



HEAVEN

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**Hhealthier EEnvironment through Aabatement
of VVehicle EEmission and NNoise**

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List of Partners				
Participant Role	Participant Number	Participant Name	Participant Short Name	Country
CO	1	Società Trasporti Automobilistici S.p.A (STA)	STA	I
AC	2	Mizar Automazione S.p.A.	MIZAR	I
AC	3	Elsag S.p.A	ELSAG	I
AC	4	Rome Municipality Environmental Dept.	DPT X	I
CR	5	Senatsverwaltung für Stadtentwicklung	SENSTADT	D
AC	7	IVU Traffic Technologies AG	IVU	D
AC	8	European Academy for the Urban Environment	EA.UE	D
AC	9	B&SU	B&S.U.	D
CR	10	City of Rotterdam	ROTTERDAM	NL
AC	11	DCMR Environmental Protection Agency	DCMR	NL
AC	12	Netherlands Organisation for Applied Scientific Research	TNO	NL
AC	13	Goudappel Coffeng	GC	NL
CR	14	Airparif	AIRPARIF	F
AC	15	Ville de Paris	VP	F
AC	16	Carte Blanche Conseil	CBC	F
AC	17	DREIF/SIER	DREIF	F
AC	18	MERCUR	MERCUR	F
CR	19	Leicester City Council	LCC	GB
AC	20	Institute for Transport Studies (ITS), University of Leeds	UNIVLEEDS	GB
AC	21	Swedish Meteorological & Hydrological Institute (SMHI)	SMHI	S
CR	22	City Development Authority of Prague	URM	CZ
AC	24	Institute of Transportation Engineering	UDI	CZ
AC	25	Czech Hydrometeorological Institute	CHMU	CZ
S	26	Heich Consult	HC	D
S	27	Rupprecht Consult	RC	D
S	28	Regional Environmental Centre for Central and Eastern	REC	HU
S	29	ARIA Technologies	ARIA	F
S	30	ECOAIR	ECOAIR	CZ
S	31	Luca Persia	PERSIA	I
S	32	World Health Organisation	WHO	I

Role: CO = Co-ordinator
 CR = Principal contractor
 AC = Assistant contractor
 S = Subcontractor

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1 Project Overview

1.1 Main achievements

The overall goal of the HEAVEN project was “*To develop and 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*”.

In the framework of HEAVEN new concepts and tools to allow cities to assess the impacts of traffic on air quality and noise pollution in near-real time have been developed. These innovative tools, merging monitoring and simulation systems by means of IST technologies, constitute an integrated, modular system which supports “tactical” and “strategic” decisions. Through the application of the HEAVEN DSS it is possible for cities to:

- obtain a near real time description of the traffic and environmental situation in urban agglomerations,
- assess the environmental efficiency of already implemented Traffic Demand Management Strategies,
- perform extensive scenario calculation and assess the environmental efficiency of Traffic Demand Management Strategies prior to their costly implementation and,
- inform professional users and the public in near real time about the traffic and environmental situation
- assist cities in identifying compliance with the EU Directives associated with Air and Noise Quality Review and Assessment procedures
- assist decision makers in formulating policies with public participation

The HEAVEN DSS provides a concrete sustainability perspective and will improve the quality of life in European cities by reducing transport-related noise and air pollution. The HEAVEN DSS supports European cities in implementing existing and forthcoming EU legislation on air quality and noise.

In addition to the system development and demonstration the HEAVEN DSS has been applied under real-life conditions in the project cities Berlin, Leicester, Paris, Prague, Rome and Rotterdam. The environmental impacts of already implemented traffic measures have been assessed. Furthermore the HEAVEN DSS was used for extensive scenario calculations where the environmental efficiency of various Traffic Demand Management Strategies has been assessed prior to their costly implementation. The traffic measures which have been considered in the framework of the project comprise for example changes of the vehicle fleet, access restrictions, speed limits, park-and-ride scheme and changes to the street network.

Through the development of the HEAVEN DSS concept and the implementation of the local DSS demonstrators, HEAVEN has produced a valuable set of results that are transferable to other cities and that constitute “tools” to support the exploitation initiatives being undertaken and envisaged by the HEAVEN partners.

The HEAVEN “toolkit” includes the following tools:

- *Comprehensive Decision Support System Concept*, that allows partial or complete transfer to other application sites, according to the local characteristics, existing components and requirements.
- *Reference System Architecture* with open interfaces, that offers flexibility and facilitates the integration with existing systems and models as well as further enhancements.
- *Range of validated Applications*, that cover monitoring and modelling of air quality, noise and traffic,

Based upon the toolkit concept HEAVEN has conducted a first analysis of the exploitation potential and of the business opportunities considering the European cities larger than 250.000 inhabitants as main potential market of about 180 applications, envisaging in the range of 20-25% of them the accessible market. In addition some interests are emerging from Latin America and from the Far East.

1.2 Recommendations

Based upon the experiences in the HEAVEN project to implement measures reducing air and noise emissions by urban traffic, it is recommended:

- i. *To inter-compare models used to assess the contribution of traffic to urban air and noise quality.*

In general, member states apply nationally developed models. There is lack of information on the quality of the performances of these models, for example on accuracy, spatial and time scale. Hence, there may be differences between the various member states on the quality of the models to assess compliance with EU-regulations.

- ii. *To improve emission factors for air pollution caused by urban traffic.*

In general, vehicle emission factors are based upon EU-standardised test-cycle. However, urban traffic is characterised by stagnation, “stop-and-go” driving and cold start conditions, which results emission factors that differ substantially from those derived from standardised tests. Hence, application of more realistic emission factors is especially relevant in an urban environment.

- iii. *To inter-compare and further develop public information approaches regarding the impact of noise and air pollution caused by urban traffic.*

In order to inform the public, thereby also increasing public awareness, the impact of traffic on air quality and noise nuisance in urban areas can be communicated in various ways to the general public. The information may be available on a web site or in the more standard media. It may relate to excesses information only, but it may also include recommendations on preferred behaviour by the public. There is a need to compare the various approaches in the different member states in order to improve the effectiveness of the communication.

- iv. *To integrate information on air pollution, noise and safety.*

Presently, the impact on air quality, noise nuisance and safety aspects road transport are reported and managed separately. In an urban environment, traffic is a major contributor to all three aspects and hence, controlling air pollution by traffic measures may also favourably affect noise nuisance and external safety. Although HEAVEN made progress to consider air quality and noise in an integrated way, there is a need to further integrate these issues, especially safety.

- v. *To inter-compare the effectiveness of various traffic measures.*

In various member states, different traffic measures are implemented to reduce air pollution and noise impact caused by traffic. These measures relate e.g. to speed control, to establishing one-way traffic and to reducing the number of specific vehicles on a road, such as buses and trucks. There is a need to further evaluate the cost – and environmentally effectiveness of these various traffic measures and to develop action plans where they are required.

- vi. *To emphasise environmental and traffic management directed at “hot spots”.*

Excesses of standards are generally related to relatively small areas within a city, for example near a heavy-traffic road crossing or stagnant traffic in a street canyon. In the integrated assessment methodologies used for the preparation of European air quality legislation, hot spots like this – and even to some extent the urban scale – are not systematically addressed. These hot spots are not only important from the legislative point of view, but also need attention because they are often subject to large public concern.

1.3 Consortium composition

The HEAVEN project consortium combined valuable expertise in the field of transport and environment of research institutes, the private sector (leading industry and supporting consultants), and the public sector. HEAVEN partners brought into the project experience and assets in terms of available advanced infrastructure for the monitoring and modelling of environment quality (air and noise) and transport flows, policy commitment to investigate and implement TDMS, in order to reduce congestion and negative environmental impact and already successfully implemented TDMS (pay parking, access control areas, road pricing initiatives, etc.).

The following cities served as the demonstration sites of the project:

Berlin;

Leicester;

Paris;

Prague (as a representative from an accession country);

Rome; and

Rotterdam.

An overview of the HEAVEN consortium and the status and role of the partners is provided in the following table.

Table 1: HEAVEN partners, status and role

Sector Affiliation	Participant Name	Country	Status
Public Sector	Società Trasporti Automobilistici S.p.A. (STA)	Italy	C
	Senatsverwaltung für Stadtentwicklung Berlin	Germany	PC
	City of Rotterdam	Netherlands	PC
	DCMR Environmental Protection Agency	Netherlands	AC
	AIRPARIF	France	PC
	Ville de Paris	France	AC
	DREIF/SIER	France	AC
	Leicester City Council	U.K.	PC
	City Development Authority of Prague (URM)	Czech Rep.	PC
	Institute of Municipal Informatics of the City of Prague (IMIP)	Czech Rep.	AC
Institute of Transportation Engineering (UDI)	Czech Rep.	AC	
Industrial Suppliers and R&D Companies	Mizar Automazione S.p.A.	Italy	AC
	Elsag S.p.A.	Italy	AC
	IVU Traffic Technologies AG	Germany	AC
	Swedish Meteorological & Hydrological Institute (SMHI)	Sweden	AC
	Czech Hydrometeorological Institute (CHMU)	Czech Rep.	AC
ARIA Technologies	France	SC	
Research and Dissemination Institutes	World Health Organisation (WHO)	Italy	AC
	Neth. Organisation for Applied Scientific Research (TNO)	Netherlands	AC
	Institute for Transport Studies (ITS), University of Leeds	U.K.	AC
	European Academy of the Urban Environment	Germany	AC

Sector Affiliation	Participant Name	Country	Status
Consultants	B&SU	Germany	AC
	Goudappel Coffeng	Netherlands	AC
	Carte Blanche Conseil	France	AC
	MERCUR	France	AC
	ECOAIR	Czech Rep.	SC
	Luca Persia	Italy	SC
Key Sub-Contractors	Heich Consult	Germany	SC
	Rupprecht Consult – Forschung und Beratung GmbH	Germany	SC
	Regional Env. Centre for Central and Eastern Europe (REC)	Hungary	SC
<u>Legend:</u>			
C:	Co-ordinator	PC	Principal Co-ordinator
AC:	Assistant Co-ordinator	SC:	Sub-Contractor

2 Project Objectives

The project's *high-level goal* was to develop and 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 demonstration in large urban areas provides a concrete sustainable development perspective and will improve 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).

This high-level 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 and their effects on health;
- Investigate the data needs of health experts and the implementation of a valid data exchange platform with health authorities;
- Identify the concrete benefits of these measures for sustainable urban development and the quality of life in cities;
- Generate commercial value out of the project;
- Draw conclusions for the implementation of local noise and air quality action plans.

Due to the nature of the project a number of *operational objectives* related to the Research and the Demonstration phase of the project have been defined. Table 2 all operational objectives for both phases and how they are related to the high-level objectives.

Table 2: High-level objectives and how they relate to RTD and demonstration goals of HEAVEN

High-level objectives	Overview of operational goals related to demonstration	Summary of operational goals related to RTD
Improve the basis for decision-making through integrated and real time information on key pollution factors.	D1: Demonstrate new monitoring technologies.	R1.1: Use DOAS-based measurements for validating and refining air models, and verification of the DOAS system
	D2: Validate the improvements in forecasting quality of new air and noise quality models	R1.2: Develop online connections (interfaces & methods) between environmental monitoring networks and model suites. R2.1: Develop methods and interfaces for linking real-time traffic databases to the environmental modelling process. R2.2: Select and calibrate emissions, dispersion and noise models. R2.3: Modify individual models and to adapt the overall modelling process.
	D3: Provide contents, operate and demonstrate the benefits of a comprehensive decision support system.	R3.1: Develop an integrated decision support system to evaluate mobility related emissions of TDMS
Inform key actors (including the public) on the state of air and noise pollution levels and their effects on health.	D4: Implement an information platform on air and noise pollution (and health-related information)	R4.1: Develop an integrated information platform on ambient air/ noise quality
	D5: Involve citizens in consultation processes and to raise their awareness on the effects of mobility decisions	R5.1: Develop models for local awareness raising & public consultation.
Investigate the data needs of health experts and the implementation of a valid data exchange platform	D6: Implement a valid data exchange platform with health authorities.	R6.1: Identify the data requirements of health authorities.
Identify the concrete benefits of these measures for sustainable urban development and the quality of life in cities.	D7: Evaluate the environmental effects of the demonstrations in the project.	
	D8: Analyse the socio-economic benefits and user impacts of the demonstrations in the project	R8.1: Develop a common validation plan for all project sites. R8.2: Further develop impact assessment methodologies (air/ noise and socio-economic impacts)
Generate commercial value out of the project.	D9: Commercially exploit the project end products.	N/A
Draw conclusions for the implementation of local noise and air action plans.	D10: Identify best practice solutions and disseminate widely to other urban actors.	N/A
	D11: Make recommendations to the European and national legislation process on noise and air quality.	N/A

3 Approach

The HEAVEN consortium selected an approach for the development and demonstration of the DSS which took account of the complexity of the project. Starting point was the development of **an overall system concept**. This stage was followed by an extensive **user need analysis** which provided substantial input to the system development. The subsequent system **verification** proved that the system worked as designed. A large scale demonstration of the HEAVEN DSS in the six project sites took place in the last year of project lifetime and was concluded by a overall evaluation. These stages of the HEAVEN approach are described in deeper detail in the following.

3.1 The HEAVEN DSS Concept

HEAVEN DSS combines **near real-time** traffic flow information into emission and dispersion models so as to determine 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.

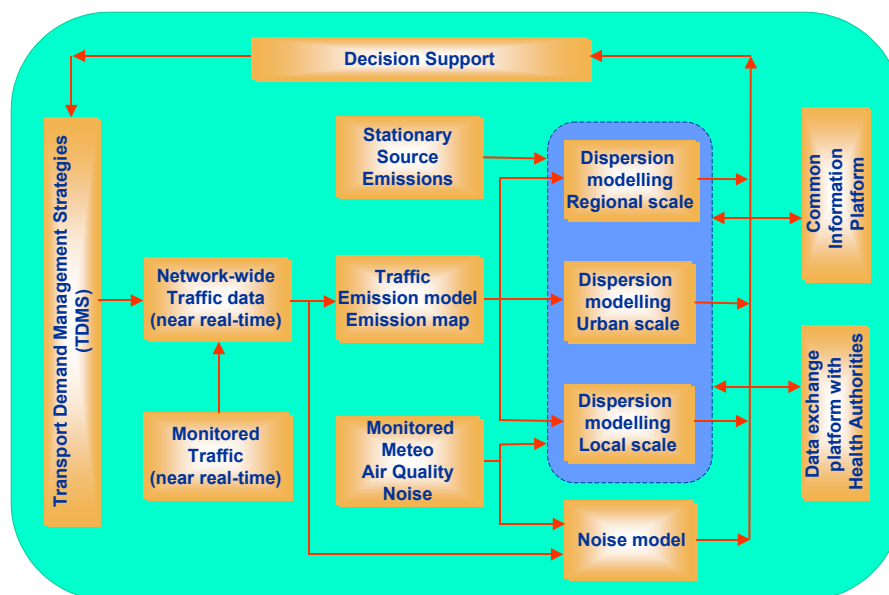


Figure 1: The HEAVEN DSS general concept

Figure 1 above describes the HEAVEN DSS building blocks concerned with Traffic and Environment modelling and their connections, and provides a representation of the general concept of the HEAVEN DSS. This general concept can be briefly described through the following points:

- The TDMS implemented in the urban area is expected to influence the traffic status in the network. Traffic is partially measured in near real-time via traffic detectors. These measurements contribute to the **near real-time traffic status estimation performed through a network-wide traffic model**. The dynamic traffic representation forms the input for the subsequent environmental models.
- Emission models calculate the **traffic related emissions** for each link of the network for a number of primary pollutants based on measured and modelled traffic characteristics. The network-related traffic emissions are then fed into **dispersion models** to calculate air quality **concentrations**. This process considers emissions from stationary sources from emission inventories and data on background concentrations from monitoring networks when available. Depending on the type and the spatial scale of the dispersion model, other data (i.e., topographic, meteorological) will also be used in the modelling process.

- The **noise model** makes use of much of the same traffic data input, together with additional information, including road surface data, topographical data, and data about the physical built environment (i.e., surface attenuation by buildings, shielding, reflection, etc). The noise model also includes information concerning static sources.
- The DSS building blocks “Traffic Detectors” and “Monitoring Sensors for Meteo, Air Quality, Noise” that are shown in the diagram are **data suppliers**. These blocks have to be processed and interpreted as the DSS interfaces between the system and the infrastructures and monitoring systems.
- The results of the emissions, air quality and noise modelling and forecast are fed into the **decision making process** and together with the traffic and environment monitoring data contribute to the building of the **Common Information Platform** of the HEAVEN system. Contents of this platform are intended also for dissemination to professional users, as well as to the public. A specific channel has been foreseen for data exchange with the Health Authorities.

3.2 User needs analysis

HEAVEN was a **user-driven project**, in which the specific needs of European cities in the field of environmental monitoring and modelling are well considered. Exploitation prospects of the end products are enhanced, through the involvement of user groups in the process of the development, demonstration and validation of products. The three user groups public administration, decision makers and general public have been involved in the user needs analysis.

Already at the early stage of the project the user groups have been approached to analyse the **user requirements** relating to the use of systems, data needs, requirements for technical system performance, user friendliness, possible soft- and hardware restrictions and legal issues. The main tool for performing the user needs analysis was a three-part questionnaires.

The results from the user need analysis provided significant input to the process of system development. During the verification phase of the project a small sample of the users was involved by providing suggestions on how the product can be modified to better meet their needs. This feedback from the validation process enables industrial suppliers to exploit the system according to the real life use of prototype applications.

3.3 System development

The characteristics of the HEAVEN DSS were derived from **system requirements** – context, functional and non-functional requirements – which reflect the user needs identified by the **User Needs Analysis** and include operational and organisational requirements. The User Needs Analysis provided extensive and articulated requirements for each DSS demonstrator and highlighted different backgrounds (e.g. existing models and infrastructures) between the project sites.

So, aiming at the implementation of demonstrators consistent with the common HEAVEN DSS concept, although **duly customised according to the needs of the sites**, and addressing **system modularity** and **transferability** issues, the project approached system design and development following a **top-down process** :

- (a) To design at first a **common Overall System Architecture** consistent with the HEAVEN DSS and
- (b) to **derive subsequently the local DSS architectures** from the common overall architecture taking care of the peculiarities and backgrounds of the sites.

Figure 2 presents the main **functional blocks** of the HEAVEN DSS and the **data flows** that constitute the dynamic information chain between the functional blocks and the DSS Data Base. In this high level functional diagram, the DSS Data Base is conceived as the complete set of **all the data repositories** of the system, including the actual system data base as well as any file system implemented to store input data, intermediate data and output data of the DSS. According to this conceptual view, the DSS DB performs the elementary functions of data organisation, archiving and retrieval not explicitly identified in the DSS functional blocks that access the DB.

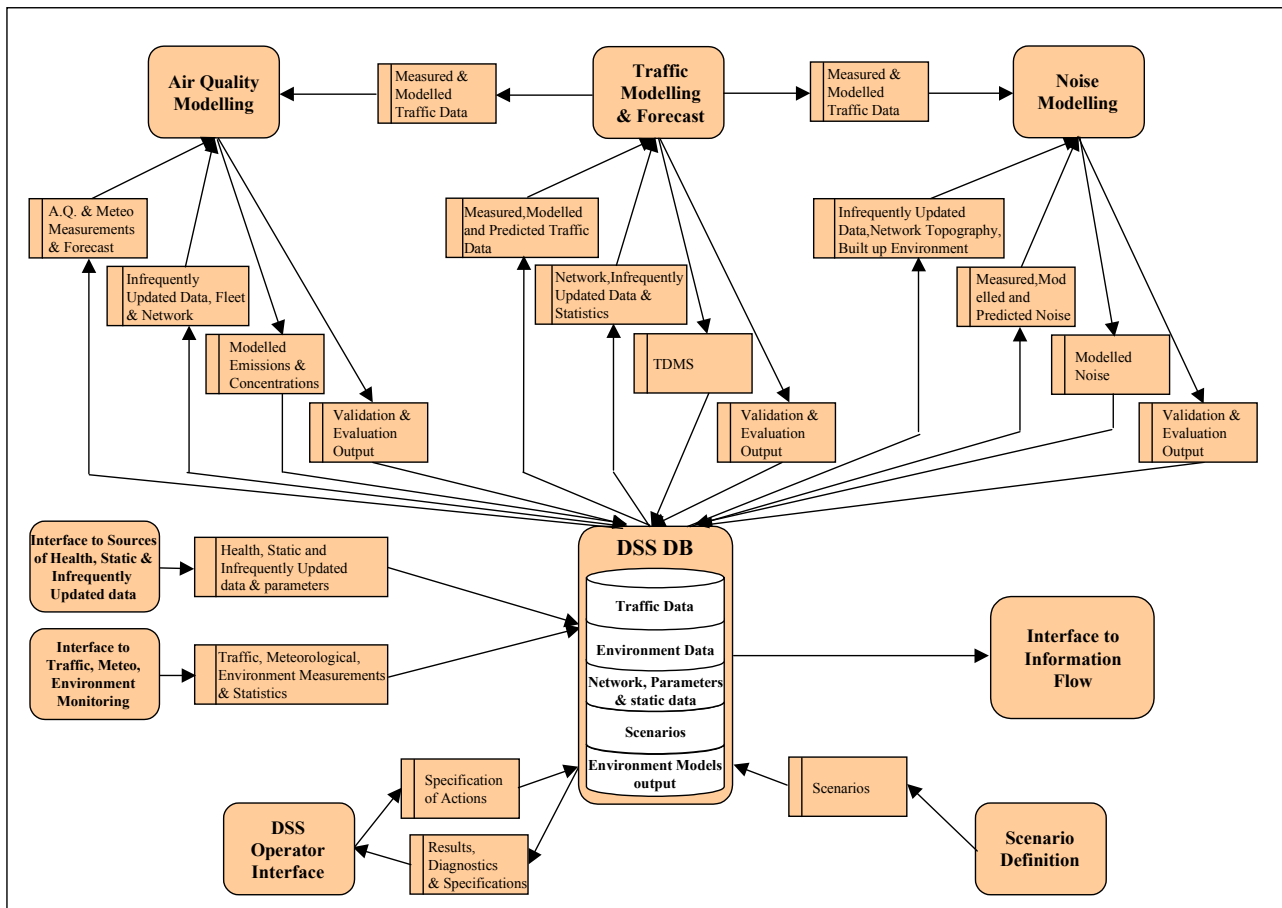


Figure 2: The HEAVEN DSS Overall System Architecture

There are three different categories of *DSS interfaces*. The **Interfaces** to Traffic, Meteo and Environment Monitoring that implement connections to the respective monitoring systems, and provide for the collection, organisation and storing in the DSS DB of the measurements, estimates and statistics obtained from such systems. The Interface to sources of Health, Static & Infrequently Updated Data represents the set of procedures to feed the DSS modelling processes with the data required. Through the Interface to Information Flow the tasks needed to extract from the DSS DB the information to be provided to the Common Information Platform users, and to deliver the information in the form expected by the users are managed.

The *DSS Modelling and Forecast Functional Blocks* concerned with **traffic and environmental modelling** and forecast are grouped in three main functional blocks linked in a dynamic chain fed by the near real-time traffic and environmental measurements and modelled data. The three functional blocks as a whole perform the evaluation of the impacts on traffic, air quality and noise of the planned/actuated TDMS. These components are **fully integrated in the HEAVEN system**. This is because air quality and noise models rely on traffic data as inputs and therefore have to work in co-operation with the same modelling framework both in time and space. It is only through **integration of legacy systems and models** as in the HEAVEN project will users experience the huge potential.

The *DSS Operator Interface* consists of a user-friendly environment that supports the operator activities concerned with the DSS maintenance and operation. For what is strictly concerned with the use of the DSS for TDMS evaluation and environment monitoring, three main sets of sub-functions are identified:

- Information presentation and management,
- Operator Intervention,
- Scenario results evaluation.

The *Scenario Definition* identifies the context and the environmental conditions where the TDMS is actuated (or simulated) and evaluated. A **scenario** is defined as a set of coherent information related to a well-defined time period. It consists of traffic demand, available road network, possible traffic restrictions (or any other TDMS), near real-time traffic data, meteorological data, and environmental measurements. The scenario can be built supported by the DSS to record actuation conditions and impacts of an implemented TDMS.

The overall system architecture described above has been used as a reference to derive the architectures of the site-specific DSS systems taking the peculiarities and backgrounds into account. **Based on the site-specific system architectures the actual system development has been undertaken by the local teams.**

3.4 System verification

HEAVEN verification was based on a **common verification concept** necessitating that indicators are measured in the same way, or at least yield comparable results across the sites. A list of common verification indicators, which took account of the main processes, data flows and data stores of the DSS have been defined. The indicators were grouped into the three main themes of verification:

- a) Testing physical functioning of the system,
- b) Preliminary user acceptance
- c) Accuracy of roadside modelling and monitoring

The tests on the *physical functioning of the system* showed that in general the different components are functioning 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 were satisfied, very supportive and enthusiastic. Recommendations for changes were made and have been incorporated in the design where possible.

Within verification the results for **accuracy of modelling and monitoring for roadside description** in the cities are 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.

3.5 Demonstration

After concluding the HEAVEN system development and system verification the prototypes have been put into operation under real-life conditions in all six project cities. The large-scale demonstration had the overall objectives to:

- a) test the HEAVEN DSS under real-life conditions,
- b) provide the basis for evaluating the benefits all stakeholders can gain and
- c) use the system to assess the environmental impacts of Traffic Demand Management Strategies by means of the HEAVEN DSS

The HEAVEN application sites were central to the success of the project since they demonstrated how HEAVEN DSS works in practice and how its systems can contribute to improved transport planning and a

cleaner environment. The application sites are situated in the six European cities participating to the project: **Berlin, Rome, Paris, Prague, Rotterdam and Leicester.**

HEAVEN builds on a solid base of previous and ongoing work in the area of Transport Demand Management and environmental management in urban areas. The foundation is twofold:

- first HEAVEN project cities were **already using various infrastructure** consisting of hardware and software tools (traffic sensors, environmental monitoring networks, emission and dispersion models) and
- second had considerable **experiences** in developing Transport Demand Management Strategies (TDMS) and **evaluating** their environmental effects on different spatial and temporal scales.

This knowledge originated from the long-term involvement of many project partners in related national and international initiatives and projects.

Further **information** about the HEAVEN project cities, demographics, traffic characteristics, local peculiarities and demonstration areas can be found in **Annex 1** of this report. A summary of the Transport Demand Management Strategies and the associated environmental impacts are described in Section 4.3 of this report.

3.6 Evaluation

Evaluation had a key role in the project to establish the benefits all stakeholders, i.e. internal and external users of the HEAVEN products, operators, and content providers could gain from the developed system. The evaluation of the achieved results allowed the project **to verify to what extent the project had met its objectives**, what impacts had been generated on the city level and what European added values could be identified.

Despite the fact that the DSS was implemented and applied in six different European cities, the HEAVEN evaluation was based on commonality. One of the major challenges within evaluation, therefore, to reach full agreement among the Evaluation Team on the concept, common impacts and indicators, operational methods, and other specifics of evaluation. “**Commonality**” was the centrepiece of the HEAVEN evaluation process. Two main aspects were considered in establishing a common evaluation basis:

- The definition of impacts and indicators common to all sites.
- Indicators selected for measurement in all sites needed to be measured in the same way, or at least yielded comparable results across the sites.

The challenge to reach commonality lay in the range of technical and institutional framework conditions, the variety of existing methods of measurement and statistical considerations, as well as the formulation of different reference cases and success criteria across the cities.

As part of the evaluation framework the project defined the following main impacts:

Impact 1: Enhanced description of current environmental situation

Impact 2: Enhanced environmental scenario analysis

Impact 3: Improved access and quality of environmental information, divided into:

Impact 3A: For professional users and

Impact 3B: For public users.

Impact 4: Improved institutional co-operation

Impact 5: Increased support of urban planning on an environmental basis

To measure these impacts in a comparable way across the sites **24 indicators** together with common assessment tools have been defined.

The evaluation team summarised the main results of the evaluation as follows:

HEAVEN **was a successful project**. The system developed has the potential to become a widely accepted and implemented tool to support key actors in their decision making with regard to traffic, air quality, noise, and beyond.

HEAVEN developed and demonstrated a DSS to evaluate environmental effects of TDMS. **The project objectives were to a large extent achieved:**

- Decision makers have more and better quality environmental data at hand in the common HEAVEN data repository, including valuable test results from traffic management scenarios.
- Key actors in urban planning issues, including the general public, can now quickly be informed on the current state of air pollution levels as well as noise to be enabled to make decisions.
- HEAVEN allowed conclusions to be drawn in regard to the implementation of local noise and air quality action plans in accordance with current EU legislation.

The impacts identified by the Evaluation Team were **all achieved** (either partially or completely).

Annex 2 of this report provides a summary of the evaluation results per impact.

4 Project results and achievements

4.1 The HEAVEN DSS

The main achievement of the HEVAEN project is clearly the development and successful demonstration and evaluation of the HEAVEN DSS and its application under real-life conditions. The HEAVEN DSS makes use of use a **variety of existing infrastructure** (e.g. traffic- and air quality monitoring networks), software tools (traffic and environmental models) and **integrates** them by means of IST technologies. The HEAVEN DSS is an integrated, modular system which supports “tactical” and “strategic” decisions. Through the application of the HEAVEN DSS it is possible for cities to:

- obtain a **near real time description** of the traffic and environmental situation in urban agglomerations,
- **assess** the environmental efficiency of already implemented Traffic Demand Management Strategies,
- perform extensive **scenario calculation** and assess the environmental efficiency of Traffic Demand Management Strategies prior to their costly implementation and,
- **inform** professional users and the public in near real time about the traffic and environmental situation
- **assist cities** in identifying compliance with the **EU Directives** associated with Air and Noise Quality Review and Assessment procedures
- **assist** decision makers in formulating policies with public participation

The HEAVEN DSS provides a concrete sustainability perspective and will improve the quality of life in European cities by reducing transport-related noise and air pollution. The HEAVEN DSS supports European cities in implementing existing and forthcoming EU legislation on air quality and noise.

4.2 The HEAVEN tools

Through the development of the HEAVEN DSS concept and the implementation of the local DSSs, HEAVEN has produced a valuable set of results that constitute “tools” to support the exploitation initiatives being undertaken and envisaged by the HEAVEN partners.

The main characteristics of some of the HEAVEN “tools” that have been selected to represent the project “physical” end-products are described below.

4.2.1 The HEAVEN DSS Concept and Demonstrators

The main project result is the *HEAVEN DSS* by itself, which is an advanced tool conceived to support the decision making processes by

- facilitating the evaluation of the impact of the transport demand management strategies on traffic and environment,
- integrating traffic and environment legacy systems,
- and enabling near real time air quality, traffic and information management.

The *HEAVEN DSS Demonstrators* are implementation of the DSS concept, developed according to specifications and solutions that depend on the characteristics and peculiarities of the Project sites. Such system concept allows **partial or complete transfer to other application sites** and is the subject of exploitation intentions of the project partners.

4.2.2 The HEAVEN DSS Reference Architecture

The HEAVEN DSS reference architecture has been designed starting from a deep analysis of user needs and technical requirements, and taking into account modularity and transferability issues. It is provided with open interfaces that offer flexibility and facilitate the integration with existing systems and models as well as further enhancements.

4.2.3 New and enhanced Traffic and Environmental Models

The implementation of the HEAVEN DSS concept in the sites has been conducted according to local needs and constraints. In particular in some sites **existing traffic and environmental models have been adopted**, in others new models have been acquired. In general the models have been enhanced and adapted to work on the basis of near real traffic, meteorological and environmental data.

In general the environmental models adopted in the sites are different although provided with some **common key features**:

- based on real time traffic data and meteorological information
- provided with forecast capability
- capable of background updating
- featured with statistical post processing.

As far as the **traffic modelling** is concerned, all the sites adopted models for Origin and Destination (O/D) matrix estimation and traffic assignment in the urban areas (in two sites traffic has been modelled in regional areas as well), the models are able to take into account local area closures and capacity restrictions, and the modelled data are on a hourly basis.

4.2.4 Model Integration and Operation Schemes

The implementation of the HEAVEN DSS concept in the demonstration sites led to different schemes for on-line and off-line integration and operation of traffic, air quality and noise models.

The complexity of these schemes depends on the characteristics of the systems and models involved. The higher level of complexity has been achieved in Leicester where country wide, regional, city and local models operate for on-line and off-line applications. This scheme is described in more detail in chapter 2.

4.2.5 Software Developments

The implementation of the different demonstrators led also to site specific software developments. Some **important development** has been done taking care of future possible portability to new realities. This is the case of: **Interfaces to legacy systems:**

In all the sites the HEAVEN DSS interaction with **existing and new traffic monitoring and control systems**, air quality, noise and meteorological monitoring systems, and with forecast models required the implementation of specific software interfaces.

As a result, a **significant set on interfaces** have been developed that are ready to be ported because they are flexible to accommodate:

- More and complementary data sources
- On-line and off-line data
- Different data accuracies and data bases

Operator Interfaces based on common features:

User friendly Operator Interfaces have been developed in the different sites according to a common concept: to develop a tool able not only to represent by nice diagrams the system outcomes, but also to support system management, on-line and off-line results analysis, TDMS definition and evaluation, scenarios definition, etc

Information Platform and solution to interact with Citizens and Authorities:

According to the site characteristics, the interaction of the HEAVEN DSS with citizens and Authorities has been implemented by specific media and solutions, in support of the concepts agreed in the Aarhus Convention

Validated Scenarios and TDMS

Demonstration in the sites is leading to the evaluation and assessment of **different TDMS** according to:

- Sound traffic, environment and meteorological scenarios
- Common criteria (impacts on traffic, air quality and noise)

The TDMS being evaluated imply actions that all the sites are interested in:

- Speed reduction
- Traffic circulation restrictions
- Area closures

The set of **validated scenarios** is forming an important background knowledge the project can disseminate among all the new realities interested in.

4.3 Scenarios and TDMS

In addition to the system development and demonstration the HEAVEN DSS has been applied **under real-life conditions in the project cities** Berlin, Leicester, Paris, Prague, Rome and Rotterdam. The environmental impacts of already implemented traffic measures have been assessed. Furthermore the HEAVEN DSS was used for extensive scenario calculations where the environmental efficiency of various Traffic Demand Management Strategies has been assessed prior to their costly implementation. The traffic measures which have been considered in the framework of the project comprise for example changes of the vehicle fleet, access restrictions, speed limits, park-and-ride scheme and changes to the street network. The nature and the results of this application of the HEAVEN DSS across the project cities will be briefly described in the following. Table 3 provides an overview about the major implemented traffic measures and the scenarios which have been assessed by means of the HEAVEN DSS. A **full** reflection of the respective measures and the results are reported in detail in the project **Deliverables D8.7 – D8.12**.

Table 3: Scenarios and Implemented TDMS

City	Scenario	Implemented TDMS
Berlin	City wide long term scenario 2005, Euro III fleet	Truck ban
	City wide long term scenario 2010, Euro IV fleet	Speed limit 30 km/h
Leicester	Air Quality Review and Assessment (2005) Park & Ride scheme for A 5460 Air Quality Management Area Park & Ride scheme for A 5460 Noise levels	Air Quality Management Areas
	Park & Ride schemes for the Leicester West Transport project	The A47 Hinkley Road Park and Ride Scheme
Paris		New bus lanes
		Car free day 22 Sept. 2002
Prague	Master plan 2010 vs. alternative ringroad	One-way Smichow, traffic claming
	Speed reduction from 70 to 50 km/h	
Rome	Access restriction for non-catalyst cars	
	Closing of a main road	
Rotterdam	New roads	80 Km/h speed limit on a highway

4.3.1 Berlin

The local measures *truck-ban* and *30 km/h speed limit* were jointly implemented in the demonstration area Beusselstraße during the demonstration phase of the project. Prior to the implementation the HEAVEN system was used to calculate the likely effects these measures would have on air- and noise pollution. These calculation showed that a combined implementation of both measures would reduce PM10 by 13,1 % and NO₂ by 16,3 % while the noise levels would be reduced by 5,7 dB(A).

Two city wide long-term scenarios have been assessed by means of the HEAVEN DSS. The first scenario had a time horizon of 2005 and assumed that all vehicles would fulfil the Euro III emission standards. The second scenario addressed the year 2010 assuming that the entire vehicle fleet meets the Euro IV standards. For both scenarios the expected traffic volumes and the expected back ground concentrations for the respective year have been calculated. Theses scenarios were then compared to the situation in 1998 as a reference case. The analysis of the results shows that the PM10 pollution will be reduced by 16 µg/m³ as a result of the lower emission and the resulting background pollution. However, the PM10 concentration will remain high and will exceed the forthcoming limit values on a high number of street segments in Berlin. The Situation for NO₂ will be very similar to the one for PM10. In certain areas in the inner city the roadside NO₂ pollution can be decreased by more than 20 µg/m³. However, the pollution situation remains critical on certain streets in Berlin.

4.3.2 Leicester

The initial task for the HEAVEN DSS was to support the Leicester Air Quality Review and Assessment, which designated several Air Quality Management Areas in December 2000. The Stage 3 identified Nitrogen

Dioxide and Particulate Matter (PM₁₀) as problem pollutants. Ozone is not covered by the current review, although it has also been identified as a problem for Leicester. A selection of Traffic Demand Management Strategies included in the Local Transport Plan were analysed. Annual NO_x Exposure results for winter and summer conditions were analysed for Park & Ride proposals associated with the Leicester West Transport Scheme on the A6 Loughborough Road, A50 Glenfield Road and the A426 Aylestone Road for inter-authority negotiations and the public consultation process together with the A47 Hinckley Road scheme which is now operational. In addition annual NO_x exposures using a street canyon model for a Par & Ride proposal on the A 5460 Narborough Road Air Quality Management Area. All results illustrated a reduction between Winter and Summer, as well as before and after P & R scheme. The AVTUNE Sound Noise Emissions model was also deployed on the A5460, identifying lower levels after implementation. The 20% speed reduction and No HGV's scenarios required a revised assessment of the traffic flows as a result of the revised criteria. This resulted in peak hour spreading together with re-routeing which increased the overall exposure levels. An analysis of Winter and Summer data from the HEAVEN DSS and 13 Roadside Pollution Monitors. Output from over 4000 receptor point annual average calculations was linked to a Geographical Information System to provide data for a statistical analysis assessing cohort study children locations throughout the day.

4.3.3 Paris

The City of Paris has implemented bus lanes which are physically separated from the other lanes in their present form during summer 2001. The use of the bus lanes is restricted to public transport, taxis, cyclists, police, emergency vehicles and cash transport. In the framework of HEAVEN three concerned streets: Rue de Rivoli (a section of 2.25 km, Boulevard de Sébastopol (1.28 km) and Boulevard de Strasbourg (0.63 km) have been studied. The study compared data from 3 periods : October 2000 (before the implementation), October 2001 (just after implementation), October 2002 (one year after implementation). Each period was represented by data profiles for an average working day, the average day being extracted from the raw data of the first 3 weeks of the respective month. The investigation comprised the emissions of CO, NO_x, PM10 and CO₂ as well as air quality concentrations.

The results for *Rue de Rivoli, Boulevard de Sebastopol and Bouluevard de Strasbourg* show that the emissions have diminished by amounts between 3 and 19 %. Depending on the street, the pollutant and on the period, the emissions thus amplify or attenuate the variation observed in traffic volume. The impact on air quality concentration is less pronounced than on the emissions. On the three sites, the results show a decrease in the pollutant concentration levels. The decrease is between 4 and 10 % for CO, between 2 and 4 % for NO_x, and between 1 and 2 % for PM10. The decrease is weaker than for emissions, since the background levels are added.

The HEAVEN DSS was also used for evaluating the impact of the *car-free day* "En ville sans ma voiture" of Sunday 22nd of September 2002. On this day, access to six designated areas has been restricted to public transport vehicles, taxis, bicycles, low-pollution vehicles (GPL, electrical), vehicles on duty, vehicles for handicapped persons, and residents. Speed has been restricted to 30 km/h in these areas. The restriction lasted from 9 a.m. to 7 p.m.

The impact on traffic is characterized, with respect to a normal Sunday, by a diminution of 6 % of traffic within the City of Paris, and a diminution of 63 % in the restricted areas. Speed has increased by 6 % within the restricted areas. The most significant shift in traffic composition is given by a share of 4,6 % of buses in the restricted areas with respect to 0,9 % on a normal Sunday.

In the time from 9-19 h the emissions of NO_x, CO, Particulates, CO₂ and VOC have been reduced between 47% and 30 % depending on the pollutant. in the restricted area The following table shows the variations in emissions. In the total City area an emission reduction between 15 – 10% has been observed. For all pollutants, the decrease in emissions is smaller than the decrease in traffic volume, due to partial compensation by higher speed and by a higher share of buses. The impact on street level concentrations has been determined by hourly measurements on two sites. They show a decrease by up to 60 % during the restriction interval

4.3.4 Prague

Prague *Master Plan* scenario has a time horizon of 2010 and assumes mayor changes in the Prague road layout were finished. The main impact on the distribution of the emission sources has the finished city ring road on the western diameter. New residential, shopping and leisure time zones as well as the zones for new jobs (office, light industries, etc.) will generate higher traffic demands, of which considerable part will be realised by car traffic. The Master Plan traffic solution should lead to rerouting of the transit traffic out of the city centre to the twofold ring road system, which consists of main 'motorway' ring road and inner city circle. The latter ring is designed to reduce the inner city transit traffic which is now located at the main roads which cross the historical part of the city centre, while the motorway ring road should reroute the long-distance freight and individual transport.

The calculation of the basic layout of the Master Plan provides the base case for any further investigations (e.g. the alternative ringroad) as well as reliable data on the emissions for stationary and mobile sources.

The location of the ringroad the north-west of Prague has been subject of political and public discussion from the time when the idea of the ringroad appeared. Apart from the track anchored in the approved Master Plan document, the second *alternative ringroad* is being assessed and highlighted by its lobby group. In order to compare the influence of both alternatives on the traffic loads, emissions and concentration levels, the calculation of this scenario was done by means of the HEAVAN DSS.

Calculation of the traffic volumes showed that the difference between traffic loads in the most affected inner city road links in both alternatives is not high enough to cause considerable changes in the average air quality of the areas. Both alternatives result in minor differences of about 1% for NO_x, CO and PM₁₀ for the whole city area. But the main difference between the variants is in spatial distribution of emission sources, influencing the aspects as exposition of population, etc.

In order to improve the traffic situation by reduction of congestions and make the overall traffic system more understandable for the drivers, the plan called "*One-way Smichov*" has been introduced in 2001. Within HEAVEN the impacts of implementation of the measure were evaluated. The implementation of the traffic measures was successful in terms of improvement of the congestions and the smoothness of the traffic flow, however, as the total amount of traffic crossing the modelled area remains similar, the implementation of the "*One-way Smichov*" scenario does not have any considerable effect in terms of air quality.

A part of the ring road in the Barrandov district was chosen to test the impact of a speed reduction from 70 down to 50 km/h. Reduction of speed caused rapid decline of the attraction of the road for the drivers due to the time losses which resulted by 10%-60% (depending on the part of the road) decrease of the traffic loads on the restricted road, which was balanced by redistribution of the reduced traffic to the other part of the network. Evaluation of emissions for the restricted road segment showed that reduction between 10 and 18% depending on the pollutant are estimated.

4.3.5 Rome

In recent years the Municipality of Rome introduced a number of measures aimed at reducing air pollution and traffic through the restriction of the circulation of private vehicles. A recent measure is the ban of the most polluting vehicles into the historic city centre (the so called Internal Rail Ring). To evaluate the benefits related to the implementation of this *access restriction* to the demonstration area it has been decided to simulate a scenario assuming an 100% catalyzed fleet. Moreover, this is representative of the current situation because this kind of restriction has been imposed to the city "ring road" since January 2003. Thanks to HEAVEN it is now possible to evaluate the environmental effects of this measure in deeper detail.

This analysis aims to describe the importance of having a DSS system able to evaluate real air pollution reduction on the network related to the implementation of a specific TDMS. In fact, the system allow to evaluate the real benefit related to the adoption of this access restriction policy assuming to carry out the comparison with the same demand, the same network configuration and the same meteo conditions. The analysis of the "before" and "after" scenario shows that imposing restriction on the fleet (assuming all vehicles as catalyzed) will impact positively on air pollution: in fact, a reduction of all the pollutant concentration has been evaluated: -35,5% for CO, -62,6% C₆H₆ and - 50,7% for PM₁₀.

Via Nomentana is a main traffic arteria located in the east side of the demonstration area. This street represents one of the main city road connecting the centre with many suburban small towns and it is characterized, especially during peak hours, by an high level of congestion. The *closure of Via Nomentana* of this road has been selected to evaluate how a specific action on the traffic network will impact on traffic and pollution in the short term. The evaluation of the environmental impact of this measure takes the whole area into account and is not limited on Via Nomentana only.

The analysis focuses on CO, C₆H₆ and PM10 emissions and air quality concentrations and covers the whole area. In both cases the comparison shows that closing Via Nomentana will impact negatively on air pollution: in fact, an increase of all pollutant concentration in the area has been evaluated: + 28,9% for CO, + 49,3% C₆H₆ and + 18,7% for PM10. In the following tables results in terms of emissions and concentrations is reported. This is because it was assumed that the traffic in the area will be redistributed. Due to congestions higher emissions will occur for the entire area.

4.3.6 Rotterdam

A long term measure to solve air quality problems in the Overschie area could be the construction of additional roads providing a connection between two highways (A16 – A13) and the extension of another one (A4). To extend the highway A4 to Schiedam would reduce the traffic on the A13 from roughly 150.000 vehicles/day to 90.000 vehicles/day. Linking A16 to the A13 north of the main residential areas and north of Rotterdam Airport would reduce traffic on the inner-city parts of the highways (A20 and A13). Construction of both roads would largely eliminate heavy-duty traffic on the A13 where it passes the Overschie area. For the scenarios as they have been calculated in the framework of HEAVEN a simple approach was adopted with a stepwise reduction of traffic densities from 150 to 90 and to 75 thousand vehicles. Results have shown that emissions of NO₂ and Benzene would be reduced between 20 and 60 % while PM would se very low reduction only.

Preliminary results of the test with an environmentally induced speed limit (from 100 to 80 km/h) in the Overschie demonstration area shows a significant impact. During weekdays it is estimated that the NO_x concentration in the study period is decrease by 14 %. The results correspond well to the modelled predictions.

4.4 Scientific/technological quality and innovation

Before HEAVEN the situation regarding the **environmental assessment of traffic** in urban areas can be characterised by the following resources and limitations:

- Available experiences and knowledge on city level about transport and its environmental impacts
- Existing monitoring hardware (traffic sensors and environmental monitoring)
- Existing software tools (traffic and environmental models)
- No real time interconnection between tools, models and applications
- Limited capabilities to inform stakeholders about the situation regarding traffic and environment
- Limited institutional cooperation among interested partners

To make efficient use of the available resources and **to overcome limitations an integrated IST system for the near real time assessment of environmental impacts mainly induced by traffic in urban areas was needed**. This system has been developed and successfully demonstrated within the HEAVEN project.

The **main innovations** are:

- The development of **an integrated system** for decision support to test the environmental effects of TDM strategies and to assess pollution levels at hotspots in near real-time;
- The **integration** of real-time traffic data from large complex street networks into the environmental modelling process;
- The **integration** of real-time environmental monitoring data into the environmental modelling process;

- The **refinement** of existing models so that in addition to average yearly concentrations forecasting, peak concentration models can accurately forecast, as required by new EU directives for specific pollutants;
- The **improvement** of the institutional co-operation of transport, environment and health authorities;
- The establishment of a data platform for the **assessment** of health effects caused by traffic-related environmental effects;
- The establishment of a data platform **to inform** professional users and the public about the traffic and environmental situation in near real time in accordance with the aspirations of the Aarhus Convention.

4.5 Community added value and contribution to EU policies

Urban areas are home to almost 80% of the European Union's population and most of the industry and traffic is concentrated here. Emissions of air pollutants and noise caused by road traffic are of particular concern to many European citizens. At local, regional, national and EU level efforts are being undertaken to reduce these adverse impacts on citizens and the environment.

In fact, the European Commission has already introduced a series of directives to improve air quality and to reduce noise levels. The Council Directive 1996/62/EC on Air Quality Assessment and Management (*Framework Directive*) and the associated *Daughter Directives* address the regular assessment of air quality through monitoring and modelling in urban agglomerations (< 250.000 inhabitants), call for Action Plans to improve air quality and require public information. Currently, the *Clean Air for Europe programme (CAFE)* within the 6th *Environmental Action Plan* is developing the thematic strategy for the further reduction of air pollution and its effects. Next to air quality, the problem of noise in densely populated areas is also of importance to most citizens. It is estimated that at least 20 % of EU population suffers from noise and its adverse effects on the quality of life. The *Council Directive 2002/49/EC* relating to the assessment and management of environmental noise obliges larger cities to produce noise maps, which indicate the number of people exposed to certain values of new harmonized noise indicators. On the basis of such noise maps, cities will have to develop Action Plans aiming to achieve noise limit values, which will be set on Member States' level.

Today, **European cities face the challenge to ensure quality of life and economic growth** while at the same time **controlling traffic and its related pollution**. Strategies are needed to face traffic demand and the environmental problems, but rational procedures and technical tools suitable to elaborate effective solutions are too often missing.

The **new concepts developed within HEAVEN** allow cities to assess the impacts of traffic on air quality and noise pollution in near-real time and support decision making have been developed. These innovative tools, merging monitoring- and simulation systems by means of Information Society Technologies (IST), are integrated into a Decision Support System in order to:

- Provide a **better description** in near real-time of the environmental impacts mainly induced by traffic and
- Assist the cities in **identifying Traffic Demand Management Strategies** that reduce the impact of traffic the environment.

The HEAVEN project **contributes therefore to the implementation of the above mentioned EU regulations** on air and noise quality by having developed and demonstrated new IST-environmental management tools. The application of the HEAVEN DSS in large urban areas provides a concrete sustainable development perspective. It aims to improve the quality of life in European cities by reducing transport-related noise and air pollution through the identification of innovative combinations of efficient TDMS and integrated environmental Information Society Technologies. The **application of the HEAVEN DSS will help cities to meet established EU directives setting threshold values for air pollution and noise.**

4.6 Contribution to Community social objectives

The high level objectives of HEAVEN to reduce traffic related air and noise pollution and to inform key actors and the public ensured that the project contributed considerably to the following community social objectives:

- Improving the quality of life and health;
- Protecting the natural environment;
- Promote public participation and consultation;
- Ensure the accessibility to information.

The project included six major European cities which all face significant problems of traffic related air and noise pollution. In the long term, the activities to reduce pollution in these six cities will have direct impacts on the quality of life of several millions of people.

Sustainable urban development and quality of life

On the basis of the decision support systems developed in the HEAVEN project, cities will improve their possibilities to implement short-term TDMS, which respond immediately to high concentrations of air pollution at “hot spots”. The project therefore identifies solutions to high levels of pollution; it identifies when short-term changes to reduce hot situations will be effective or identifies when more long-term solutions are required. Moreover, cities will use the decision support system as a tool for planning environmentally friendly transport management strategies for the whole city.

The realisation of environmentally friendly TDMS, which reduce car traffic and thus the level of pollution, contributes significantly to a healthier and more environmentally friendly life in urban areas. A lower density of car traffic in certain areas will lead also to an upgrading of public spaces and therefore to a more socially friendly environment.

Decrease health risks through information services

The transport activities in urban agglomerations have adverse effects on the environment and on health, i.e. through air pollution and noise. Research on the reduction of vehicle related environmental burden as well as on the health impacts is essential for a sustainable development. Dealing with health impacts will ensure that both the health and environmental impacts are considered, along with the objectives of environmental improvement and economic development.

HEAVEN provides near real-time information on air quality and noise in order to validate the health effects of air pollution. The efforts of HEAVEN are a first step towards building on-line information services on the exposure of health damaging pollutants at “hot spots” at a certain time and about the measures to be taken. The provision of data on potential health effects of traffic related pollutants allow health organisations to introduce near real-time information services to the public and to especially affected or sensitive population groups (i.e. asthmatics). By means of these information services, health authorities can warn the public of potential hazardous concentrations of air pollution and give recommendations of how people should respond in critical situations of high concentrations of pollutants. Consequently, improved data on health effects of traffic related air pollution can reduce the risk of the detrimental effects on health caused by high emission levels.

High quality information to the public and to professional users

HEAVEN improved the data quality concerning existing air and noise pollution. A clear social benefit of the project can be seen in its support to making environmental data available to the public, media and authorities by finding new ways of data presentation through visualisation and interactive use. HEAVEN developed new solutions so that the huge amounts of environmental data can be used in the most efficient way and that essential information can be presented in an operable manner. As a result HEAVEN demonstrated possibilities of how the increasing demand of citizens to obtain access to high quality and up-to-date information on the status of the environment can be met.

Enhanced public consultation and participation

HEAVEN assists to the improvement of the overall relationship between citizens and public authorities, since this information policy allows the establishment of wider consultation processes and improves the transparency of decision-making processes.

Within the HEAVEN project the demonstration of environment-oriented TDMS were accompanied by awareness raising campaigns. In order to raise the public acceptance of TDMS in general but also for specific user groups that might fear mobility restriction, the TDMS that have been demonstrated and their results have been discussed with the public and the affected user groups. Thus HEAVEN provided innovative solutions for public consultation and participation in transport policies, allowing individuals to see how their mode choice can impact the environment.

Support decision-making processes for political action

The availability of real-time data on environmental pollution means that public authorities will obtain support for facilitating the decision making-process for political action to reduce pollution. The project developed methodologies of how real-time traffic and environmental data can be used as a decision support for implementing different strategies of Transport Demand Management. This means that the effects of urban traffic as well as the effects of certain TDMS on health and the environment have been made more obvious not only to the planning authorities, but also to the public. Decision-makers are now more obliged to look at factual information when discussing different policy strategies and therefore the whole decision-making process became more transparent.

Improved institutional co-operation

The task to reduce traffic related environmental stress requires co-operation of the local and regional traffic and environment administrations. In all cities the environment and traffic administrations have closely co-operated in order to implement and validate environmentally friendly traffic management measures. This is an essential step towards the reduction of traffic-related pollution and supports the EU-directives to improve ambient air quality. The cities involved in HEAVEN were committed to the project objectives and the necessary work to be done in order to meet these objectives. The project actively stimulated the co-operation between the different administrations. The set up and review of air quality management plans in the light of local transport plans facilitated the co-operation especially between those who are responsible for traffic and environment. In addition consultation and co-operation took place with the local health authorities as part of the health database implementation.

4.7 Economic development and S&T Prospects

The **end products** of HEAVEN will be in **highly demand amongst European cities** since they are giving considerable support for complying with existing and forthcoming European and national legislation on air and noise pollution. The end products allow cities to implement innovative concepts for improving environmental monitoring and modelling which result in clear benefits for the overall quality of life in cities. Therefore **the products are suitable for the market of advanced Information Society Technologies**.

The attractiveness of a city or a region will become increasingly dependent on the quality of the environment. Therefore the role of environmental quality in the decision process for finding a location for investment will increase. Environmental pollution will have serious negative impacts on the economic prospects of a city or a region. In particular high levels of air and noise pollution can in the long run have considerable effects on the overall attractiveness of a city, since public health and the values of cultural heritage and property can be reduced.

In order to achieve long-term and sustainable improvements to the environment, policy strategies for preventing environmental damage, become more important. According to that, the **demand of environmental technologies is already changing from end-of-pipe technologies to additive technologies and integrated technologies** that allow the implementation of measures to prevent environmental damage.

It is expected that the **global environmental technology market will double in the next eight years**. The number of companies in the sector of environmental technology has increased four times since 1990. The growth of this sector will be highest in integrated and preventive technologies, as developed in the HEAVEN project. HEAVEN will provide advanced environmental IST which contribute to the prevention of pollution rather than simply establishing "end-of-pipe-control".

5 Deliverables and other outputs

5.1 Major project deliverables

Table 4: List of major project deliverables

Del. no.	Del. Name	Scope
D1.1	Final Report	This reports describes ad publishes the project results
D1.2	Technology Implementation Plan	Defines the framework for the further development, dissemination and use of the results
D 2.1	Project Presentation	Gives a brief overview about the project
D 2.2	Dissemination and Use Plan	The dissemination and use plan sets out the framework for dissemination and publicity activities.
D 2.3	Technical Workshop	At a technical workshop, held on 7 th December 2001 in Paris, the interim results of the project have been presented and discussed with about 100 participants.
D 2.4	Final Project Conference	At the final conference, held on 5/6 th December 2003 in Prague, the final results of the project have been presented and discussed with about 150 participants.
D 3.1	Final Evaluation Plan	Defines the overall evaluation framework built on common impacts and indicators.
D 3.2	Evaluation Report	Reports on the evaluation results as they were established on the overall evaluation framework.
D 4.1	User Requirement Report	Sets out the results of the user-needs analysis and specifies the user requirements as starting point for system development.
D 5.1	Environment Monitoring and DSS Architecture	Presents the overall system architecture of the HEAVEN DSS and describes the functional and information architectures for implementation in the project sites.
D 5.2	Overall System Architecture and Implementation Plan	Presents the technical specifications of the soft- and hardware components of the local DSS', and the activity plans that will lead to demonstrator implementation in the sites.
D 6.1	Definition of System Components and Analysis of Commonalties	Provides detailed specifications of the DSS for components used at all sites and analyses commonalties in creating a generic DSS.
D 6.2	Analysis of Actual Implementation of Sites	Presents the work carried out in the framework of the implementation of the DSS.
D 7.1	System Verification Report	Sets out the concept for system verification and results of verification across project sites
D8.1 – D8.6	Demonstration Plan for Rome, Rotterdam, Berlin Paris, Leicester and Prague	A report for each of the six cities details the planning and implementation associated with the demonstration.
D8.7 – D 8.12	Demonstrator: Rome, Rotterdam, Berlin, Paris, Leicester and Prague	A report for each of the six cities describes the demonstrator and summarises the results of the demonstrations.

Del. no.	Del. Name	Scope
D9.1	Description of HEAVEN suite of End-Products	The report describes the main characteristics of the HEAVEN “tools” that have been selected to represent the project end-products.
D9.2	Business and Exploitation Plan of the HEAVEN End-products	Sets out the approach selected for exploitation and presents the exploitation plan.

5.2 Other output

The project has prepared **four newsletters** which were delivered , either in electronic or printed form to a set of more than **1800 addresses**. The project website <http://heaven.rec.org> was accessed from over 50 countries with more than 80.000 hits and more than 1200 downloads. In addition the project has been presented at a number of conferences and workshops and has published several papers as shown in Table 5 below.

Table 5: HEAVEN presentations and papers

Date	Event	What
4/5.5.2000	1 st DG INFSO Concertation meeting, Brussels	The HEAVEN presentation in Session II: “Air Quality, emissions, transport and noise”:
6-8.11.2000	IST-2000 Conference, Nice	HEAVEN presentation in session “Mobility, transport and environment” and paper: M. Tomassini, H.-J. Heich, F. Forestieri: “HEAVEN Project: Healthier Environment through the Abatement of Vehicle Emissions and Noise”
6-9.11.2000	ITS-2000 Conference, Turin	HEAVEN presentation in EC special Session 10: “IST tools for better environmental integration in transport Management”.
1.12.2000	15 th Annual POLIS Conference- Translating the Kyoto Targets into Local Transport Actions across, Prague	HEAVEN presentation in the session “Current overview of the EU 5 th Framework Programme for RTD” and paper: M. Tomassini, H.-J. Heich, M. Kazmukova: “HEAVEN Project: Healthier Environment through the Abatement of Vehicle Emissions and Noise”
30.11-1.12.2000	European Environment and Health Committee meeting	HEAVEN presentation
9.2.2001	UK AIRVIRO Group User Meeting at Chester (UK)	HEAVEN presentation
31.5-1.6.2001	ITS-01 Conference, Prague	HEAVEN presentation
10-12.7.2001	EUROLATIS Workshop, Quito, Equador	HEAVEN presentation
19.9.2001	DGINFSO Clustermeeting	HEAVEN presentation

Date	Event	What
	- Environmental Protection Applications	
11.10.2001	Environmental Informatics 2001, Sustainability in the Information Society, 15 th International Symposium Informatics for Environmental Protection, Zürich	HEAVEN presentation and paper: M. Tomassini, H.-J. Heich: “Environmental Assessment of Transport Demand Management Strategies in European Cities”
7.12.2001	HEAVEN Workshop	Various presentations of the HEAVEN interim results and interactive discussion with participants
7-10.2. 2002	EUROPOLIS 2002, Bologna	HEAVEN presentations
28.2.2002	X Urban Zenit 4.4, Genova	HEAVEN presentation
16-20.4.2002	Euro-China Co-operation Forum, Beijing, Session B6	HEAVEN presentation and paper: H.-J. Heich, M. Tomassini, Carlo di Taranto: “The HEAVEN approach to Environmental Assessment of City wide Transport Demand Management Strategies
19-21.6.2002	11 th International Symposium Transport and Air Pollution, Graz Austria	HEAVEN presentation and paper: N. Hodges “Demand Responsive Traffic Systems to Control Pollution”
25-27.9.2002	EnviroInfo 2002, Environmental Communication in the Information Society, 16 th International Symposium Informatics,	HEAVEN presentation and paper: H.-J. Heich, M. Tomassini, Carlo di Taranto: “The HEAVEN approach to Environmental Assessment of City wide Transport Demand Management Strategies”
27.03.2003	IntelCity Conference, Siena, Italy	HEAVEN presentation within paper N J M Hodges “Mobility and Traffic Management”
08.04.03	TRAFFEX 2003- Smart Move Conference, Birmingham	HEAVEN presentation within Paper M C Bell, N J M Hodges, J Tate and K Wood “The Role of Intelligent Transport Systems in supporting Sustainable Transport”

6 Project management and co-ordination aspects

HEAVEN represented a group of public and private sector organisations and individuals well-experienced in the management of large European technology projects. The project, therefore, agreed upon an unambiguous management structure which was simple but took account of the complexity and ambition of a project of this size.

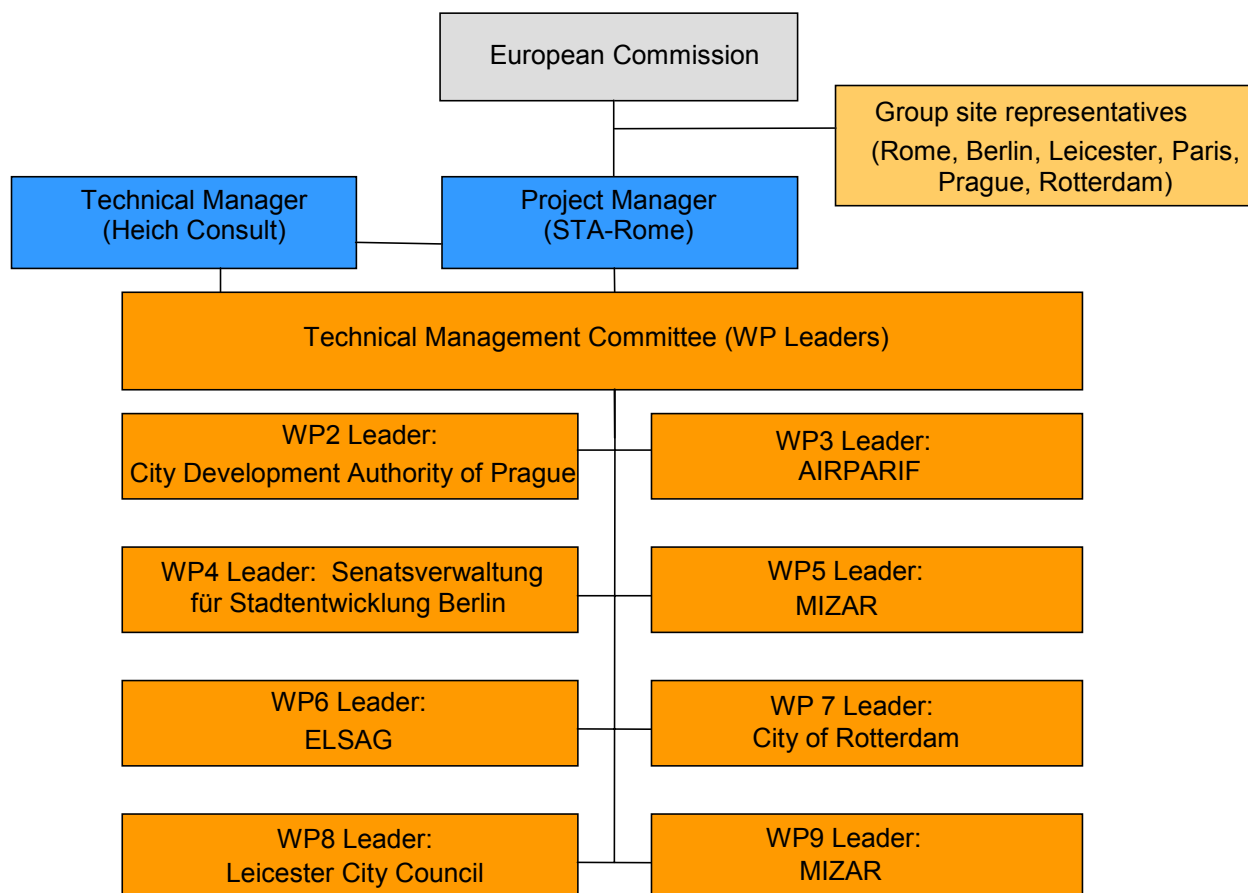


Figure 3: Management Structure of the HEAVEN Project

Steering Group: formed by executive level representatives of the principal contractors, was responsible for providing strategic guidance and in charge of steering the project.

Technical Management Committee: formed by all Local Site and WP Managers and the Project Manager; met regularly to review technical progress on overall and site level and identified needs for corrective actions; reports regularly to the Steering Committee via the Project Manager.

Project Manager: the single contact point for the European Commission Project Officer, had 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; specific responsibility for administrative and financial management and quality control; assists the Steering Committee and prepared and followed up on its decisions. The Project Manager was 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.

Technical Manager: responsible for the day-to-day management of the project, co-ordination of the various tasks and works 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 encompassed WP supervision, interfacing with WP leaders, and overall co-ordination of deliverable production. Additionally, the Technical Manager was in charge of co-ordinating the participation in programme level clustering and ensuring high level of evaluation.

WP Leaders: had the key task to co-ordinate activities on site and project level for the duration of a WP, to assist the Technical Manager during the active period of their WP and to co-ordinate the production of the deliverables of the WP.

Local Site Managers: co-ordinated all contributions to the project from their respective local partners. This was particularly important during the demonstration and exploitation phase. The respective Local Site Managers were the single contact point for their site towards the project consortium.

7 Outlook

The HEAVEN partnership includes Public Administrations and connected institutions, Academic Partners and research bodies, Industrial partners and consultants. Furthermore, the **consortium know-how** covers several areas:

- - Traffic and transport modelling and control systems
- - Environmental models and applications
- - System architecture and system integration schemes
- - Application of telematics in the field of real-time operation schemes.

Although the HEAVEN results in general and the **project end products** in particular constitute the physical items for transferability and exploitation purposes, the exploitation activities envisaged by the project partners base on the consortium extensive know-how and on the expertise the partners gained during the project lifetime.

The intentions for **exploitation** declared by the project partners reflect their background:

- *Local Administrations:* Wish to extend and keep in full operation the DSS demonstrators for actual use in their city.
- *Academic Partners:* See the project results as a basis for further research projects.
- *Industrial Partners:* Investigate opportunities to sell system components and know-how together with support services and assistance for implementation in new sites.
- *Consultants:* Intend to further disseminate the project results and guide the process of exploitation by identifying possible sites for implementation

So, including the general objectives of the project, HEAVEN has identified the following channels to exploit its own results:

- i. Direct use in the demonstration sites
- ii. New R&D projects
- iii. Sales of systems components and services
- iv. Dissemination
- v. Contribution to European Directives and Standards.

The analysis of the exploitation potential conducted by the project concerns channels ii and iii mainly.

7.1 Method for exploitation potential analysis

The analysis of the potential exploitation of the project results has been conducted through the following steps:

- i. Definition of the HEAVEN “toolkit” and of the project approach to exploitation
- ii. Statistical analysis of the potential interest in the HEAVEN DSS and of the conditions available to implement the DSS in the European cities
- iii. Identification of the number of European cities where the HEAVEN DSS could be implemented
- iv. The analysis of the actual transferability of the HEAVEN DSS to some specific sites and the evaluation of the potential revenues from the implementation of the system, through the development of a set of case studies
- v. Extrapolation of the results achieved from the case study analyses to the complete set of European cities where the HEAVEN DSS could be implemented

The outcomes of the first step are reported in Section 4.2 of this report.

The second step has been performed through the creation and distribution of a specific “exploitation questionnaire” conceived in order to identify the actual interest of public administrations and consultants of European cities in the HEAVEN DSS and approach, and to collect some key information concerning the feasibility of the HEAVEN DSS implementation in these cities (such as the existence of infrastructures and systems to monitor and control traffic and environment, or at least the intentions and plans to build those infrastructures and systems).

In order to keep the analysis of the exploitation potential at a credible level, only a subset of the European cities have been addressed: the cities with more than 250,000 inhabitants in some key European countries mainly because the existing EU legislation on air quality addresses these urban agglomerations explicitly.

The **possible implementation** of the HEAVEN DSS has been analysed in details for **some selected sites** that constituted actual “**case studies**”. The case studies were following a common approach and have been performed by the industrial partners of the HEAVEN consortium through visits of the transfer cities and structured interviews. These case studies have been conceived to provide details on the existing traffic and environment models, infrastructures and systems, to define the activities required to build and to maintain the HEAVEN DSS in those situations, and to **estimate the revenues** possibly coming to the project partners for such activities.

7.2 Transferability issues

Concept and objectives of the HEAVEN DSS base on the availability of infrastructures for real time traffic and air quality monitoring to be connected and integrated with the DSS models. This constitutes a basic requirement for the actual transferability of the HEAVEN DSS.

So, in order to approach the HEAVEN DSS transferability issues from a consistent point of view, the local authorities involved in the case studies conduction have been made aware of the following practical aspects:

- The implementation of the HEAVEN DSS is reasonable in the sites where the infrastructures for real time traffic and air quality monitoring already exist or are planned.
- The HEAVEN DSS is modular and can grow in terms of functionalities and space coverage according to infrastructures development and enhancement.
- The HEAVEN DSS modelling capabilities can reduce the size and optimise the location of the infrastructures actually necessary to monitor air quality and traffic.
- In the sites where investment capabilities are limited and the infrastructures grow slowly, the HEAVEN DSS can start from the off-line operation and improve step by step according to the infrastructure development. The analysis of these aspects contributed to the correct elaboration of the case studies and suggested considerations the consortium will use in any future exploitation activities.

7.3 Exploitation intentions

The analysis of the project results **exploitation potential** and of the **overall business potential** makes sense only if a suitable organisation will be settled by the HEAVEN partnership with the purpose to survive to the HEAVEN project and to perform exploitation and dissemination of the HEAVEN results on a long term.

This organisation should operate as a reference for both external bodies and HEAVEN partners.

From the marketing and commercial point of view, it should be a reference for current and potential clients (transfer cities) as well as for possible partners in new research projects.

Inside the project partnership, the organisation should fix the rules concerning:

- The IPR on the common developments and studies
- The HEAVEN DSS brand protection and support
- The role of the partners
- The sharing of the market between competing partners
- The distribution of the revenues from exploitation of the HEAVEN results
- Provisions for further development of the system in a coherent way

According to the estimates presented in the Deliverable 9.2 chapter 5, porting the HEAVEN DSS to the potential European transfer cities **could require a specific staff of more than 100 skilled technicians**, working for these implementation projects longer than five and possibly ten year. After implementation support is expected to last longer.

This kind of effort needs to be managed in a flexible way both because its nature - it is a potential commitment that should be confirmed by the market needs in the next future, and because of the size of the staff to get organised. A reasonable approach could be to give the primary responsibility to address the market of different countries to the industrial and research partners already involved in those countries, although respecting the normal competition between partners according to the EU legislation, and to keep at the central level the regulation of the common interests and obligations of the partners. This organisation should then be temporary and flexible according to the needs of founding partners.

A kind of organisation with such characteristics is known as G.E.I.E – Groupement Européen d'Intérêt Economique (European Group with Economic Interest). This organisation is currently envisaged as the organisation to propose to the partnership analysis for a final decision to be taken in the next months.

Annex 1: The HEAVEN sites

Berlin

City demographics

Berlin, Germany's capital and biggest city, has a population of roughly 3.5 million people and covers an area of 889 square km (1997). The city is surrounded by a sparsely populated countryside. Berlin has inherited a polycentric structure. Since the fall of the Berlin Wall in 1989, the formerly divided Eastern and Western parts of the city are gradually growing together and the city is slowly merging with its surroundings to form a single region.

Traffic characteristics

Passenger movements - In 1997 a daily total of roughly 12.5 million passenger journeys was undertaken in Berlin and its environs. Approximately one quarter (26%) of these journeys was made on foot, 5% by bicycle, another quarter (23%) on public transport and 45% by private car.

Traffic infrastructure - Berlin has some 5,100km of roads. 70% of these are in areas with a speed limit of 30km/h. The rest are main roads with a total length of approximately 1,100km. The system of main roads together with 64km of motorway is the mainstay for commercial traffic. In addition, Berlin has an extensive public transport network comprising 1,230km of bus lines, 179km of tramway lines, 153km of underground lines and 296km of suburban train lines (1997).

HEAVEN in Berlin

In Berlin, the HEAVEN project was designed to provide the following core functions:

- near real time data on air and noise pollution at street level;
- information on historical data in order to compare existing levels with historic levels;
- information when pollution limits are exceeded,
- modelling functions in order to evaluate the environmental effects of long-term transport policies and of operational TDMS.
- Real life test of environmental effects of TDMS on the environment

The development of HEAVEN was closely linked to the set-up of the new Transport Management Centre in the summer of 2001, which collects real time traffic data from 158 measurement points in the city of Berlin.

In the end, the HEAVEN project was successfully completed in Berlin with the development of an online environmental monitoring and modelling system and an environmental information platform accessible via the Internet. Different TDMS were modelled, tested and their impact on traffic and environment evaluated. In addition, long-term scenarios with measures to attain EU noise and air quality standards were modelled.

Modelling and Information presentation

In Berlin, the IMMIS modelling chain for calculating traffic emissions, rooftop concentration and roadside pollution for air pollutants and noise was used. The accuracy of these models met previously defined quality standards. The results of the online modelling as well as statistical and historic environmental data for selected road segments are presented on the Internet-based HEAVEN information platform (<http://heaven.ivu.de/>) available since May 2002.

The demonstration area

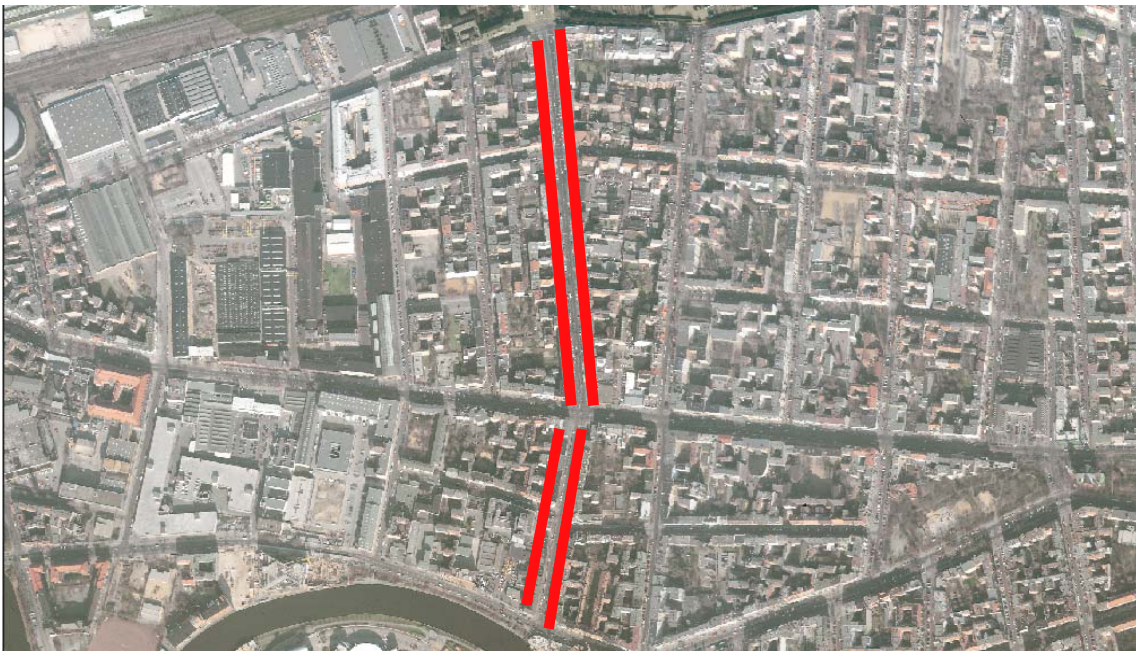
Berlin chose its Beusselstrasse as demonstration area – a mostly residential area with a high load of truck traffic. It is located in a district with a very co-operative administration, and which is particularly suited for transfer, i.e. tested measures could easily be taken up by other districts or other cities.

Co-operation at the local level was regarded as a basic pre-condition as HEAVEN measures were implemented in a main Berlin road and, therefore, political and administrative support at all levels had to be obtained. In addition, existing neighbourhood management guaranteed effective involvement of residents, shop-owners and tradesmen in the area. Technical aspects such as existing and planned detection within the network of Berlin's future transport management centre also contributed to the selection of the site. Additional environmental data was collected by installing mobile measuring equipment.

A particular characteristic of the Beusselstrasse area is the large share of truck traffic leading to high pollution levels – both in terms of air and noise pollution.

For the purpose of measuring the pollution concentration in the demonstration area, a mobile unit with automatic devices for PM10, CO, NO, NO₂, NO_x and benzene monitoring was used, which recorded values with a time resolution of 30 minutes. Two different locations were chosen in order to account for different traffic loads in the Northern and Southern part of Beusselstrasse.

Figure 1: Beusselstrasse Demonstration Area in Berlin



Set of measures

The following set of measures was chosen in order to test TDMS.

- Speed limit (introduction of a speed limit of 30 km/h implemented from July 1 to August 26 2002)
- Bans for trucks including detour recommendation (implemented from August 26 – September 15 2002)

It was assumed that the demonstration would support efforts to make progress with a transport policy that aimed to decrease the growth of individual car traffic in order to establish an environmentally and socially orientated city development.

The HEAVEN system architecture in Berlin 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.



Figure 2: HEAVEN Information Platform: Presentation of online modelling results

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.

Leicester

City demographics

With a population of 300,000, greater Leicester being part of a 450,000 conurbation, with a 500,000 hinterland, is located in the East Midlands at Junction 21 in the M1 motorway. Leicester was the first UK City to be awarded the status of “Environment City” and it was selected as “European Sustainable City 1996”. Leicester City Council is the Highway, Planning and Environmental Health authority and oversees all strategic and tactical traffic management and control, air quality, noise and traffic monitoring functions.

Traffic characteristics

Traffic flows in and out of Leicester are very high. About 70,000 people commute into Leicester and about 20,000 out of the city centre daily. The most common form of transport within the region is by car, making up 62.5% of transport to work. 12.5% of the population use the bus and 10% travel by foot. The train, motorcycle and bicycle are used by less than 5% of the population respectively, while around 3% of the population work from home, so have no need to travel on a daily basis. The public transit network consists of heavy rail and bus. Heavy rail has 33.8km of track within the demonstration area with a traffic volume of 13385 vehicle-kilometres. The bus network is much larger than the rail, covering a distance of 649.058 kilometres and giving a traffic volume of 225223 vehicle-kilometres. The majority of motor vehicles (including buses), enter and exit the city along the major radial and inner ring roads, causing high congestion in these areas during peak times of the day.

HEAVEN in Leicester

Leicester City Council, an average sized European City, representing the smallest city in HEAVEN, has developed tools to support network managers and policy makers in assessing the impact of traffic on air quality and noise levels. HEAVEN is helping multidisciplinary teams from both the city and its environs to work together on scenario evaluation, ensuring public involvement and assisting strategic land use and transport policy development. The project provides valuable data to help politicians from the City Council and surrounding authorities resolve sensitive issues, for example by supporting cross-administrative boundary solutions to the Local Transport Plan and the Air Quality Review and Assessment, such as a major Park and Ride programme.

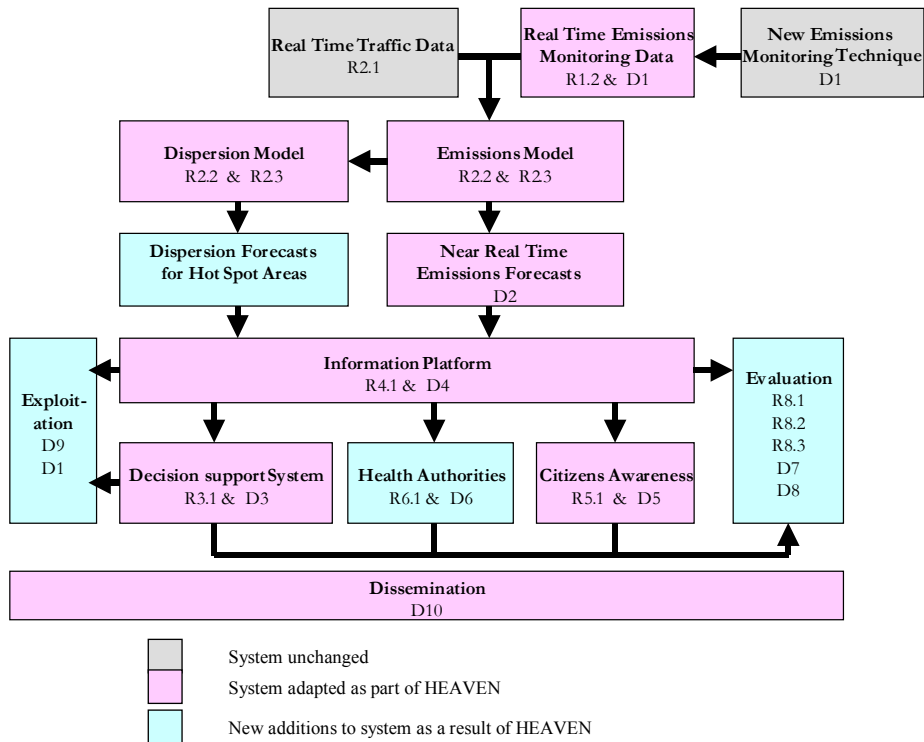
Leicester’s HEAVEN user-friendly on-line interface provides simple, timely information to the public and more technical data for professional users, with access to further information via www.leicesterequal.co.uk. A public email Bulletin gives local, daily air quality, traffic and meteorological real-time and forecast data with links to more detailed information such as time series data online. Professionals can use the HEAVEN system to assess the effect of different traffic demand management scenarios on pollution levels.

It is not only the modelling system that has been enhanced by HEAVEN, good working relationships have been established as well. This has led to a better understanding of how different teams and organisations can work together in the long term to reduce transport-related pollution. To achieve this, the following concrete steps were taken: The Institute for Transport Studies, University of Leeds, upgraded its live traffic congestion map of Leicester to calculate carbon monoxide, nitrogen dioxide and noise.

The Swedish Meteorological and Hydrological Institute has upgraded its software and integrated SCOOT live traffic data and Automated Classified Vehicle Counts. Background pollution forecasts from the University of Madrid’s European scale air quality model OPANA and the UK Met Office’s National Air Quality model NAME can also be accessed. Pollution monitoring data from the roadside and National monitoring networks has been incorporated, this assists in forecasting background levels and provides information for Airweb, an online time series database. An existing street canyon dispersion model has been further developed, upgraded, verified and validated. Finally, a prototype

database and routines for correlating air pollution data with epidemiological incidence has been developed to support health studies. The Heaven System carried out in Leicester is shown.

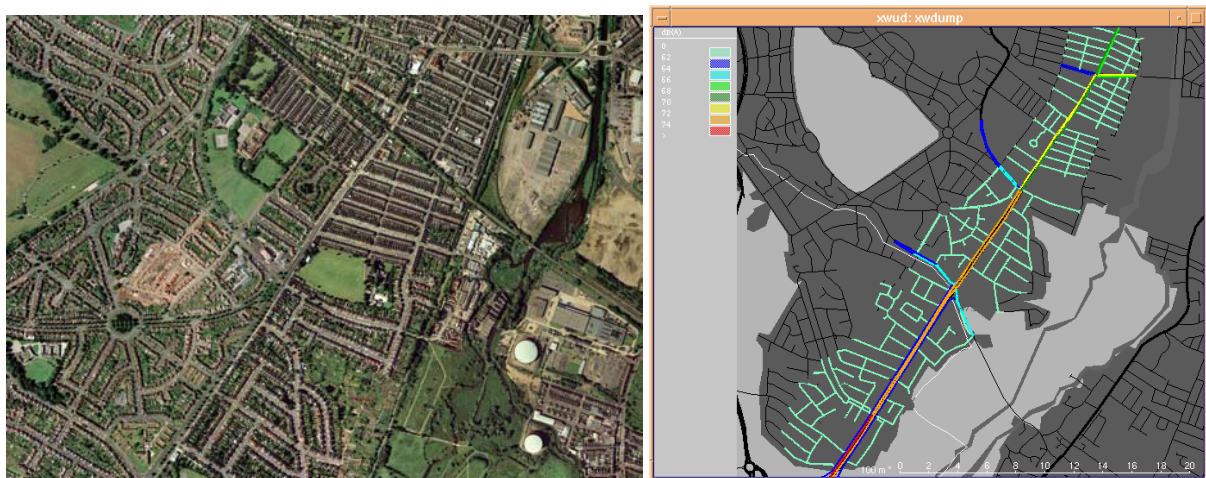
Figure 3: HEAVEN system in Leicester



The demonstration area

Narborough Road was chosen as demonstration area in Leicester. The road is 4.43km in length and has a high number of residential areas situated along it, with high population densities. It begins in the City Centre, where traffic can reach high levels during peak times.

Figure 4: Narborough Road demo area and its mean weekday noise emissions maps (L_{A10}, 1-hour)



This area has gradually developed into a large “Out of Town” retail area over the last ten years, which has further increased traffic congestion and made this end of Narborough Road well used, most significantly at weekends. It also constitutes one of the principle routes into the city, thus experiences heavy congestion during the a.m. and p.m. peak periods. The Western end of the road features a dual

two-lane carriageway, with two-lane two-way service roads on either side. The next stretch occurs as dual three-lane carriageway, turning into a four-lane two-way carriageway further along.

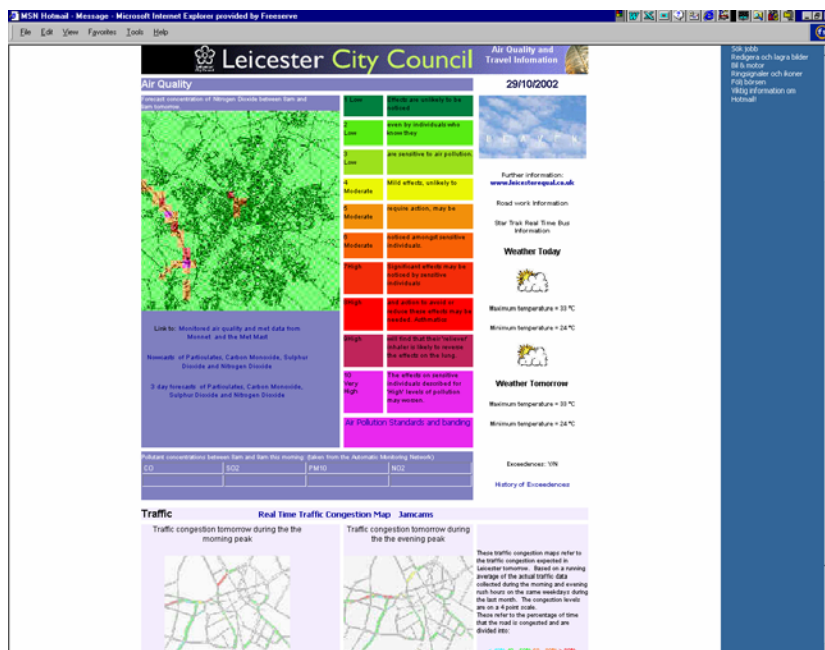
The SCOOT demand-responsive signal control system operates along the whole length to the city centre. There is also a Roadside Pollution Monitor (RPM) and NO_x/TEOM monitor situated along the road. The RPM at Fulhurst Avenue measures NO₂ and CO and is maintained by Leicester City Council Pollution Control, on behalf of Area Traffic Control who monitor and makes use of the data collected. The NO_x/TEOM monitor at Imperial Avenue measures NO_x and PM₁₀ levels. This is also maintained by Pollution Control, who supplies the data to Area Traffic Control.

Set of measures

As part of the project the benefits of several traffic demand management strategies have been quantified. The results show that reducing vehicle speeds in Leicester by 20% can lead to peak traffic spreading. However, putting restrictions on heavy goods vehicle access and promoting Park and Ride would have positive impacts for both noise and air quality due to the significant reduction in flow.

One of the principal reasons for implementing HEAVEN in Leicester was to assist decision makers and the public with sustainable environmentally friendly transport choices. HEAVEN has sort to bring together existing data from traffic groups, pollution control groups and UK Met Office in order to all the estimation of emission and noise from traffic. The resultant information provides a suite of tools that can then be used to support the HEAVEN Decision Support System (DSS). These tools can be accessed by both professional users and the public, allowing easier access to information and strengthening the ability to develop cross boundary Traffic Demand Management Strategies (TDMS). These Goals have been met in a number of ways within Leicester.

Figure 5: Air bulletin start page in Leicester



HEAVEN has not only produced accessible information products but has also brought together different interested parties from both within Leicester City Council and other institutions. This has allowed innovative solutions to be sought and better information and experience sharing to take place. The closer relationships that have been fostered through HEAVEN will have benefits that can be carried into future projects and work on technical and policy levels. HEAVEN has allowed in Leicester wider pool of expertise and experience to be formed. With this working infrastructure in place it is clear that HEAVEN will continue to directly benefit the people living in Leicester helping to improve their urban environment, and helping to start to realise the concept of a sustainable city.

Paris

City demographics

Paris, the capital of France and the country's largest city, is situated in the centre of the Ile-de-France Region. The city and the region constitute a tightly integrated socio-economic fabric. Whereas Paris itself has a population of 2.1 million inhabitants on 105 km², the Ile-de-France Region has a population of 10.8 million people and covers an area of 12,000 square km. The whole area is densely populated and 20% of France's population are actually concentrated on these 2% of the country's territory.

Traffic characteristics

Passenger movements – there is a daily amount of 22 million trips by car or public transport in Paris and the Ile-de-France Region. Public transport systems carry ten million passengers every day.

Traffic infrastructure – Paris is situated at the centre of a dense road network consisting of the “Boulevard Périphérique”, a dual carriageway encircling the city, and a public motorway network representing more than 600 km, complemented by toll motorways. The main road network comprises 21000 km. In addition, Paris and its region are served by an extensive public transport system. Five different modes of transport – railway, subway, tramway, automated light rail and buses – operated by RATP or SNCF - cover the whole region. There are around 300 subway stations, 450 railway stations, a handful of tramway stops and over 25,000 bus stops.

HEAVEN in Paris

In Paris, as in Leicester, the HEAVEN project has brought about a co-operation between the city and its environs. For the first time, Paris and the Ile-de-France region have developed a strong partnership between the authorities in charge of traffic modelling and management (Municipality of Paris and the “Direction Regional de l'Equipement d'Ile-de-France”) and Airparif, the air quality monitoring network, assisted by two consulting companies, Eurolum and Carte Blanche Conseil.

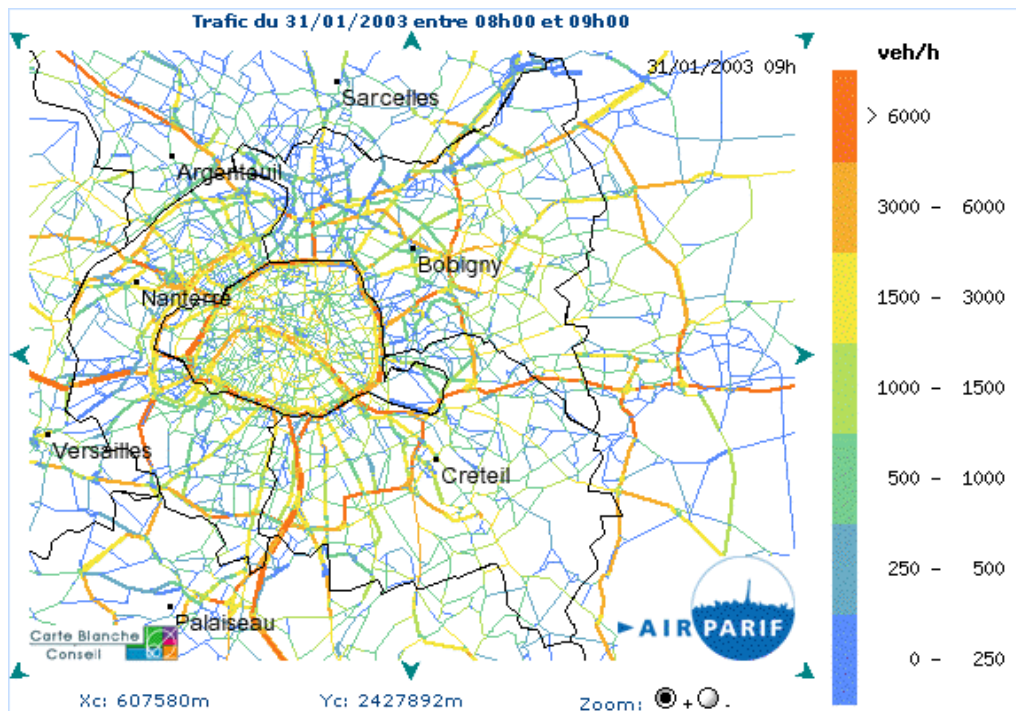


Figure 6 : Map of modelled traffic situation in Paris.

This collaboration has been very effective in developing and exchanging near real-time information between these organisations, for example data on traffic conditions and detailed descriptions of the vehicle fleet. As a result, a new integrated system has been developed. It first calculates the traffic emissions and then the levels of air pollution related to this traffic. The impacts of any given traffic reduction measure implemented by the authorities can then be assessed.

Today, HEAVEN is providing:

- The public and decision makers with continuous and complete information on traffic related air pollution for the entire Paris and Ile-de-France region including over 35,000 road segments. Information is updated hourly and easily accessible on the Airparif website (<http://www.airparif.asso.fr/>, link “en direct de la rue”).
- Decision makers with a useful tool that assists them in developing efficient traffic management and urban development strategies taking environmental issues into account. Traffic management policies can be tested and the impact measures that are already implemented have on air quality can be evaluated.

The presentation of information is two-fold : compact in the bulletin, and detailed in the sections Context, System presentation, Traffic data, Emissions data, Street level concentrations, Background concentrations, Scenarios.

LES INDICATEURS D'ÉMISSIONS
 Les émissions relatives par axes de circulation le 31/01/2003 entre 06h et 10h pour la Petite Couronne

Choix de l'axe de référence :

Choix d'un axe supplémentaire :

Axe de circulation	Monoxyde de carbone	Oxydes d'azote	Particules	Dioxyde de carbone	Hydrocarbures	Benzène
A103 Rosny	0.4	0.4	0.4	0.4	0.4	0.4
A1 Chapelle	1	1	1	1	1	1
A13 St Cloud	0.7	0.7	0.7	0.7	0.7	0.7
A14 Nanterre	0.7	0.6	0.7	0.6	0.6	0.6
A4 Bercy	1.4	1.5	1.4	1.5	1.6	1.6
A6a Arcueil	0.8	0.8	0.8	0.8	0.9	0.9
A6b Kremlin	0.7	0.7	0.7	0.7	0.8	0.8

Figure 7 : Table of traffic emissions. For a selection of road axes, the relative level of emissions is given for CO, NO_x, particles, CO₂, hydrocarbons and benzene.

Future developments of the system mainly focus on the more precise description of the vehicle fleet and road typology. In particular All partners wish now to increase the audience of the HEAVEN web site. The web site is an optimal tool to ensure transparency on how public policies affect air quality.

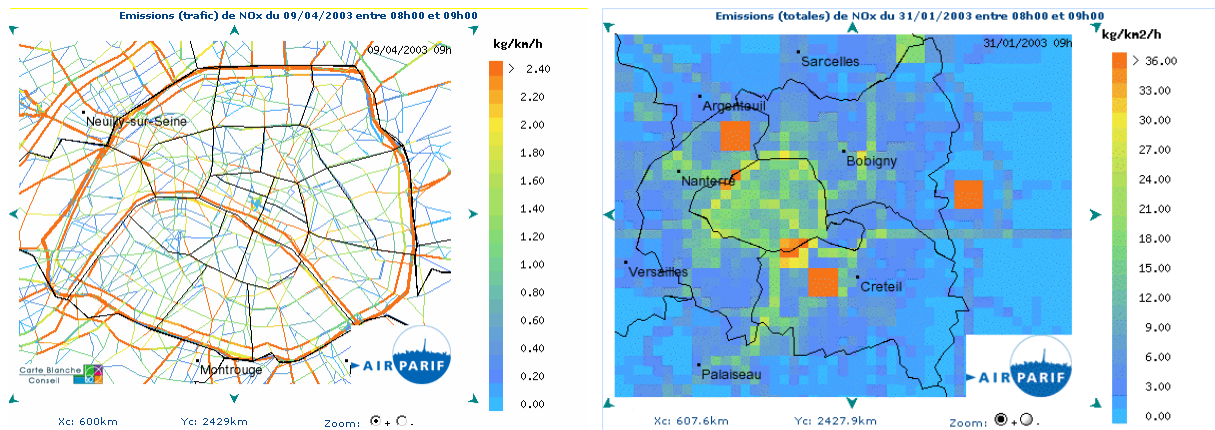
The demonstration area

The demonstration area comprised the whole Ile-de-France region. The Ile-de-France region lies in the centre of the so-called Paris basin. It is a flat region with isolated hills. The city of Paris lies on the river Seine at an average of 62 metres above sea level.

The regional air quality modelling tool "Pollux" as well as the air quality modelling tool "Street" for annual values and "static" traffic matrix were implemented and validated.

The demonstration area for the NO₂ and O₃ background pollution modelling was a domain of 180 x 180 km² containing the whole Ile-de-France region, with a grid resolution of 6km. More detailed information (zoom) was also available on a domain of 90 x 90 km² with a grid resolution of 3km containing the dense urban area (“agglomeration parisienne”).

Figure 8: Paris demonstration area and modelled NOx emissions



Set of measures

Airparif has successfully tested the HEAVEN system, assessing the impact two traffic reduction and management measures had on air quality: (A) The European and national initiative “A day without my car”, taking place in Paris every September 22, and (B) the municipality of Paris’ implementation of segregated bus lanes on three major circulation axes.

HEAVEN is a success for all French partners. The project has achieved its technical objectives, and it has brought forward the institutional co-operation.

The technical achievements of HEAVEN enhance the modelled air quality information in the Ile-de-France region. Firstly, by introducing measured real-time traffic data as a direct data source to air quality modelling. Second, by refining the traffic description for air quality modelling through a refined traffic module, and through engaging interchange of expert knowledge between traffic and air quality specialists. Besides, the refined traffic module and its reference traffic assignment database constitute a exploitable result for DREIF. Third, HEAVEN has integrated an automatic *quasi* real-time modelling chain going from traffic to pollutant concentrations.

The chain operates on-line without raising problems. Used off-line, the integration significantly increases Airparif’s productivity in studying scenarios. Fourth, HEAVEN has progressed in street-level pollution modelling. The technical difficulties encountered in this field, normal in research & development, do not lower the merits of the project in any way.

The HEAVEN system has proved its benefit for the City of Paris in the case study on new bus lanes. It allows the assessment of strategic traffic management measures. In the case of bus lanes, its results support the City’s policy.

The partners intend to pursue common prospective scenario studies. They will address the expected impacts on air quality of the current regional transport master plan (PDU), and the required reduction of motorised traffic for achieving the objectives of the regional air quality protection plan (PPA).

Earlier prospective studies of Airparif have shown that a reduction of emissions by 50 to 80 % would be necessary for achieving the air quality objectives defined by the European directives. Traffic being the principal emitter of pollutants in the Ile-de-France region, the evaluation of the air quality impacts of traffic management measurement will remain a central issue in forthcoming years.

Prague

City demographics

Prague, the capital of the Czech Republic, has a population of approximately 1.2 million people and covers an area of 496 km². The city is located on terraces and hills which overlook the wide flowing river Vltava. Prague is divided into fifteen districts, the centre being dominated by the ancient castle, dating back to the ninth century, the largest inhabited castle in the world, now seat of the Czech president.

Traffic characteristics

Passenger movements – There are 17.1 million vehicle-kilometres on an average workday, i.e. 5.65 billion vehicle-kilometres annually. The modal split is 57% for public transport and 43% for car transport.

Traffic infrastructure – The total road network amounts to 3411 km, including 87 motorway km (11 of these within the city). The metro is operating on 49.8 km, trams run on 137.5 km and buses use 669.5 km of the road network.

HEAVEN in Prague

The keyword of HEAVEN in Prague was “communication”. Experts in the city administration now have a tool for flexible and complex monitoring and assessment of the interrelationships between air quality, weather and traffic, providing immediate information as well as data for medium-term and long-term traffic and urban planning.

The different partners were enabled to communicate with each other. HEAVEN has catalysed the technical development to link data on traffic, air quality, and meteorological conditions into one information platform based on the Airviro air quality management system. The on-line traffic data of the two demonstration areas in Prague’s city centre (Holesovice and Pravobrezní) are now available for common use, other areas are under preparation.

HEAVEN has established a cross-departmental platform where people can communicate, share their experience and develop common solutions.

Information on air quality and the weather is available for everyone in the form of easy-to-understand maps, graphs and tables.

The HEAVEN system was developed simultaneously at two places: At the City Development Authority, where strategies and long-term issues were mostly of interest and at the Czech Hydrometeorological Institute, where on-line data management and near real-time air quality modelling were developed. The City Development Authority as Local HEAVEN co-ordinator was assisted by three partners: The Czech Hydrometeorological Institute, the Institute of Transportation Engineering, dealing with TDMS preparation, and the Administration of the Road Network in Prague, which is the administrator of the Traffic Control Centre, and which is also in charge of all on-line traffic data and traffic control systems management in the area of Prague.

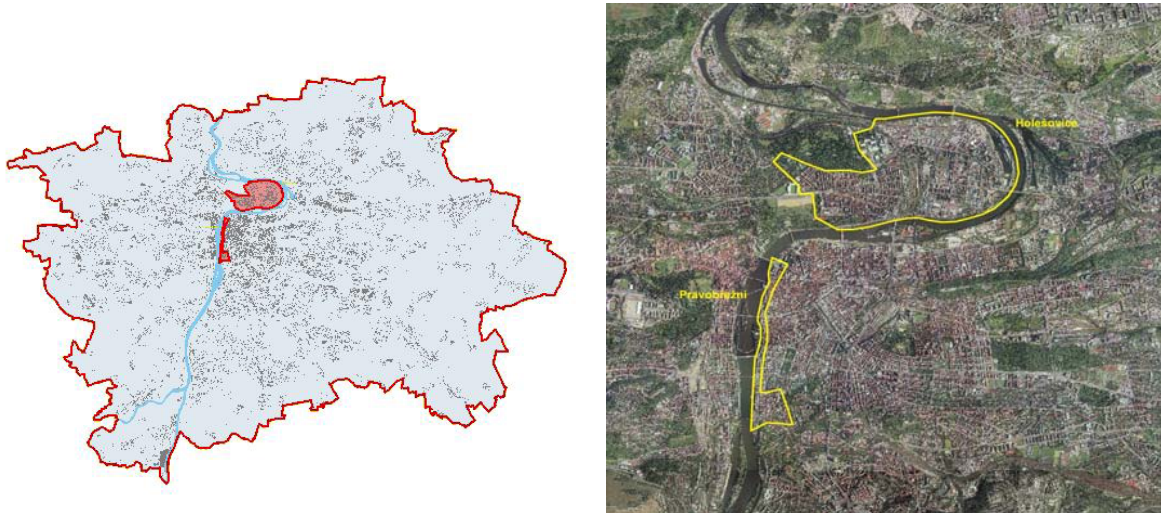
HEAVEN in Prague also played the role of catalyst for the encouragement of the co-operation between various municipal departments, namely the Department of Transportation, the Department of Environment, the City Borough Administrations, and others.

The demonstration area

The demonstration area for the urban planning system covered the rectangular area circumscribing the whole Prague administrative area. The road network was depicted with associated traffic loads for the years 2000 (survey) and 2010 (prediction) respectively. The static input data sources came mainly from Prague’s digital cadastral map, Master Plan of Prague, classified and statistically evaluated

emission inventories and other sources. The demonstration area here covered an area of 496 km² with more than 8,000 road links.

Figure 9: Prague and its HEAVEN demonstration areas



Through the co-operation of the Traffic Control Centre, the Czech Hydrometeorological Institute and the City Development Authority, the first real-time system was developed, which brings on-line traffic data to users other than the traffic control centre operators. The system was based on the Airviro system which was interlinked with on-line sources coming from traffic data (about 160 system loops), meteorological data (two monitoring stations), ambient air quality data (13 Automated Emission Monitoring system stations) and the weather forecast system ALADIN.

First, the Holešovice area was chosen for closer monitoring. But Prague was victim to a terrible flood that stroke Central Europe in August 2002 which rendered the monitoring tools partly useless. In cooperation with TSK new area equipped with the traffic monitoring system was selected - Pravobřežní - and the organisational and technical specification of on-line connection with HDRU system was negotiated. In the meantime, the Holešovice's system has been under restoration. Till the end of November 2002, both Holešovice and new Pravobřežní demonstration areas were linked to the HEAVEN interface and operational.

The Pravobřežní demonstration area is the narrow area along main street, which makes by-pass around the historical centre on the right bank of the Vltava river. The daily traffic load on this street is about 26,000 vehicles. On-line traffic data comes from detectors, which are installed on eleven traffic junctions. The total length of all measured links in area is 4,3 km. Only about 4,500 inhabitants live in the whole area. However, during the summer and winter months, i.e. the main tourist season, the number of daily visitors increases considerably. The public transport in the area comprises the metro and trams.

The table below describes the technical parameters of both the old and the new demonstration areas.

Table 1: Technical parameters of HEAVEN demonstration areas in Prague

	roadlinks sum	roadlinks sum (m)	measured (m)	%
Holešovice (H)	85	52043	19374	37
Pravobřežní (P)	61	8244	4333	53
Total	146	60287	23707	39

In these demonstration areas, the final product fulfils the following requirements:

- online traffic data available from the Traffic Control System for various usage (including the air quality modelling)
- Regularly updated environmental database for environmental modelling and research
- air pollution concentration maps for NO_x, SO₂ and CO for hourly updates and 24 hour forecast (for 6, 12, 18 and 24 hours)
- on-line information platform for city administration and the general public

The on-line environmental data and the Air Quality model outputs were made available at the PREMIS website (<http://www.premis.cz>). The city administration was also equipped with the on-line outputs of the traffic monitoring system and the internet presentation of the on-line modelling results was launched. The final GUI of the website is as follows:

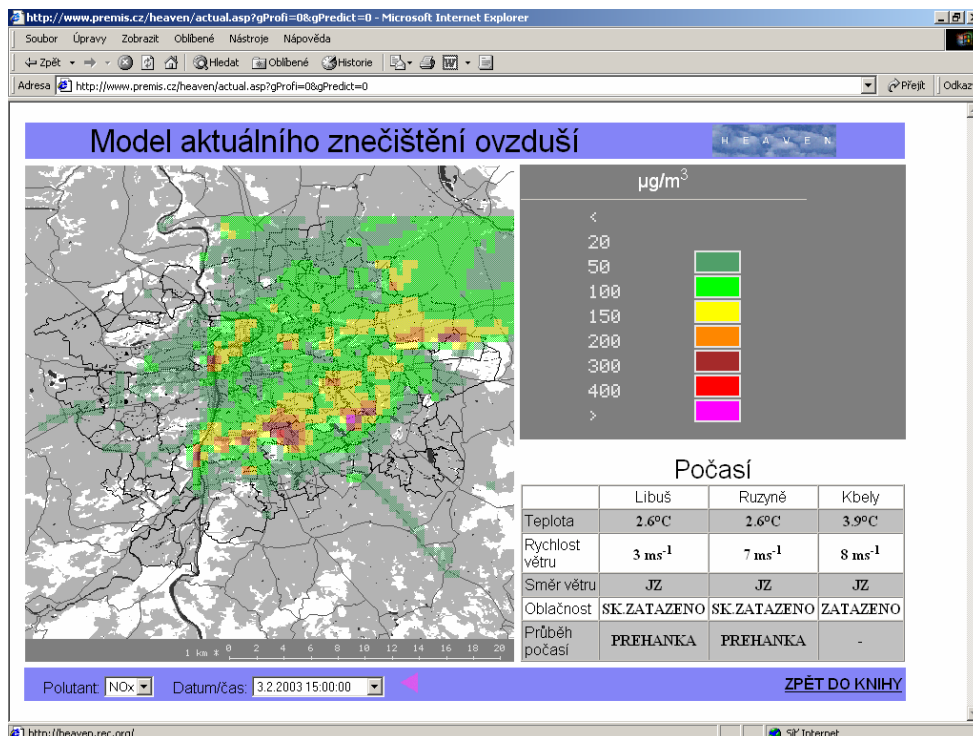


Figure 10: HEAVEN website in Prague

Set of measures

HEAVEN system was tested on the implementation of the “One-way Smichov” scenario, assessing the impact of the traffic management changes (one-way roads) in order to enhance the traffic and alarming air quality situation in former industrial area with recent dynamic commercial boom.

HEAVEN in Prague was a successful project, which contributed considerably to the process of building the integrated approach to the improvement of environment covering all three mayor pillars: urban planning, transportation management and environmental management. For the near future, the highest interest Prague is seen in improvement of the information platform for both Environment and Traffic data, improvement of the on-line traffic data measurement and road network description, improvement of the meteorological data measurement. As for the research topics the roadside and 3d canyon modelling for the wide networks, on-line traffic assignment or on-line noise modelling for Prague is of the high interest. Also improvement of the MMI through implementation of the internet-based operator interface, building the distributed databases and change of the operation system to Linux is planned.

Rome

City demographics

Rome, Italy's capital, rises on the banks of the Tevere about 25 kilometres from its main outlet in the Tyrrhenian Sea. It is situated at the centre of an undulating plain, the Campagna Romana, which is confined one side by the hills of Monte Mario, Gianicolo and Monteverde and on the other side by smaller hills of volcanic origin - the so-called "Seven Hills." Rome is part of Latium (Lazio in Italian), with 5.25 million inhabitants the third most populous of Italy's 20 regions. Almost 55% of the population reside in Rome, giving the region a population density that is the fourth highest in the country. The city of Rome has approx. 2.8 million inhabitants on 1,285 km².

Traffic characteristics

Passenger movements and traffic infrastructure – In the last 35 years, there was a large increase in terms of kilometres travelled in the metropolitan area of Rome, due to the increased length of trips and the number of vehicles (+650%). This growth has not been matched by a parallel development of the public transport system that has only a 90% increase recorded (in terms of kilometres travelled) over the same period. Consequently, the public transport modal share, holding 56% of total motorised trips in 1964, has sharply decreased and today accounts for only 34% of all motorised trips.

To reverse this trend, the municipality has set a few clear goals aimed at achieving equilibrium between transport demand and supply and it approved the Piano Generale del Traffico Urbano (PGTU - Urban Traffic General Plan) to tackle the mounting problematic of public transport, mobility and transport-related emission.

HEAVEN in Rome

Before the implementation of HEAVEN in Rome, detailed traffic data was only available on monitored links. Traffic flow information (through the Origin Destination matrix assignment procedure, updated every five years) existed for the rest of the traffic network. Pollution data was obtained from twelve measurement stations and emission maps were produced yearly in an off-line process, there was no interlinking of the required modules by means of Information Society Technologies.

Therefore, it was the aim to have an integrated data monitoring and evaluation system which offers almost real-time information online. After the implementation of the HEAVEN system, the total number of monitored and modelled links in the demonstration area is 739. Traffic, speed and emission data is updated every five minutes while pollution concentrations are calculated hourly for four different pollutants (CO, C₆H₆, NO₂, PM₁₀) in 4,356 points. Traffic, emission and concentration maps are produced on-line.

Main system features of HEAVEN in Rome were:

- Interface with Existing/External Systems: In the HEAVEN demonstration area a measurement station and 132 count detectors at actuated signalised intersections with flows, speed, queue and occupancy values measured every five minutes were installed; meteo interface with a system update performed on an hourly basis; air quality interface with day-by-day data acquisition.
- Traffic Modelling Module: Traffic network composed by 51 centroids, 282 endpoints and 739 oriented links; the deterministic user equilibrium assignment was performed on the network and then a correction algorithm (developed by STA) is running.
- Air Pollution Modelling Module: Emissions are computed based on measured traffic flows and speeds and output emissions (CO, C₆H₆, NO₂) on every link of the traffic network. The emission-modelling process is divided in two main sub-processes that calculate emissions with a different degree of detail according to input data available, i.e. TEE emissions

calculation model and Modal Emissions Estimation Mode; Concentrations are estimated running the air quality model ADMS programme, using as input the emission module output and giving as output concentration (CO, C₆H₆, PM₁₀, NO₂) on regular grid of 4356 points where an algorithm is applied to have isocontour maps.

- Health component with the creation of the logical data exchange process: health data and statistics can be reviewed with the output from air quality models for analysis on the exposure of each population group.

Today, HEAVEN in Rome is providing:

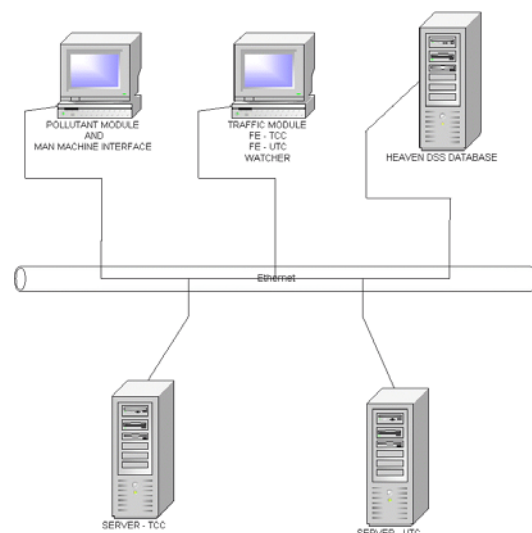
- The public and decision makers with continuous and complete information on traffic related air pollution for the Rome HEAVEN demonstration area. Information is updated hourly
- Decision makers have now at hand a useful DSS and scenario evaluation tool that assists them in developing efficient traffic management and urban development strategies taking environmental issues into account. Traffic management policies can be tested and the impact measures that are already implemented have on air quality can be evaluated in advance and after.
- Correlation between traffic emissions, the resultant pollutant concentrations and their health impact.

The implementation of the Rome Heaven DSS is based on a distributed architecture. Different workstations are dedicated to run different software processes categories as follows:

- Front end SW modules devoted to connect to external interfaces and data sources
- traffic & pollution processes devoted to traffic modelling and to pollution modelling
- scenario & HMI processes devoted to scenarios management and operator interfaces

The workstations are connected on a Local Area Network (LAN) linked on a Wide Area Network (WAN) with the external interfaces. All data are stored on relational databases served by a system database server.

Figure 11: HEAVEN implementation for the Rome DSS



The system provides hourly concentrations of carbon monoxide (CO), benzene (C₆H₆) and particulates (PM₁₀) on the demonstration area of 16km², with a spatial resolution of about 60m. An user friendly operator interface has been realised in order to display real time traffic emission and dispersion data on the map of the demonstration area. 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 study area in Rome. Common tools such as zoom in zoom out, information on links, time of day, vehicle fleet and meteorological data are provided to the user.

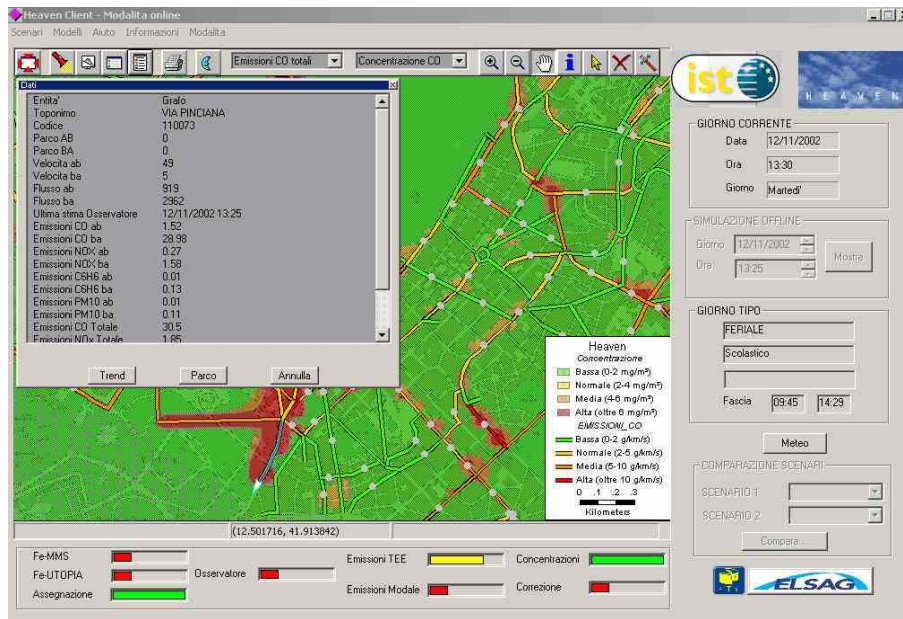


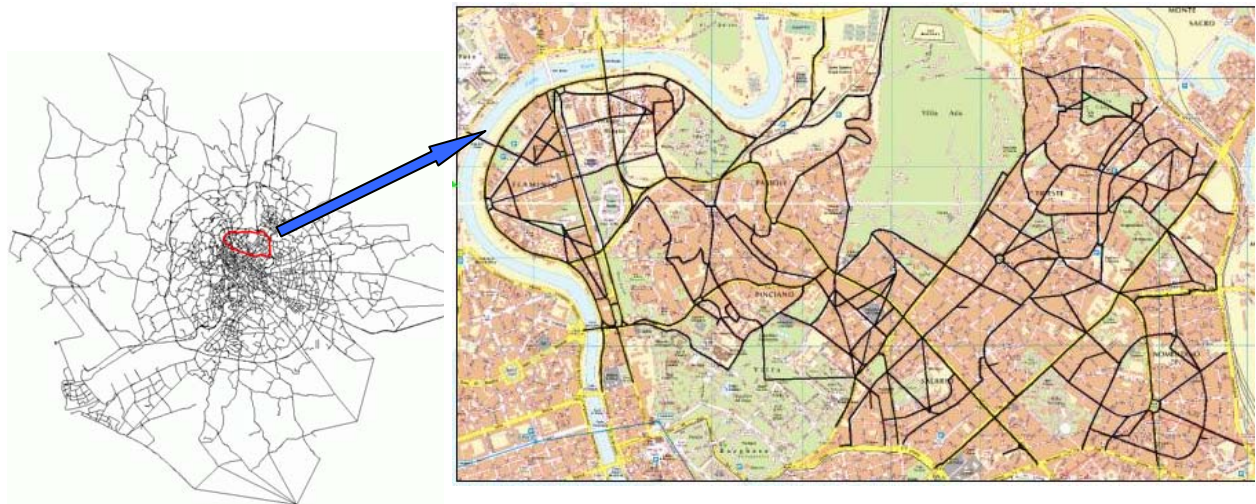
Figure 12: HEAVEN user interface in Rome

In the future, the demonstration area will be enlarged to the whole “Rail Ring” area where the not-catalytic vehicle are now forbidden and the updated information will be easily accessible on the municipality and STA websites.

The demonstration area

HEAVEN has been implemented in a demonstration area of 16km² located in the North-East area of the city of Rome, a residential and commercial area where almost 300,000 inhabitants live.

Figure 13: Rome demonstration area



The demonstration area is included in the so-called Rail-Ring (a ring including the central area of the city) and it has clear boundaries:

1. In the North-East: Olimpica and Tangenziale, primary traffic routes and inner ringroads.
2. In the South: Muro Torto, primary traffic route to access the city centre.
3. In the West: the Tevere River with its monitored bridges and the Lungotevere, the only longitudinal axis of Rome.

The area included two important green zones: Villa Borghese and Villa Ada, where an environmental background monitoring station is located. In the North of the area most of the important sports

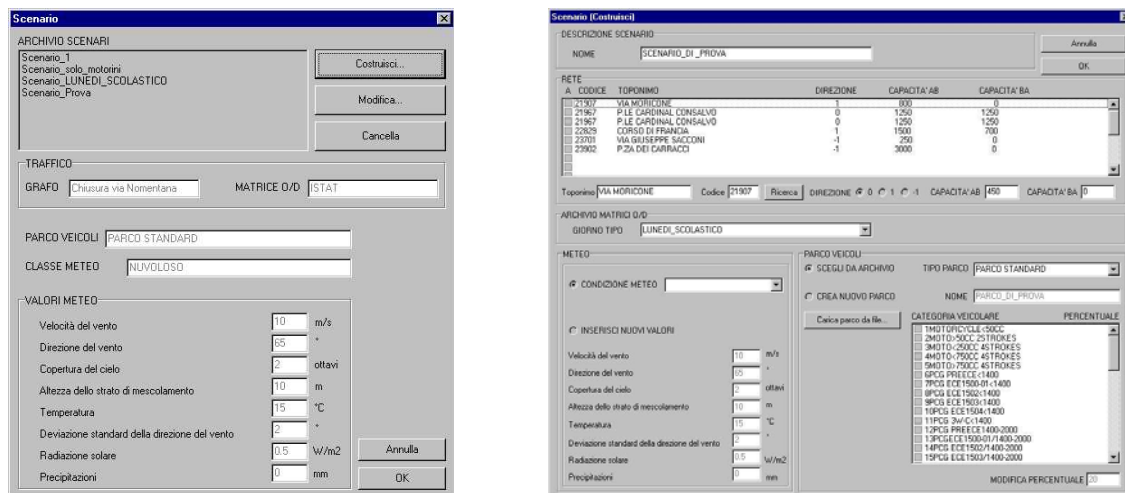
facilities in Rome (Stadio Olimpico, Stadio Flaminio, etc.) are located. They are used especially at the weekends. The area works as a link between the suburbs and the central area. Traffic inside the area is mainly concentrated on three inner main roads. The South-East of the area is mainly a residential zone; it has a regular topography, representing an important example of mid-central urban district architecture. Inside the area, there are three “Consolari” (main roads, developed on the basis of already existing roads in the Ancient Roman Period): Nomentana, Salaria and Flaminia, three main access routes to the city centre. The demonstration area includes 131 km of primary roads (56km monitored) and 673 links (213 monitored). The edge boundaries of the area are completely monitored. There are two air quality monitoring stations within the area.

The chosen area exhibits environmental problems, both noise and air pollutant emissions, with a high number of people affected, especially due to the large numbers of institutions such as schools, hospitals, kindergarten, etc. and other highly frequented areas (shopping &/or government areas, cinemas, etc.).

Set of measures

In the off-line mode, HEAVEN is used to assess the environmental impact of TDMS. With this aim a scenario interface has been planned in order to allow the decision makers and professional users to easily handle all of the traffic and environmental parameters needed to define TDMS and their impacts on environment. An user friendly scenario allows the definition of the TDMS, deciding mobility intervention (road closure, traffic banning to certain categories, speed reduction), renewal of vehicle fleet.

Figure 14: Scenario interface



STA has successfully tested the HEAVEN system, assessing the impact of two TDMS, representing realistic situation in the City management like Demand modification due to fleet renewal and a Network modification due to closure of a main road.

The first one is related to Environmental Ministry decree number 163 of April 21st 1999, whose aimed is banning the access at non catalysed cars, from January 2002 (partially) and June 2002 (definitively) inside the HEAVEN demonstration area while the second TDMS represents a realistic situation in the City traffic management. The results obtained by the evaluation of the above mentioned scenarios can be seen as a very positive step in the methodology of comparing different transport policies in Rome, allowing to analyse how traffic and related pollution reacts to the implementation of different mobility policies.

Besides, the activity of health estimation effects by combining the exposure model with available dose-response curves is proceeding in Rome and key issue is the quantification of number of cases of several health outcomes due to PM air pollution in each specific site, especially where sensible points like schools are located.

Rotterdam

City demographics

The city of Rotterdam is located in the Southwest of The Netherlands, at the heart of the Rijnmond region. The Rijnmond region is made up of 18 municipalities with more than 1.2 million inhabitants, which covers less than 2% of the Netherlands. The city of Rotterdam, with 0.6 million inhabitants, is the economic, social and cultural centre of this metropolitan area and the industrial heart of The Netherlands. As of January 1, 1999, the municipality had an area of 304 km² (208 of them land area).

Rotterdam has by some accounts the largest harbour in the world, and it functions as an important transit point for goods transported between the European continent and other parts of the world by ship, river barge, train and road. A faster, new cargo railway to Germany, the *Betuweroute*, has been under construction since 2000. More than half of all containers from and to the harbour are transported by road now.

Traffic characteristics

Passenger movements – Public transport has a yearly amount of 21.8 million traveller kilometres in the Rotterdam region. The division of modes used to travel in the city of Rotterdam is 50% car, 15% bus, tram or metro, 34% two wheelers and 1% train.

Transport infrastructure – A ring road (national highways) surrounds the city of Rotterdam. Rotterdam itself is divided into “Rotterdam-North” and “Rotterdam-South” by the river the Nieuwe Maas. Three tunnels (the Beneluxtunnel, Maastunnel and the Heinenoordtunnel) and three bridges (van Brienoordbrug, Willemsbrug and the Erasmusbrug) connect the two parts. In addition, people can travel back and forth by subway (metro), train, buses and trams. Rotterdam has the second largest airport of the country, Rotterdam Airport (formerly known as *Zestienhoven*), which is located north of the city.

HEAVEN in Rotterdam

The abatement of air pollution has been a prominent concern for Rotterdam since the 1970's. Industrial emissions (SO₂, NO_x and VOCs) have been reduced substantially, but the decrease in ambient concentrations of NO₂ and particulate matter (PM₁₀) has been modest due to high background concentrations and diffuse emissions related to domestic heating and, for a large part, traffic.

Before HEAVEN, less attention had been paid to traffic-related air pollution in Rotterdam. With HEAVEN, the public and authorities were informed on traffic-related air quality by an Environmental Information Platform that relied on a Decision Support System:

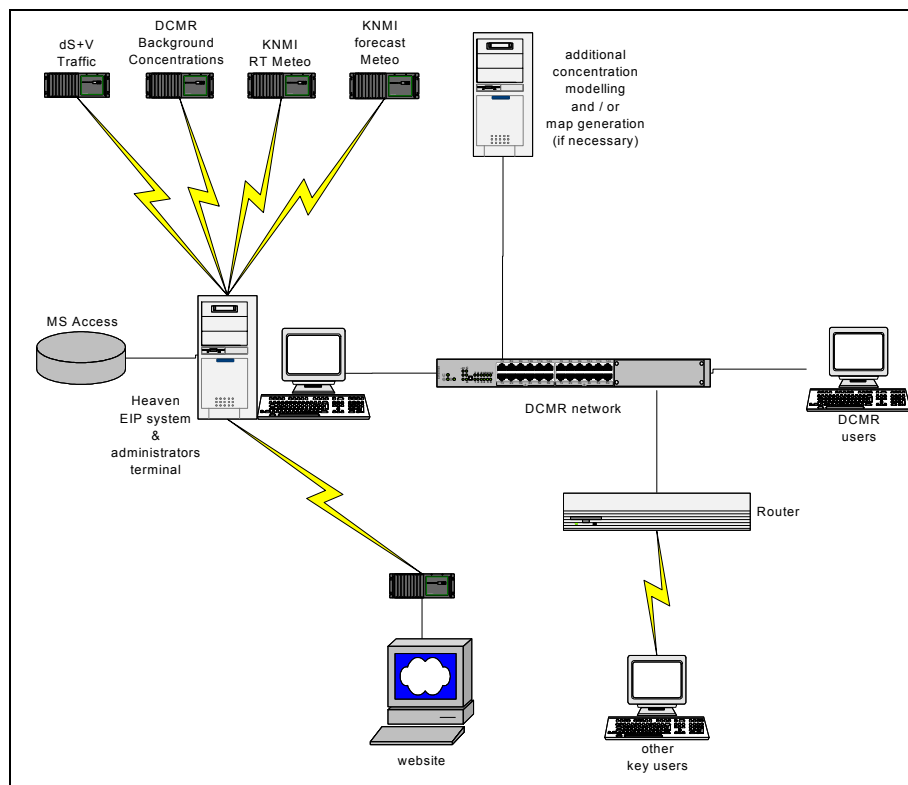
- The DSS comprised the models and data acquisition systems necessary to determine the air quality in and around the Rotterdam ring road and on one feeder road leading into the city centre. Air quality information was updated on an hourly basis using modelled concentrations from vehicle emissions and measured background concentrations. The system also provided a 24-hour air quality forecast. Parameters of interest were NO₂, particulate matter (PM₁₀) and benzene.
- The EIP was implemented as a public website. The general public, road managers and other authorities can monitor the air quality in 500m wide bands along the main traffic axis. Key-users are also provided with a stand-alone version of the DSS that can be used to analyse scenarios or events, using real (logged) or scenario data. The system is built to provide “what if” capability, producing maps of the air quality as a function of user-chosen input data. In addition to maps, impact statistics can be generated showing the concentration in a certain area or the number of people exposed to air pollution.

The HEAVEN project in Rotterdam has led to increased collaboration among a wide variety of local and regional decision makers, among them road authorities, the province and departments of environment, health and traffic. The collaboration is continued in the new “Masterplan Air” for the

Rotterdam region. The port authorities, an important (economic) player in the Rotterdam region, joined the collaboration. Emissions of ships are taken into consideration. In the future, further focus will be on an increasing public awareness about air quality, the health effects and the fact that a considerable part of the air quality problems are caused by traffic.

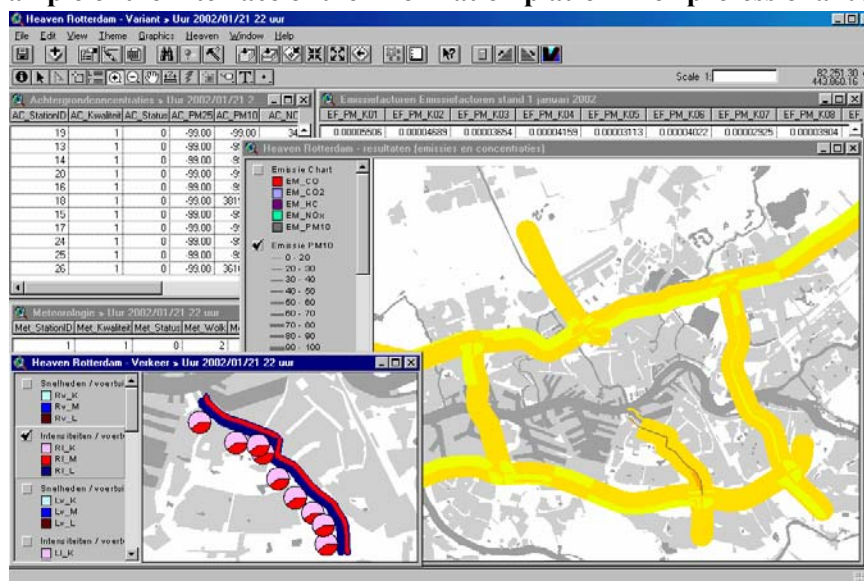
The implementation in Rotterdam concentrated the majority of the functions on HEAVEN EIP - Environmental Information Platform, located at DCMR (Regional Environmental Protection Authority). For other key-users, distribution is performed through an ftp server and in general the functionality of the system is the same for all users.

Figure 15: Hardware components of the Rotterdam DSS



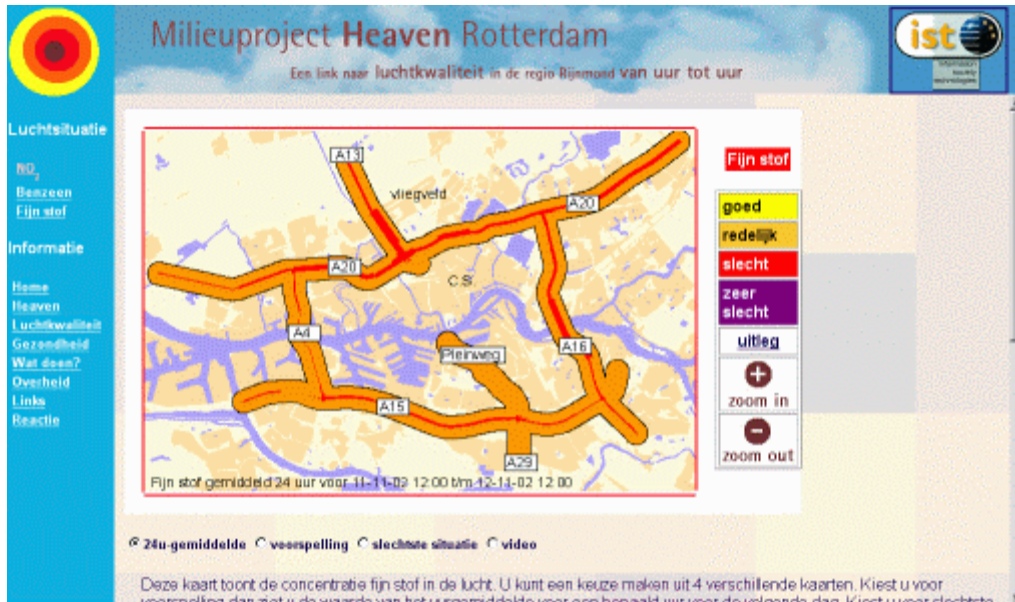
An user friendly interface has been realised in order to display real time traffic emission and dispersion data on the map of the demonstration area. The information platform has two appearances, GIS based interface for professional users and website for public users.

Figure 16: Example of the interface of the information platform for professional users



The web site (officially launched on 5 July 2002) provides the public with information on traffic related air-quality. The web site shows hourly NO₂ concentrations, and hourly updates of 24-hour moving averages for benzene, NO₂ and PM₁₀. It also provides a 24 hour forecast and information on air quality and health. Furthermore a “video” of the last 24-hours is added as extra feature.

Figure 17: Public interface of the Rotterdam information platform



The demonstration areas

In Rotterdam the total highway ring and two more limited demonstration areas were chosen. The first demonstration area for monitoring and modelling was the Rotterdam ring road, including the Overschie district. This area is the major hotspot in the Rotterdam region for traffic-related pollution. The traffic volumes on the national highway that crosses the district are among the highest in the region and the first line of dwellings is at less than 30 metres from the road. On the A13 national highway, loops gather the necessary traffic data, and there is a variable message sign (VMS) to inform road users.

Figure 18: Rotterdam demo areas – Overschie (upper circle) and Pleinweg-Vaanweg (lower circle)



The second demonstration area for monitoring and modelling is the Vaanweg/Pleinweg/Maastunnel corridor. This urban road is one of the corridors with the highest urban traffic volumes. On this corridor, the city department for Traffic and Transport gathers real-time traffic data. The Maastunnel, which is also on this corridor, makes it possible to have tunnel-based emission measurements. The corridor is, up to now, one of the two urban roads that are equipped with a VMS.

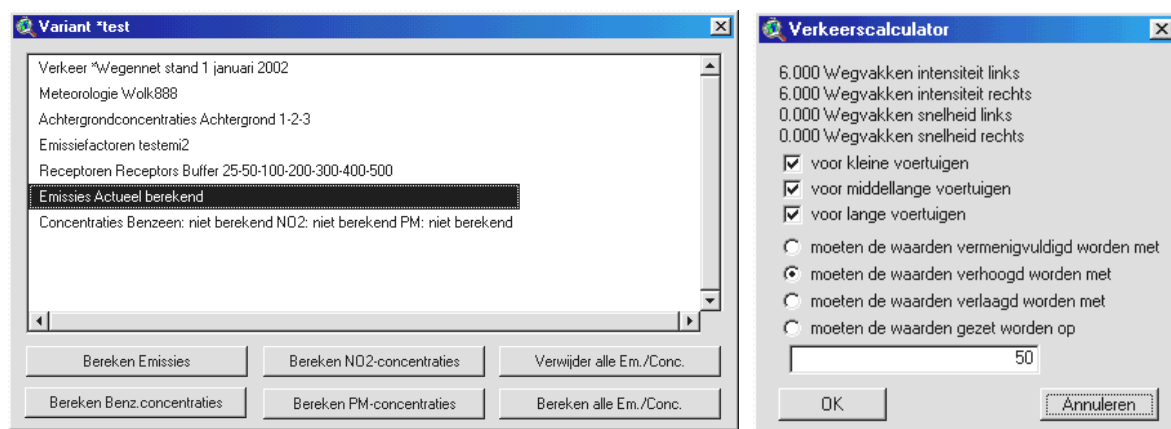
Two national highways cross the Overschie area. The North-South bound national highway A13 intersects with the East-West bound A20 within the Overschie district. During the morning and afternoon peak-hours, both the A13 and A20 highways are congested. The first line of dwellings is very close on both sides of the A13. In the year 2000, sound barriers were built between the highway and the dwellings.

The Pleinweg/Vaanweg corridor connects the national highways in the South of the region with the city centre on the North bank of the river Maas. The Maastunnel at the Northern end of the corridor is one of the three points in the city centre where the river Maas can be crossed. Commuters from the southern parts of the Rijnmond region use the corridor to reach the city centre. The corridor is congested during morning and afternoon peak hours.

Set of measures

In the off-line mode, HEAVEN in Rotterdam is used to assess the impact of Traffic Demand Management Strategies (TDMS) on air quality. An interface has been designed in order to allow the decision makers and professional users to easily handle all of the traffic and environmental parameters needed to define TDMS and analyse their impacts air quality. The DSS allows the analysis of mobility scenarios such as road closures, banning certain categories of traffic, speed reductions but can also be used to assess the impact of the renewal of the vehicle fleet.

Figure 19: Presentation of user interface for scenario analysis by professional users



One of the measures to decrease traffic-related air pollution is to change the traffic flow. In the Overschie residential area, the highway A13 passes through a densely built area. Typical traffic densities are 150,000 vehicles/day, creating a situation where the threshold limits for air quality and noise are exceeded. Reduction of the maximum speed from 100 to 80 km/h was estimated to yield a 20% reduction of NOX emissions. The beneficial effects on air quality are mainly due to a reduction of the traffic dynamics as the speed reduction results in a more homogeneous flow of traffic. A preliminary assessment of the impact of the speed limit suggests that there are indeed minor improvements in air quality and a substantial reduction of noise. Final results are expected by mid 2003.

The whole HEAVEN process generates interest from political decision makers and urban planners as a source of information for potential solutions for traffic related air pollution. Communication and mutual understanding is judged to be improved considerably by the key-users and authorities. The HEAVEN project facilitated the establishment of direct contact and direct information exchange between organizations and highly increased the attention towards the environmental problems linked to traffic amongst the public and local/national politicians.

Annex 2: Summary of Evaluation Results

Conclusions from evaluation

HEAVEN was a successful project. The system developed has the potential to become a widely accepted and implemented tool to support key actors in their decision making with regard to traffic, air quality, noise, and beyond.

HEAVEN developed and demonstrated a DSS to evaluate environmental effects of TDMS. The project objectives were to a large extent achieved:

- Decision makers have more and better quality environmental data at hand in the common HEAVEN data repository, including valuable test results from traffic management scenarios.
- Key actors in urban planning issues, including the general public, can now quickly be informed on the current state of air pollution levels as well as noise to be enabled to make decisions.
- HEAVEN allowed to draw conclusions in regard to the implementation of local noise and air action plans as they are part of current EU legislation.

The impacts identified by the Evaluation Team were all achieved (either partially or completely). As depicted in the following table 37, HEAVEN successfully contributed to:

- Enhanced description of current environmental situation
- Enhanced environmental scenario analysis
- Improved access and quality of environmental information for professional as well as for public user
- Improved institutional co-operation
- Increased support of urban planning on an environmental basis

In addition to table 37, individual impacts are summarised in textual form below.¹

¹ Summaries provided in this conclusion are identical to those in the respective final sub-chapters of chapter 5.1 to 5.5.

Table 2: Impact achievement

Impact	Achievement
Impact 1: Enhanced description of current environmental situation	+
1.1: Increased coverage of the traffic and roadside pollution network	++
1.2: Increased grid resolution	o
1.3: Accuracy of roadside description	+ air + noise 1
1.4: Increased frequency of update intervals regarding air quality	+
1.5: Increased efficiency of air quality description	++
1.6: Increased frequency of update intervals regarding noise pollution	++* 1
1.7: Increased efficiency of noise pollution description	o
1.8: Noise roadside emission: Length of network	++
1: Berlin only provided a limited amount of noise data for evaluation purposes.	
Impact 2: Enhanced environmental scenario analysis	++
2.1: Increased coverage of the traffic and roadside pollution network	++
2.2: Increased grid resolution used in modelling	o
2.3: Reduced time to produce environmental descriptions regarding air quality based on scenario analysis	++
2.4: Reduced time to produce environmental descriptions regarding noise pollution based on scenario analysis	++
Impact 3: Improved access and quality of environmental information	++
Impact 3A: For professional users (i.e. everybody but the public)	++
3A.1 Improved time resolution	++
3A.2: Reduced delivery time	+
3A.3: Increase in usefulness (interviews)	++2
3A.4: Increased efficiency of daily/ weekly bulletin	+*
Impact 3B: For public users	++
3B.1: Improved time resolution	++ 3
3B.2: Reduced delivery time	+
3B.3: Increase in usefulness (questionnaires)	++ 2
3B.4: Increased efficiency of daily/ weekly bulletin	+ 4
2: The low number of questionnaires and interviews, respectively, hampered the analysis.	

Impact	Achievement
3: In Rome, where only the municipality is allowed to disseminate environmental information to the public, no public user questionnaire data were available due to the prototypical version of the system reserved just for the evaluation by decision makers.	
4: Paris was the only HEAVEN site that produced a daily bulletin as planned and outlined in project deliverable D3.1 – Final Evaluation Plan	
Impact 4: Improved institutional co-operation	+
4.1: Increased quality of co-operation (interviews)	+ 5
4.2: Increase in time-efficiency of information exchange	++ 5
5: The low number of interviews severely hampered the analysis of institutional co-operation and its changes due to HEAVEN	
Impact 5: Increased support of urban planning on an environmental basis	+
5.1: Amount of data entered in common repository	++
5.2: Increased usefulness for urban planning (including quality of data structure and storage of common repository)	+
Legend	
++ Impact achieved	
+ Impact partly achieved	
o Impact not achieved	
? Insufficient data to allow assessment of impact achievement	

HEAVEN partially achieved impact 1 - enhanced description of current environmental situation.

The description, merging monitoring and modelling systems, was focused on traffic, air pollutant emissions, air quality concentrations and noise.

The length of the traffic and roadside pollution network was increased due to HEAVEN in all involved cities, thereby increasing the network coverage and providing a more extensive description of the current environmental situation caused by traffic.

Increased grid resolution, i.e. the reduction of grid cell sizes, was achieved in Paris, Prague, and Rome for NO₂ background modelling. In Berlin and Leicester no new developments had been implemented within the HEAVEN framework, and in Rotterdam, background concentrations were not modelled in real time but based on direct measurements in the demonstration area.

For O₃ background, success was not achieved. This modelling was only done in Paris, where the grid size had not been reduced during HEAVEN, even though the size of the domain covered (number of cells) had been extended. Hence, the achievement gained through HEAVEN for background modelling, while not a priority in HEAVEN, was only a “mixed” success.

According to the success criteria for **accuracy of roadside description provided by the European Directive 1999/30** related to air quality, the results showed a **good achievement**. Most of the cities reached the target for at least two pollutants.

HEAVEN also significantly improved the frequency of update intervals for roadside descriptions (PM₁₀, NO₂, CO, and C₆H₆). Therefore, the time between occurrence of an environmental situation and its description provided by simulation tools was reduced – allowing for updates in “near real-time”. In contrast, the situation for background pollution improved for less than 50% of the parameters.

Increased efficiency of air quality description was achieved through an efficient combination of simulation tools and monitoring devices. This approach of HEAVEN also allowed for scenario analyses.

With regards to noise, both Berlin and Leicester are now able to undertake quasi real-time noise modelling for limited road networks.

However, whilst a more extensive description of the current environmental situation has been achieved, there remain some issues with regards to the accuracy of the modelling techniques used. In Leicester these accuracy issues relate to the treatment of low-flow, high-speed (i.e. overnight) conditions, whilst in Berlin accuracy was affected by the modelling of large numbers of goods vehicles. Remedial measures are still being studied for both cases.

**Impact 1
Achievement: +**

**Increased network
coverage**

**Good achievements
concerning
accuracy of
roadside description**

**Quasi real-time
noise modelling**

HEAVEN achieved impact 2 - enhanced environmental scenario analysis.

Urban planners and other **professional users of the HEAVEN system now have an efficient and useful tool** at hand for the analysis of environmental effects of **TDMS scenarios**.

The length of the network expressed in kilometres significantly increased in the cities involved, thereby fulfilling the success criteria for an increased coverage of the traffic and roadside pollution network and an improved description of environmental impacts in near real-time as well as in the long-term.

HEAVEN could, however, only provide partial success in terms of increased grid resolution used in modelling. A reduction of grid cell sizes was anticipated both for real time descriptions and in “offline” modes for scenario analysis. Only for NO₂ background modelling, the evaluated cities met the success criterion. Therefore, HEAVEN provided an important contribution, since background modelling for the test of local scenarios was of major interest merely for NO₂.

Five so-called “black and white” scenarios comprising different strategies of traffic management were tested within HEAVEN2:

- an homogeneous speed reduction of 20% for the whole running fleet;
- a vehicle fleet without Heavy Duty Vehicles (truck ban);
- a vehicle fleet without two wheelers;
- no traffic emissions; and
- a scenario anticipating for each type of vehicle the implementation of the most advanced legislation (Euro IV or V).

With regards to noise, both Leicester and Berlin have demonstrated that the implementation of their respective HEAVEN systems has drastically reduced the time required to produce assessments of traffic related scenarios whilst expanding the network available for analysis. However, at the present time, the scenario assessment reports produced automatically in Leicester are based solely on traffic noise emissions.

**Impact 2
Achievement: ++**

**Efficient and useful
tool for analysis of
TDMS scenarios**

**Time to produce
assessments
reduced**

² Results of the scenario analysis are summarised in annex 9 to this Evaluation Report.

HEAVEN achieved impact 3 - improved access and quality of environmental information.

The impact was analysed separately for professional users (impact 3A) and public users (impact 3B). For both user groups the assessment revealed that the access to and quality of environmental information provided improved through HEAVEN.

In the impact assessment, a particular emphasis was put on time improvements. Evaluation was concerned with the time resolution, i.e. the finest temporal description of air pollution patterns technically obtained after the development of the HEAVEN system. This time resolution improved when related to roadside concentrations. For background locations an improvement was achieved in less than half of the cases. In general, time resolution improved to a larger extent for professional users than, in comparison, to public users.

HEAVEN proved that it was able to **produce near real-time descriptions of current environmental situations**. Delivery times, i.e. the time needed to produce an up-to-date description of an environmental situation (for example air pollution levels), were reduced for both professional and public users. Comparable to the results concerning time resolution described above, professional users benefited to a larger extent from reduced delivery times than, in comparison, public users.

Close to two out of three public users perceived HEAVEN as useful in general terms.

A daily or weekly news bulletin was produced within HEAVEN. For the impact assessment, the time efficiency to produce such a bulletin was evaluated. Time efficiency could not be expressed in operational terms due to the lack of reference data. However, the time required to produce a bulletin in the four cities of concern (Berlin, Leicester, Paris, and Rotterdam) was between an “acceptable” and time efficient one and two hours depending on the update frequency (hourly, daily, weekly) and the types of data included, i.e. meteorological, emission, air pollution background, air pollution roadside, noise, and traffic data.

The news bulletin was a side-product of the HEAVEN evaluation exercise. It represented a useful means to disseminate air quality (and noise) information to professional as well as to public users. The news bulletin should be further developed and used in future HEAVEN-related projects or activities. A particularly useful example of a news bulletin was the one created by the project partners in Paris.

**Impact 3
Achievement: ++**

**Improved time
resolution and
reduced delivery
time**

**HEAVEN news
bulletin a useful
by-product of
evaluation exercise**

HEAVEN partially achieved impact 4 – improved institutional co-operation.**Impact 4
Achievement: +**

The Evaluation Team intended to analyse two kinds of interview data, namely interviews conducted with:

- members of local authorities as “Direct HEAVEN Users” from either traffic and transport, environmental, health, or urban planning departments as well as with
- decision makers as “Indirect HEAVEN Users” from either the area of urban development, traffic and transport, environment, or health.

It was clear that HEAVEN demonstrated merely a trial version within the limitations of a research and demonstration project. Only few interviews of local authority members were conducted by the HEAVEN cities Berlin (two); Leicester (three), Prague (four), and Rotterdam (six), and only Prague interviewed two political decision makers. It was argued that (political) decision makers and local authority members were not approached for interviews because of strategic (political) reasons and the apprehension of presenting an “incomplete” and still to be enhanced HEAVEN system. Moreover, it was argued that the demonstration phase was too short to realise and observe any improvements in terms of institutional co-operation.

**Only few
interviews available
for analysis**

From the viewpoint of the evaluator, these arguments would have been considered in the analysis of the interview data. In consequence, the availability of only fifteen interviews from four cities seriously limited the assessment of institutional co-operation in HEAVEN.

The few interviews conducted in Berlin, Leicester, Prague, and Rotterdam revealed perceived positive changes in quality of institutional co-operation. In particular, time efficiency gains were stated for the information exchange in all areas suggested in the interviews, i.e. transport, air quality, noise, as well as scenario information.

HEAVEN generated an amount of data that was not adequate for the size and ambitions of the project. It could be argued that insufficient data was available for an assessment of the impact achievement and even that the impact was not achieved. Nevertheless, interview statements that were provided (while few) were very positive, revealed the **potential of HEAVEN to be a suitable tool to improve institutional co-operation**, and, therefore, justified the assessment of partial impact achievement.

**HEAVEN a suitable
tool to improve
institutional
co-operation**

HEAVEN partially achieved impact 5 - increased support of urban planning on an environmental basis.

HEAVEN was successful in making available a substantial amount of data available in its common data repository and thereby supporting urban planning. It is noteworthy that all cities entered traffic emission data concerning NOx and PM10 in the common data repository.

The increase in the amount of data was more important for data related to emissions than to concentrations. The modelling chain going from traffic to traffic emissions is easier to implement and control. More than air pollutants concentrations, the availability of emissions data was of major interest for urban planners and decision makers.

Public users as well as professional users confirmed the increased amount of data available by their positive perceptions expressed in questionnaires and interviews.

In addition to the perceived quantity of data available, their quality significantly improved in the views of professional and public users as a consequence of the HEAVEN system introduction.

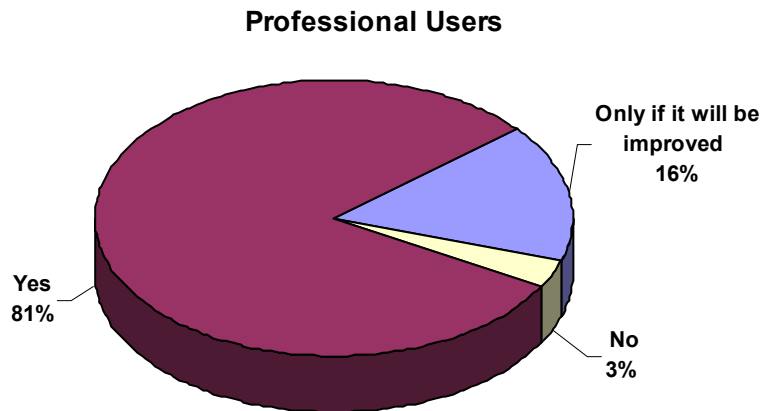
HEAVEN realised an increased support of urban planning on an environmental basis. However, users also made clear that the system still needed to be improved in some areas, in particular, by improving the usability of the information platforms, adding more data and content, increasing the scope (in order to cover an entire city or region), adding topics such as the effects of pollution on human health, and applying additional means of information delivery.

**Impact 5
Achievement: +**

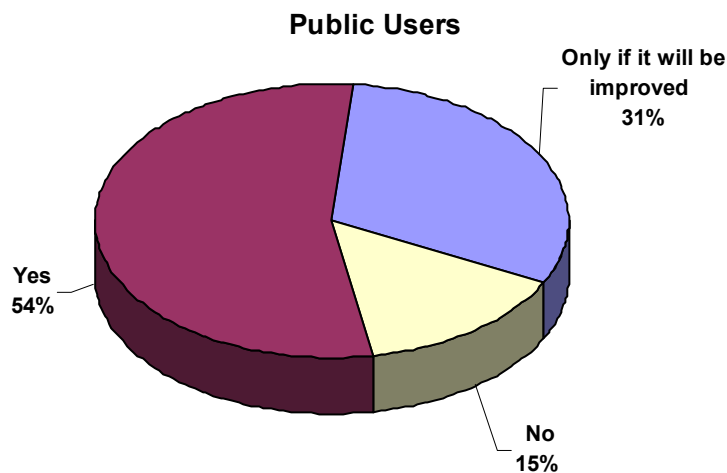
**Increased amount
of data available in
common data
repository**

**Improved
quality of data**

Figure 20: Intention among professional and public users to use HEAVEN information system in the future



n=62



n=109

The majority of professional users (81%) and public users (54%) intend to use HEAVEN in the future which represents a positive and promising results for the future of the system developed within this project.

While being a successful project, it is clear that HEAVEN should be further improved. As seen in figure 20, many professional users (16%) as well as public users (31%) stated that they would only use HEAVEN in the future if it was improved. The Evaluation Report, therefore, formulated recommendations to Improve the information base, Enhance information delivery, Strengthen institutional co-operation, and Increase scope and relevance.

**Promising future
for the system
developed**