main road network.

Lessons learned from implemented TDMS

Within the demonstration phase, also different Transport Demand Management Strategies to reduce pollution and avoid exceedances were developed, tested and evaluated in the demonstration area “Beusselstrasse”, an area in Berlin characterised by heavy truck traffic. These measures consist of:

- introduction of a speed limit of 30km/h;
- introduction of a truck ban.

In the initial phase of the project it was also planned to modify the signaling in the demonstration area in order to optimize dynamically traffic flows coming into the demonstration area. Due to some technical problems it was not possible to implement this TDMS to its full extent. Instead, the signaling inside the demonstration area was changed during the phase of the speed reduction in order to allow a steady traffic flow inside the Beusselstraße when traveling with a speed of 30 km/h.

The introduction of both TDMS were - in terms of changes in traffic behavior - only partly successful as average speed was only reduced by 10% to approx. 38 km/h and only 50% of all trucks followed the truck ban. This implies that the monitored pollution reduction could have been even higher if the road users had better followed the temporary traffic rules. Nevertheless, significant reductions in additional PM10 and NO2 pollution could be monitored while these TDMS were in force.

Outlook: Support for Decision Making

The results of these implemented TDMS together with the HEAVEN online information system and the improved modeling capabilities can be used as an important input for future traffic and environmental planning in Berlin. In Berlin the specific focus of the Senatsverwaltung für Stadtentwicklung is to develop and implement strategies which will reduce air pollution of particulate matter (PM10) and nitrogen dioxide in the city in order to meet the limit values which must be attained by the year 2005 and 2010, respectively. Given the predominant share of the traffic emissions in the air pollution in the city measures to reduce air pollution will have to address especially the transport sector. As the long-term scenario runs with the HEAVEN tools revealed pursuit of a "clean vehicle policy " is a vital but not sufficient a way forward towards full compliance with European air equality standards. Having successfully developed the tools within HEAVEN complementary traffic management measures can be designed for those hot spot areas where the technical emission control potential is not enough.

The TDMS tested in Berlin in the framework of the HEAVEN project will become a reference case, on the basis of which traffic dynamic management measures, aimed to reduce air and noise pollution, might be implemented on a wider scale in other parts of the city. Those measures are introduced when certain limit values are exceeded, or – which is more likely – are introduced when exceedances are forecasted. The data gathered in HEAVEN will allow for a very a good prediction of pollution levels in dependence of the expected traffic volume and the expected meteorological conditions. Thus suited measures (such as changes in signalling but also speed limits and bans) can be introduced in order to avoid exceedances. Combined with the HEAVEN system it will then be possible to develop optimal, individual transport strategies for different areas. Those strategies can consist of long term measures related to technical emission control or traffic planning. The modelling tools developed within HEAVEN will assist the Senate by developing long term transport measures as it facilitates the assessment of the impact of those strategies on traffic and the environment.

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