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Executive Summary

HEAVEN (Healthier Environment through Abatement of Vehicle Emissions and Noise) was a research project co-funded by the Information Society Technologies (IST) programme within the 5th Framework Programme of the European Union.

Major European cities, leading industry and research institutes joint in the project to develop and demonstrate a fully integrated, and IST-based, Decision Support System (DSS) envisaged to evaluate the environmental effects, and more specifically the air quality and noise effects, of Transport Demand Management Strategies (TDMS), in large urban areas.

Demonstrations were carried out in the cities of Berlin, Leicester, Paris, Prague, Rome, and Rotterdam. All six HEAVEN cities have in common environmental problems caused by increasing traffic. They are examples for major agglomerations where transport-related noise and air pollutant emissions pose imminent threats to the well-being of their citizens. Hence, the reduction of transport-related noise and air pollutant emissions through the innovative combination of efficient TDMS and integrated environmental Information Society Technologies was an important driving-force in these cities to demonstrate HEAVEN and its DSS.

Summary of Key Results

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 are 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.

Overall Evaluation Framework

The project was organised and conducted following an efficient workpackage (WP) structure. Project WP3 was responsible for the evaluation within HEAVEN. The key role of WP3 was 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. Despite the fact that the HEAVEN DSS was implemented and applied in six different European cities, evaluation was based on commonality.

The main aspects considered in establishing a common evaluation basis were:

- Impacts and indicators common to all sites needed to be agreed upon.
- Indicators selected for all sites needed to be measured in the same way, or at least yielded comparable results, across the sites.

A major challenge within WP3 was, therefore, to reach full agreement among the Evaluation Team on common impacts and indicators as well as assessment methods.

Impacts, Indicators, and Assessment Methods

In various evaluation workshops and other consultations, the Evaluation Team consisting of six Local Evaluation Managers, a WP Leader, and an independent Evaluation Manager, identified common impacts and indicators as well as measurement tools as the key elements of the evaluation process.

The HEAVEN impacts were:

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

The following categories of tools were jointly developed by the Evaluation Team and applied during the course of the HEAVEN large scale demonstration phase:

- Automatic Counts
- Monitoring Campaign
- Surveys
- Task Observations
- Factual Information Collection

Recommendations

The present Evaluation Report describes evaluation results for each of the identified HEAVEN impacts and culminates in the formulation of recommendations and conclusions.

Derived from evaluation results, seventy-one recommendations are provided, structured according to four anticipated reader types as well four key thematic issues.

The key thematic issues are:

- Improving the information base;
- Enhancing information delivery;
- Strengthening institutional co-operation; and
- Increasing scope and relevance.

Recommendations are tailored to four reader types:

- HEAVEN partners for further roll-out activities they may envisage;
- Potential take-up partners for new implementations;
- The European Commission for setting up future programmes; and
- Readers interested in methodological issues for future assessments.

1 Guide to the Reader

This Evaluation Report will be read by different types of readers. It covers in a comprehensive manner what HEAVEN was about, the underlying evaluation framework, the actual evaluation results, recommendations, and conclusions.

…four different reader types

It is anticipated that, in addition to other readers interested in the evaluation results, this report will primarily by of interest to:

- HEAVEN partners;
- Potential take-up partners;
- Evaluation professionals interested in methodological issues; and
- The European Commission.

Each reader type will be interested in different aspects of the Evaluation Report. Therefore, "customised" reader guides for navigating through the document are provided.

The Evaluation Report culminates in recommendations (and the final conclusion) structured according to four key thematic issues and tailored to the four anticipated reader types listed above. A table of recommendations is provided as a separate annex 8 to this document. The reader may choose to print out this table and use it as a parallel document when going through the Evaluation Report.

Who should read what?

HEAVEN partners are expected to be most interested in the actual evaluation results. These are presented in chapter 5 of this document for each of the five defined impacts of HEAVEN. In chapter 6, specific recommendations are given for each reader type, including HEAVEN partners.

Potential take-up partners (not involved as partners in the HEAVEN project) should, more or less, be interested in the entire Evaluation Report. They may want to obtain information about the project itself, in particular how it was set up (in terms of objectives, work programme, management structure, etc.). This respective information is provided in chapter 2. For the set-up of a potential take-up project, in particular chapters 2.3.2 and 2.3.3 the work programme and management structure of the HEAVEN project should be of interest. Chapter 5 presents detailed results for all five HEAVEN impacts. Depending on the focus of the take-up project in question, the reader can concentrate on the appropriate impact chapter. A potential take-up partner may also want to have a close look at the recommendations provided specifically to her/his reader type.

Evaluation professionals interested in methodological issue should primarily focus on chapter 4 which describes the evaluation framework in detail (structure, agreement process, proceedings, etc.) as well as underlying methodology used in terms of indicator selection and definition, data measurement tools, the process of gathering data, the data analysis, etc. Chapter 6 offers specific recommendations for future assessments of (IST-) projects.

The European Commission will be most interested in the comprehensive results of the HEAVEN evaluation. Therefore, in addition to the executive summary and the conclusions, the European Commission should read, in chapter 6, the recommendations it may want to consider in setting up future programmes (and projects). In this sense, also the recommendations primarily targeted at potential take-up partners for new implementations as well as the methodological recommendations for future assessments should be read carefully.

2 The HEAVEN Project

HEAVEN stands for Healthier Environment through Abatement of Vehicle Emissions and Noise. It was a Fifth Framework project co-funded by the European Commission's IST Programme.

2.1 Background

Desire for increased mobility spurs traffic

The environmental impacts caused by traffic in urban areas have been of major concern for decades. Due to society's continuous desire for increased mobility, the quality of urban environment is expected to remain on the agenda for some time in the future. Moreover, large European cities represent particularly complex situations in which it is difficult to compromise between environmental quality (air and noise) improvements and vital economic centres.

Traffic causes (negative) environmental impacts

This pollution context has resulted in efforts being undertaken at local, regional, national and EU levels to reduce these adverse impacts on the environment. In fact, the EU has introduced (or proposed) a series of directives to improve air quality and to reduce noise levels.[1]

The HEAVEN project provided a contribution to the implementation of EU regulations on air and noise quality by researching and demonstrating new IST environmental management tools. These innovative tools, merging monitoring and simulation systems, were integrated in a DSS in order to:

- provide a better description in near real-time of the environmental impacts (on air and/ or noise) mainly induced by traffic and
- assist the cities in identifying TDMS which reduce the impact of traffic on the environment.

Compliance with (EU) regulations has been particularly important for the major European cities of the consortium, which are looking to proactively plan for future environmental standards.

[1] European air quality and noise directives relevant for the framework of HEAVEN are described in detail in chapter 2.4 of this Evaluation Report.

2.2 Objectives

The project's **high-level goal** was to develop and demonstrate a DSS which could evaluate the environmental effects (air quality and noise quality - both emissions and dispersion forecasting) of TDMS in large urban areas.

DSS: a decision support system to evaluate environmental effects of TDMS

This demonstration in the large urban areas of Berlin, Leicester, Paris, Prague, Rome, and Rotterdam (i.e. the six HEAVEN sites)[2] provided 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.

This goal was 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 potential 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 TDMS 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 action plans.

The project consisted of a partner consortium from major EU cities and one CEEC city, leading industries, and research institutes as described below.

[2] The six HEAVEN sites and their HEAVEN context are described in detail in chapter 3 of this Evaluation Report.

2.3 Structure

2.3.1 Consortium

high expertise in field of transport and environment

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 the only city from an accession country);
- Rome; and
- Rotterdam.

An overview of the HEAVEN consortium is provided in the following table.

Table 1: Example Table – The HEAVEN Consortium

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
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

Legend:

C: Co-ordinator
AC: Assistant Co-ordinator
PC Principal Co-ordinator
SC: Sub-Contractor

2.3.2 Work Programme

Public and private partners of the consortium jointly implemented the project and its DSS in the six HEAVEN sites over a period of thirty-eight months. During this period, the project followed a well-structured WP scheme based on a life-cycle model to realise a Research and Technical Development (RTD) system.

As indicated in the table below, the first three WPs covered the horizontal issues - project management, dissemination and validation co-ordination - whereas the six technical WPs covered the lifecycle of a combined research and demonstration project. WPs 4-7 focussed on the research and development of the systems, while WPs 8 and 9 covered the demonstration and exploitation phases of the project.

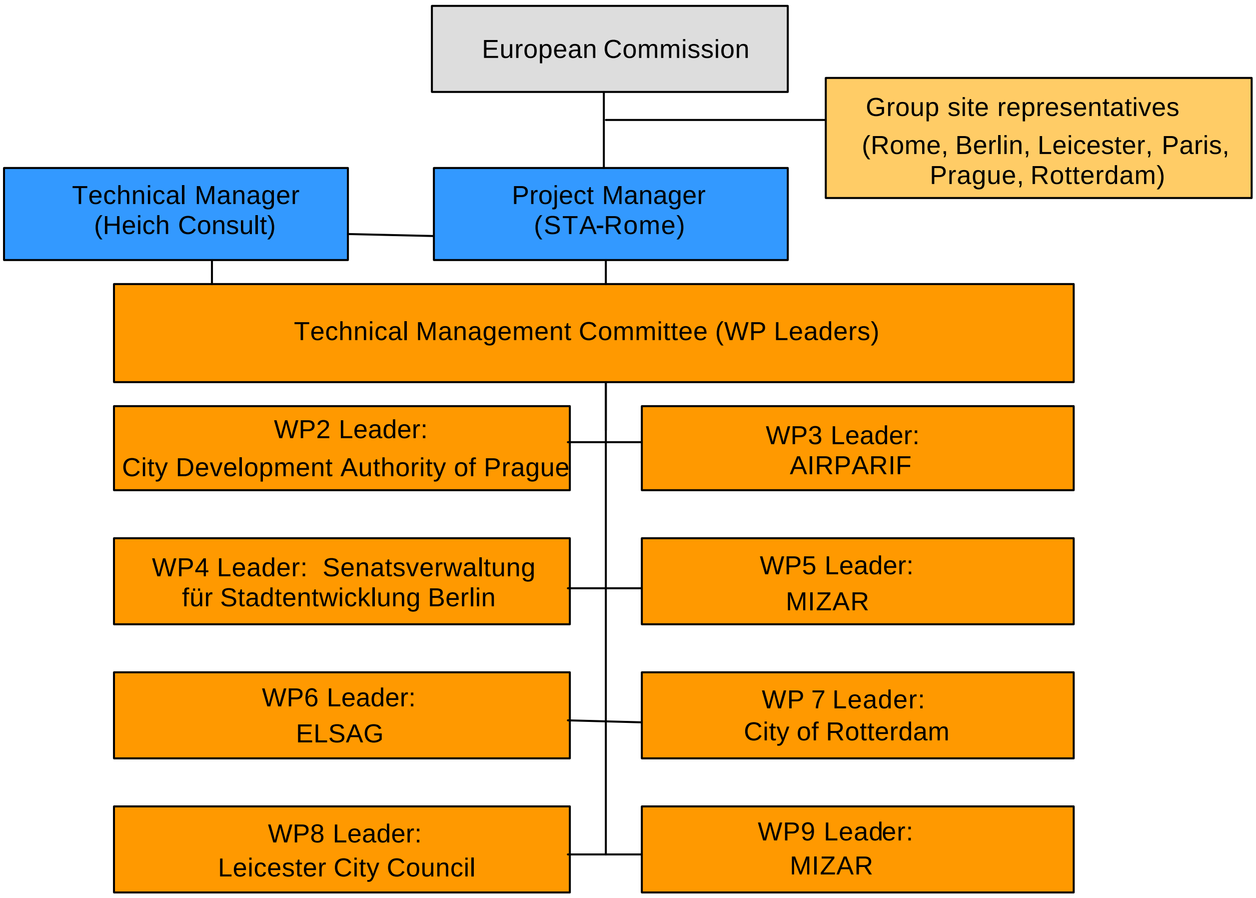
Table 2: HEAVEN Workpackages

WP Number	Description
1	Project Management
2	Dissemination
3	Validation Co-ordination
4	User Requirements and Implementation Framework
5	Functional Specifications/ System Architecture
6	Build Integrated Systems
7	System Verification
8	Large Scale Demonstration
9	Exploitation and Business Planning

2.3.3 Management Structure

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 1: 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.

2.4 HEAVEN in Perspective

Contribution to the implementation of EU air quality and noise policies

HEAVEN has developed a DSS to provide integrated and near real-time information on air and noise pollution and to identify TDMS that reduce the impact of traffic on the environment. The project contributed to the implementation of the EU policies on air quality and noise as well as on public information as this is part of the related policies. Throughout the project lifetime, HEAVEN has closely followed the developments of the related policies and has taken account of existing or emerging policy needs and geared the HEAVEN DSS to meet the policy requirements. The major EU regulations and policies regarding air quality and noise and their development during the lifetime of HEAVEN are outlined in the following.

When the HEAVEN project was launched in January 2000 the Framework Directive on air quality (European Commission, 1996) and the first Daughter Directive (European Commission, 1999a) have been in force. The Framework Directive covers the revision of previously existing legislation and the introduction of new air quality standards for previously unregulated air pollutants and sets the timetable for the development of daughter directives on a range of pollutants. The list of atmospheric pollutants to be considered includes sulphur dioxide, nitrogen dioxide, particulate matter, lead and ozone and benzene, carbon monoxide, poly-aromatic hydrocarbons, cadmium, arsenic, nickel and mercury.

The framework directive calls for action plans to improve air quality and requires public information. The Daughter Directives set the numerical limit values, or in the case of ozone, target values for each of the identified pollutants. Besides setting air quality limit and alert thresholds, the objectives of the daughter directives are to harmonise monitoring strategies, measuring methods, calibration and quality assessment methods to arrive at comparable measurements throughout the EU and to provide for good public information.

European air quality and noise directives emerging

The first Daughter Directive relating to NO_X, SO_2, Pb and PM10 came in force in July 1999 and Member States had two years to transpose the Directive and set up their monitoring strategies. The limit values for NOx for the protection of vegetation must be met by 2001. The health limit values for SO_2 and PM10 must be met by 2005. The other health limit values for NO_2 and Pb must be met by 2010.

The second Daughter Directive (European Commission, 2000a) establishes limit values for benzene and carbon monoxide and came into force in December 2000 when the HEAVEN project was running for almost one year. The limit value for carbon monoxide must be met by 2005 and the limit value for benzene must be met by 2010 unless an extension is granted.

The third Daughter Directive (European Commission, 2002b) on ozone came into force in February 2002. This directive sets long-term objectives equivalent to the World Health Organisation's new guideline values and interim target values for ozone in ambient air to be achieved as far as possible until 2010. Non-compliance requires Member States to work out reduction plans and programmes to be reported to the Commission and to be made available to the public so as to allow citizens to trace progress towards meeting the ozone standards. The directive includes also improved and more detailed requirements to monitor and assess ozone concentrations and to inform citizens about the actual pollution load.

CAFE for human health

In addition to the above-mentioned directives on air quality the European Commission is undertaking efforts to reduce air pollution. The Clean Air For Europe (CAFE) Programme (European Commission, 2001b) was launched in May 2001 and will lead to the adoption of a thematic strategy on air pollution under the Sixth Environmental Action Programme (European Commission, 2002a) in 2004. Its aim is to develop a long-term, strategic and integrated policy advice to protect against significant negative effects of air pollution on human health and the environment. The integrated policy advice from the CAFE programme is planned to be ready by the end of 2004 or beginning of 2005. The European Commission will present its thematic strategy on air pollution during the first half year of 2005, outlining the environmental objectives for air quality and measures to be taken to achieve the meet these objectives.

Noise directive adopted in 2002

The starting point of HEAVEN in relation to the policy on noise was a proposal for a Directive relating to the assessment and management of Environmental noise (European Commission, 2000b) which was prepared in July 2000. Further to this proposal the European Parliament and Council have adopted the Noise Directive (European Commission, 2002c) in June 2002. The main aim is to provide a common basis for tackling the noise problem across the EU. The underlying principles of this Directive are:

a) The Monitoring the environmental problem; by requiring competent authorities in Member States to draw up "strategic noise maps" for major roads, railways, airports and agglomerations, using harmonised noise indicators L_{den} (day-evening-night equivalent level) and L_{night} (night equivalent level). These maps will be used to assess the number of people annoyed and sleep-disturbed respectively throughout Europe;

b) Informing and consulting the public about noise exposure, its effects, and the measures considered to address noise, in line with the principles of the Aarhus Convention;

c) Addressing local noise issues by requiring competent authorities to draw up action plans to reduce noise where necessary and maintain environmental noise quality where it is good. The directive does not set any limit value, nor does it prescribe the measures to be used in the action plans, which remain at the discretion of the competent authorities;

d) Developing a long-term EU strategy, which includes objectives to reduce the number of people affected by noise in the longer term, and provides a framework for developing existing Community policy on noise reduction from source.

3 The HEAVEN Sites

3.1 Berlin

City demographics

Polycentric city structure

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.

New traffic management centre set-up in 2001

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.

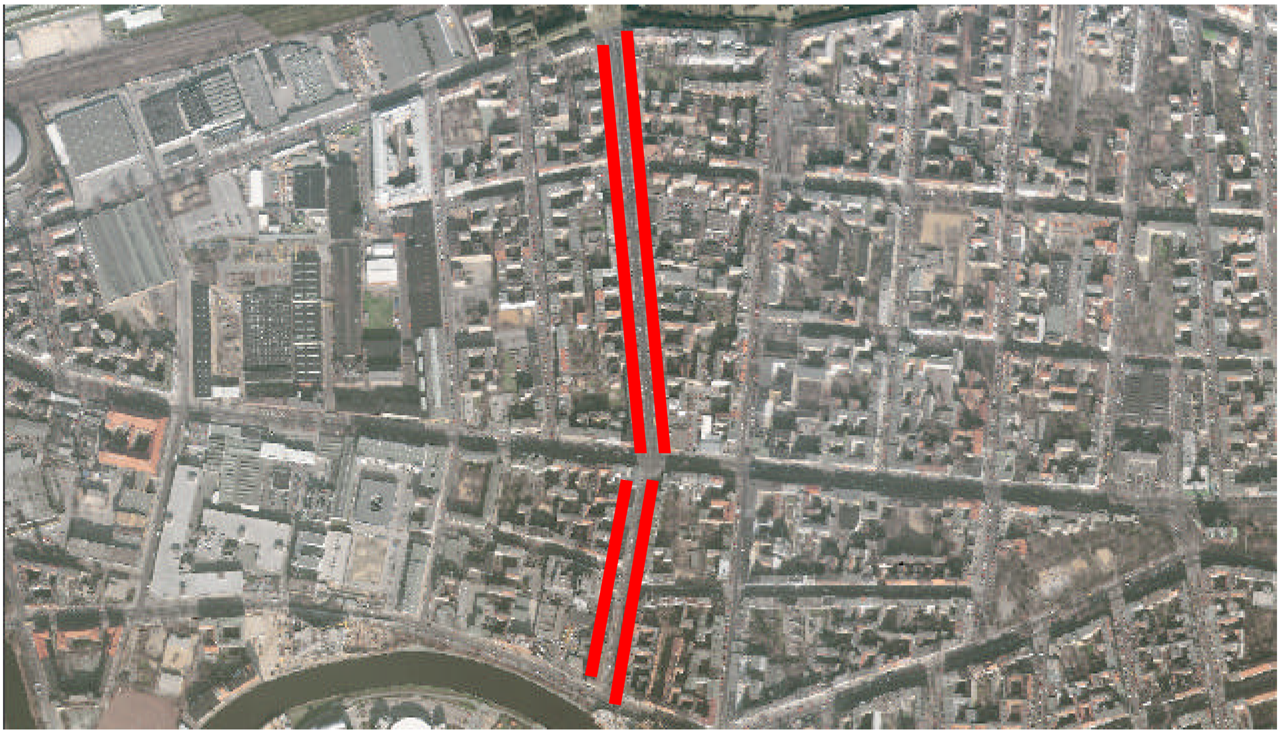
Residential demonstration area with large share of truck traffic

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, NO_2, NOx 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 2: Beusselstrasse Demonstration Area in Berlin



Set of measures

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

Speed limit and truck ban measures tested

- 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.

3.2 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.

Leicester selected as "European Sustainable City" in 1996

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 then 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 demonstration area

Narborough Road demonstration area one of the principal roads in Leicester

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. 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 NO_2 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 PM_{10} levels. This is also maintained by Pollution Control, who supplies the data to Area Traffic Control.

Figure 3: Narborough Road demonstration area in Leicester

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.

3.3 Paris

City demographics

Close socio-economic integration between City and Region

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 km^2, 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.

Extensive public transport system used by ten million passengers daily

Traffic infrastructure – Paris is situated at the centre of a dense road network consisting of the "Boulevard Périphérique", a dual carriage-way 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.

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.

Future developments of the system mainly focus on the more precise description of the vehicle fleet and road typology.

The demonstration area

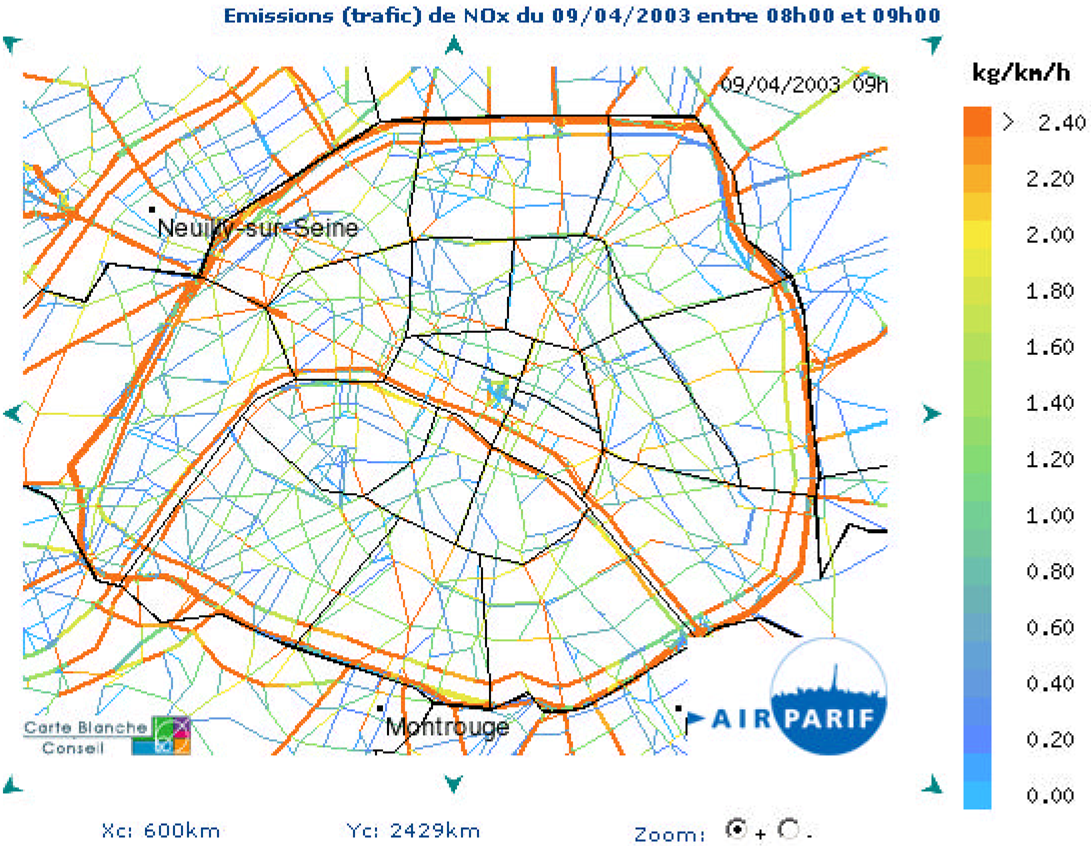
Whole Ile-de-France Region chosen as demonstration area

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 NO_2 and O_3 background pollution modelling was a domain of 180 x 180 km^2 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 km^2 with a grid resolution of 3km containing the dense urban area (“agglomeration parisienne”).

Figure 4: Paris demonstration area



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.

3.4 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 km^2. 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.

More than one million people are living in the Czech capital

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.

HEAVEN as a tool for improved institutional communication

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.

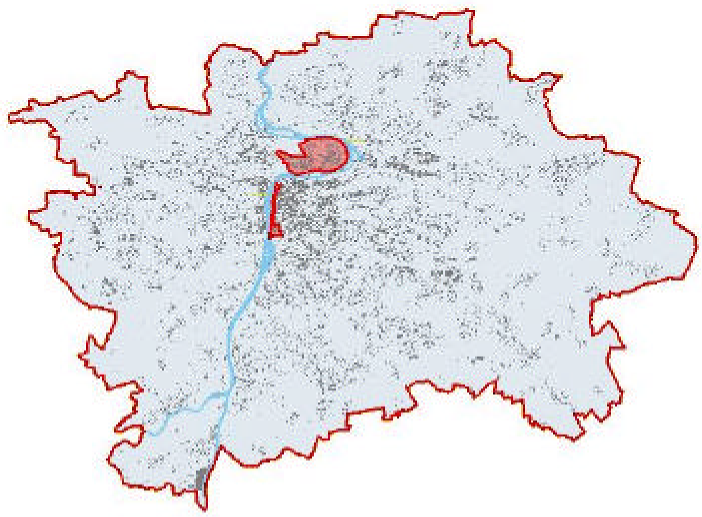
HEAVEN in Prague also played the role of catalyst for the encouragement of the co-operation between various municipal departments, namely the Department of Transportation, the Department of Environment, the City Borough Administrations, and others.

The demonstration area

Flood in August 2002 caused extension of Prague's original 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 km^2 with more than 8,000 road links.

Figure 5: Prague and its HEAVEN demonstration areas

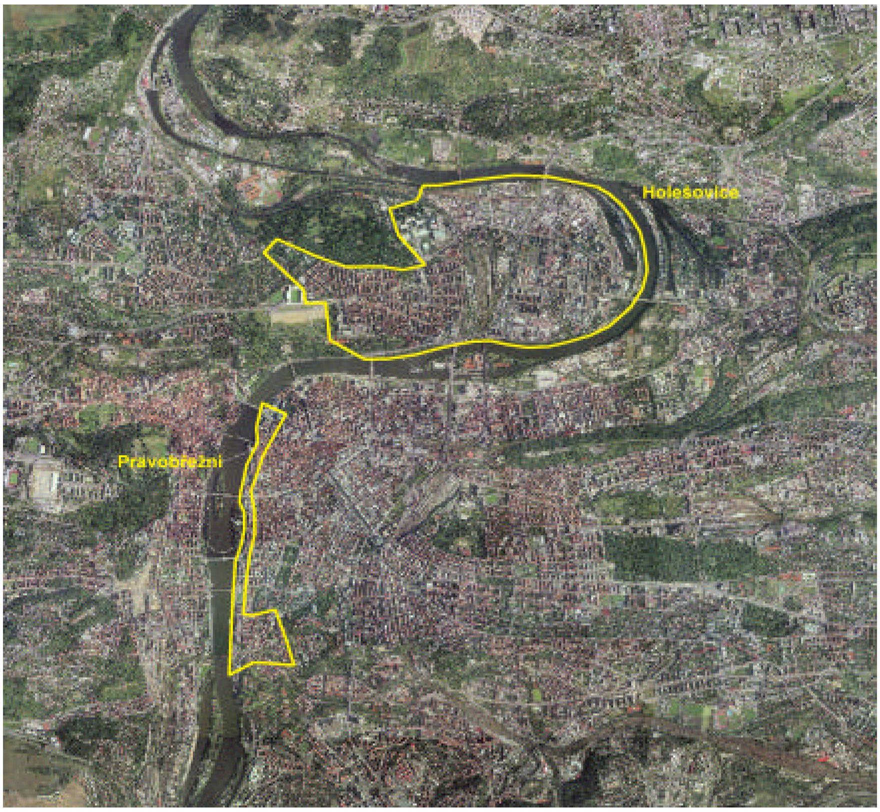


Through the co-operation of the Traffic Control Centre, the Czech Hydrometeorological Institute and the City Development Authority, the first real-time system was developed, which brings on-line traffic data to users other than the traffic control centre operators. The system was based on the Airviro system which was interlinked with on-line sources:

- traffic data from about 160 system loops
- meteorological data from two monitoring stations
- ambient air quality data from 13 Automated Emission Monitoring system stations
- 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 - Pravobrezní - 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 Pravobæžní demonstration areas were linked to the HEAVEN interface and operational.

Figure 6: Extension of Prague demonstration area



The Pravobæžní 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 3: Technical parameters of HEAVEN demonstration areas in Prague

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

In these demonstration areas, the final product was supposed to fulfil 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, SO_2 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.

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.

3.5 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 $km^{2.}$

Rome part of the Lazio region

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

Traffic, speed and emission data updated every five minutes

pollutants (CO, C_6H_6, NO_2, PM_{10}) 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, C_6H_6, NO_2) 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, C_6H_6, PM10, NO_2) 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 poli-

cies 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.

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 16km^2 located in the North-East area of the city of Rome, a residential and commercial area where almost 300,000 inhabitants live.

300,000 people living in Rome’s demonstration area.

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

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

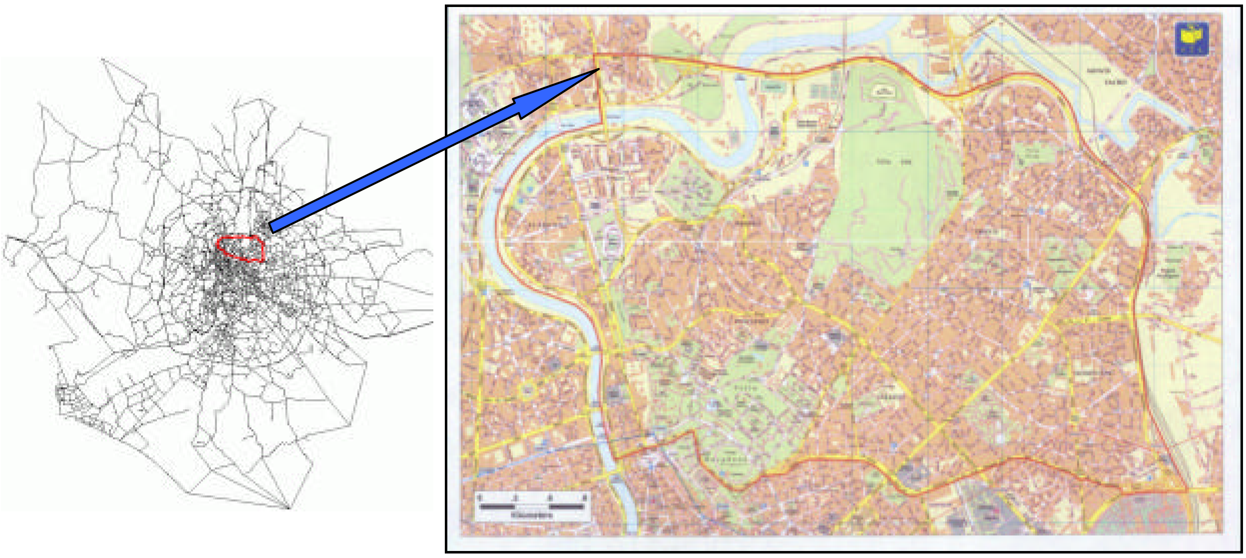
The area included two important green zones: Villa Borghese and Villa Ada, where an environmental background monitoring station is located. In the North of the area most of the important sports facilities in Rome (Stadio Olimpico, Stadio Flaminio, etc.) are located. They are used especially at the weekends.

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.

Figure 7: Rome demonstration area (red boundary)



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 areas, government buildings, cinemas, theatres, etc.).

The main features of the demonstration area are:

- 131 km of primary roads (56km monitored);
- 673 links (213 monitored).

The edge boundaries of the area are completely monitored.

There are two air quality monitoring stations within the area. One is located in the middle of a park and it gives primarily information on the background concentration, the other is a roadside monitoring station and that will be used for model verification.

Set of measures

STA has successfully tested the HEAVEN system, assessing the impact of two TDMS, representing realistic situation in the City management:

Fleet renewal and road closure measures tested

- Demand modification: fleet renewal;
- Network modification: 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.

3.6 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 km^2 (208 of them land area).

Industrial heart of The Netherlands

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.

Largest harbour in the World

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 Brienenoordbrug, 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 (SO_2, NO_X and VOCs) have been reduced substantially, but the decrease in ambient concentrations of NO_2 and particulate matter (PM_{10}) 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 NO_2, particulate matter (PM_{10}) 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.

“Masterplan Air” for the Rotterdam region

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 demonstration areas

Two demonstration areas in Rotterdam

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.

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.

Figure 8: Rotterdam demonstration areas – Overschie (upper circle) and Pleinweg-Vaanweg (lower circle)

Set of measures

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 NO_X 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.

Measure to reduce maximum speed tested

4 Evaluation Framework

4.1 Approach

HEAVEN was a research project that included a large scale demonstration phase. WP3's key role in the project was 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.

strong emphasis on commonality in the evaluation process

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 WP3 was, therefore, to reach full agreement among the Evaluation Team on the concept, common impacts and indicators, operational methods, and other specifics of evaluation (see chapter 4.2). The common evaluation basis of HEAVEN is described in further detail in chapter 4.1.3 of this document.

The results from the evaluation process provided important input to the definition of business, exploitation and marketing plans and are, therefore, instrumental for decisions on the direction of any future investments in the final product.

Extensive desk research on evaluation guidelines was conducted, and actual project evaluation plans in previous European RTD Programmes were analysed, especially from projects of a similar approach as HEAVEN in order to draft a generic model for assessment tasks in HEAVEN as input for forming agreement within WP3. Particularly useful was the work undertaken by projects ANIMATE, CONVERGE, and VATAM in the Telematics Applications and MAESTRO in the Transport Research Programme (both within Framework Programme IV).

For HEAVEN, the agreed concept was mainly based on the evaluation guidelines of the environment sector of the Telematics Applications Programme issued by ANIMATE. It has been ensured that the methodology was also in line with the "Six steps for building evaluation into the Description of Work" of the "Guidelines for Contract Preparation for Co-ordinators of IST Projects" (European Commission, 1999c). The agreed overall evaluation process is summarised in figure 10.

The foundation for a thorough evaluation was laid out in a comprehensive Final Evaluation Plan (Deliverable D3.1) as well as complementary Evaluation Guidelines and a so-called HEAVEN Tool Book in which expected impacts, related indicators, reference cases, success criteria and data gathering tools were described.

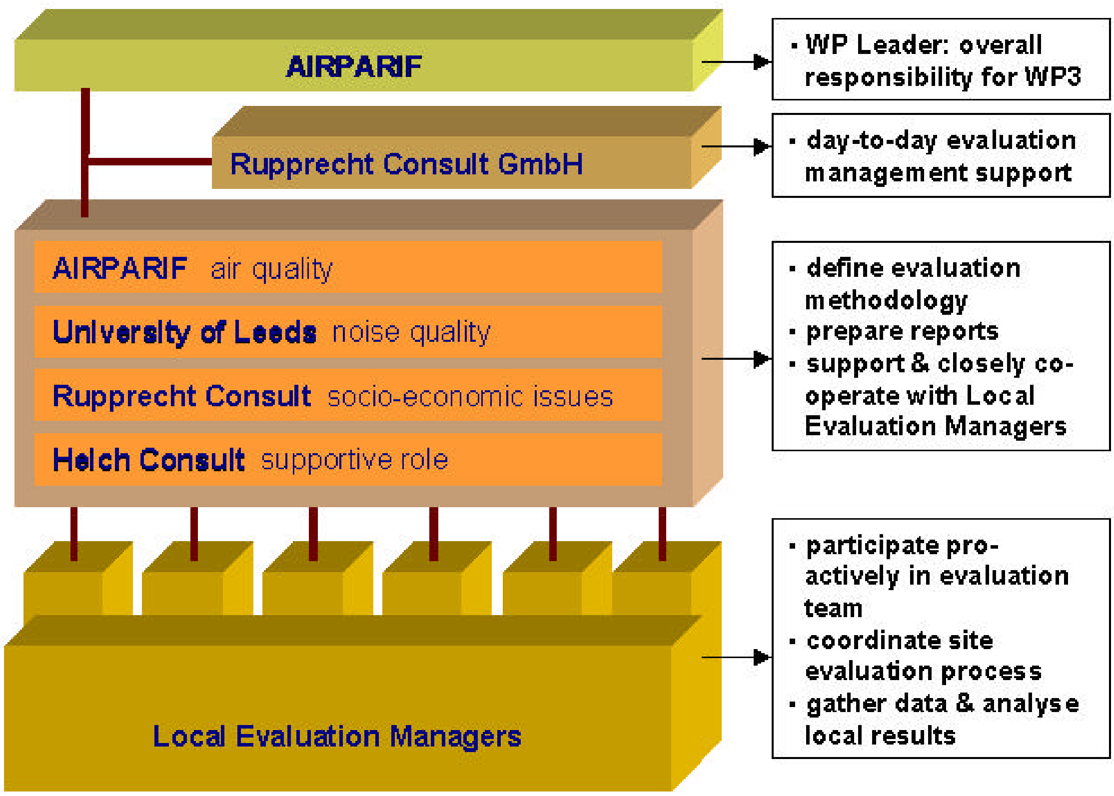
4.1.1 Evaluation Management Structure

The HEAVEN Evaluation Team consisted of a Workpackage Leader (AIRPARIF), an independent Evaluation Manager (Rupprecht Consult), and Local Evaluation Managers from the participating HEAVEN cities.

task forces on air and noise supported evaluation activities

Two Task Forces – the Task Forces Air and Noise - were established to provide specific (technical) support to the evaluation team. The Task Forces were composed of project-internal technical experts in the area of air pollution and noise pollution, respectively. While the Task Force Air further developed the evaluation concept of air pollutant measurement and air quality modelling issues (in particular, practical criteria) and further specified air-related impacts and indicators, the Task Force Noise developed guidelines for noise measurement, modelling, and assessment in HEAVEN cities and planned and provided guidance for sensitivity testing of noise.

Figure 9: Management Structure of WP3 - Evaluation



As graphically depicted in figure 9, AIRPARIF and Rupprecht Consult agreed upon the practical responsibilities and the co-ordination of

WP3. Accordingly, AIRPARIF was responsible for the overall co-ordination of the WP and, in co-operation with the technical manager (Heich Consult), for establishing and maintaining strategically important contacts outside HEAVEN. Rupprecht Consult were responsible for the scientific co-ordination of evaluation activities, in particular, for the preparation and organisation of evaluation work-shops and the preparation of WP3 deliverables.

4.1.2 Agreement Process

Throughout the thirty-eight-month project duration of HEAVEN, a number of evaluation workshops have been scheduled where Local Evaluation Managers, the Evaluation Co-ordinator as well as other HEAVEN participants directly or indirectly involved in evaluation processes got together. In addition, the technical co-ordinator, the WP7 verification co-ordinator and the WP3 evaluation co-ordinators gathered for two brainstorming meetings. The majority of these workshops and meeting was held in conjunction with the project's quarterly Technical Management Committee meetings. An overview is provided below:

frequent evaluation meetings basis for agreement process

Evaluation Workshop 1: Rotterdam, 10 April 2000

Contents:

- Introduction of Local Evaluation Managers
- Presentation of desk research
- Discussion of evaluation framework

Evaluation Workshop 2: Paris, 5 June 2000

Contents:

- Identification of six "core applications" in HEAVEN, including three common applications[3]
- Identification of potential appraisal groups[4]
- Discussion of impacts and indicators

[3] The Evaluation Team identified "air quality monitoring", "air quality modelling", "urban noise modelling", "decision support system", "common information platform", and "health data platform" as applications of HEAVEN. "Air quality modelling," "decision support system," and "common information platform" were considered common applications, i.e. they were to be covered by all six HEAVEN cities. See also project deliverable D3.1 – Final Evaluation Plan, chapter 3.2.

[4] See project deliverable D3.1 – Final Evaluation Plan, chapter 3.1 for a description of HEAVEN appraisal groups.

Brainstorming Meeting 1: Cologne, 7-8 September 2000

Contents:

- Re-definition and description of impacts
- Discussion and suggestion of condensed list of indicators as input to evaluation workshop 3
- Set-up of responsibilities between WP3 Evaluation and WP7 Verification

Evaluation Workshop 3: Paris. 19 September 2000

Contents:

- Composition and definition of sensitivity testing
- Discussion of role and set-up of the HEAVEN Task Forces Air and Noise
- Discussion and finalisation of impacts
- Discussion and re-definition of indicators
- Discussion about HEAVEN bulletin, i.e. a product common across HEAVEN cities providing one-page information on a daily or weekly basis.

Early agreement on common HEAVEN bulletin

Evaluation Workshop 4: Prague, 27 November 2000

Contents:

- Finalisation of common indicators

Evaluation Workshop 5: Genoa, 5 April 2001

Contents:

- Co-ordination of activities towards the completion of project deliverable D3.1 – Final Evaluation Plan
- Discussion about indicator fact sheet format to be applied in D3.1
- Co-operation with WP7 (verification)

Evaluation Workshop 6: Rotterdam, 24 October 2001

Contents:

- Confirmation of Evaluation Guidelines
- Discussion about data gathering tools, including allocation among members of the Evaluation Team of leading roles for development of these tools
- Discussion of Local Evaluation Plans

Evaluation Guidelines as basis for tool development

Evaluation Workshop 7: Brussels, 14 January 2002

Contents:

- Presentations of current tool development work
- Discussion and fine tuning of individual data gathering tools

Evaluation Workshop 8: Rome, 25 March 2002

Content:

- Final agreement on data gathering tools
- Preparation of an official response to European Commission comments concerning evaluation during the last Annual Project Review.
- Discussion about the "tool book" and the data input mask"

Evaluation Workshop 9: Paris, 23 September 2002

Content:

- Set up of the "Data Analysis & Interpretation Team"
- Discussion about status of evaluation across sites
- Discussion about a specific evaluation timetable for Prague where evaluation activities could not been carried out according to the originally envisaged timetable because of the disastrous flood in August of 2002
- Discussion about structure of Evaluation Report

Revision of Prague evaluation timetable due to disastrous flood in August 2002

Brainstorming Meeting 2: Cologne, 18 November 2002

Content:

- Finalisation of Evaluation Report Structure

- Discussion and agreement about responsibilities among "Data Analysis & Interpretation Team" concerning the preparation of the Evaluation Report

Evaluation workshops offered the opportunity for effective discussions in face-to-face situations. Additionally, the technical manager, the project manager, the independent evaluation co-ordinator, and the local evaluation managers also maintained frequent contact via e-mail, phone, and audio-conferences.

successful comment-revision process

The described means of communication allowed the HEAVEN evaluation team to keep up a productive cycle of proposals, comments, and revisions that ultimately resulted in mutual agreement. This agreement process was particularly important in finding commonalities across the cities, such as common impacts and indicators which are crucial in evaluating a major European RTD project such as HEAVEN.

4.1.3 Common Evaluation Basis

HEAVEN was a truly European project. Cities from five EU countries (Germany, the United Kingdom, France, Italy, and the Netherlands) and the Czech Republic as an accession country were participating. After completion of the project, it is now intended to implement HEAVEN in further European cities. For the task of evaluation, it was therefore important to focus on the commonalities of HEAVEN.

Commonality centrepiece of HEAVEN evaluation

"Commonality" was the centrepiece of the HEAVEN evaluation process. Two main aspects were considered in establishing a common evaluation basis:

1. The definition of impacts and indicators common to all sites.

Since the cities, for example, focussed on different applications and appraisal groups, it was not always possible to use an indicator in all six HEAVEN cities. Only indicators used in all six cities were considered "common indicators." Comparably, only those impacts analysed by at least one common indicator were considered "common impacts."

2. 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 lied 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.

4.1.4 Steps in the Evaluation Process

nine-step evaluation process

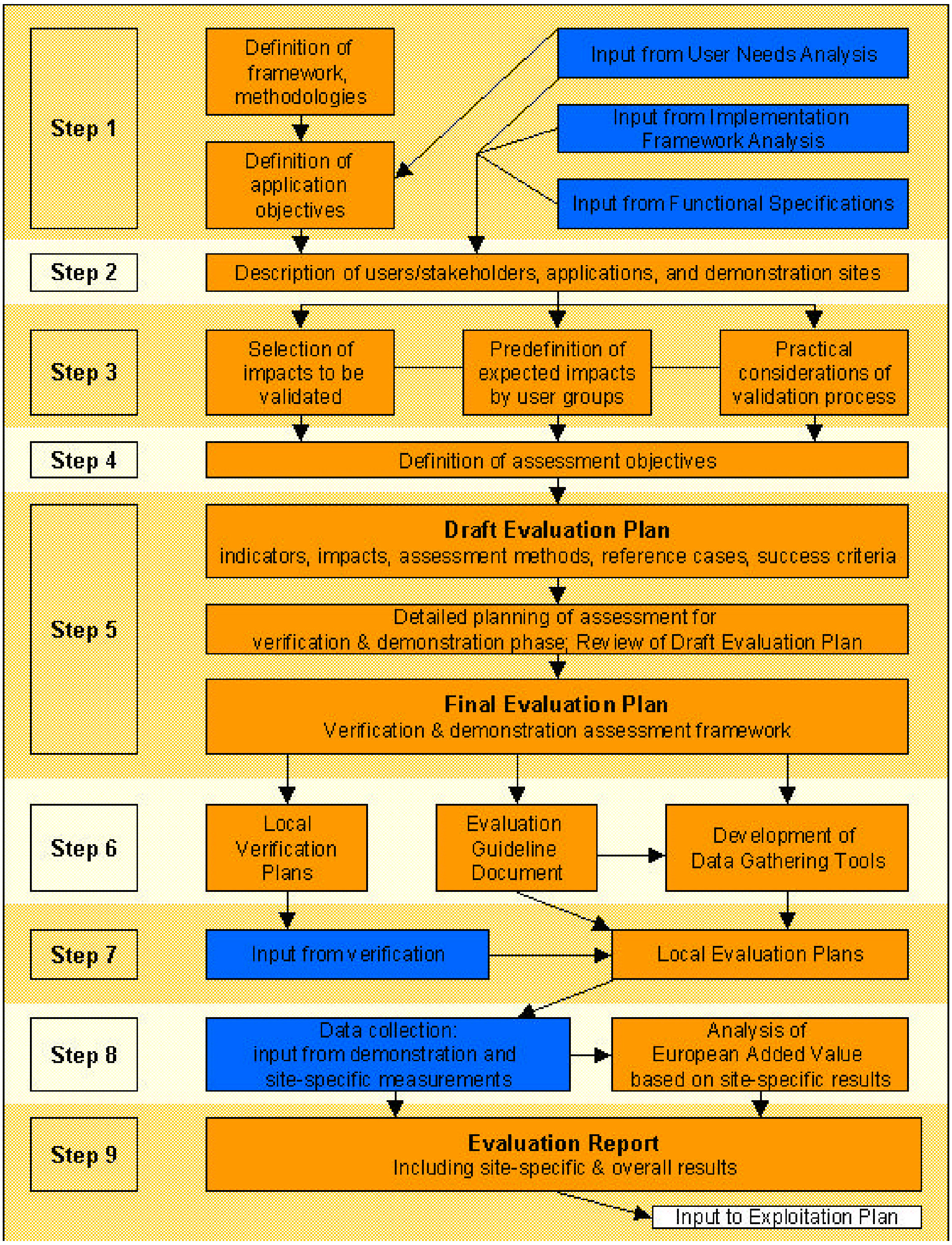
During the life-time of the HEAVEN project, the following steps were undertaken to facilitate the consensus-formation process within WP3 in a systematic and comprehensive manner summarised in table 4 below. The steps in the evaluation process are also provided in graphical form in figure 3.

Table 4: Steps in the Evaluation Process – Descriptions and Explanations

Step	Description	Explanations
1	Definition of specific and detailed objectives	As an initial step of HEAVEN evaluation, application objectives were defined. Input was used from both, the analysis of users needs and the implementation frameworks (WP4) and also from the analysis of functional specifications (WP5).
2	Precise description of the key development goals of the project	Following the initial step of HEAVEN evaluation, application sites, applications as well as users, key stakeholders etc. were described.
3	Impact definition	
3.1	Selection of impacts to be validated and justification of this selection	The Evaluation Team identified impacts of HEAVEN and selected five impacts for evaluation purposes
3.2	Definition of expected impacts by groups of users/ non-users	Each selected impact was defined and described taking into account specific impacts on users and non-users of the HEAVEN system.
3.3	Practical considerations of validation	In defining impacts, practical considerations were taken into account, such as the actual feasibility to validate an impact, the extent (effort) required for validation and methodological restrictions and basic ions for impact analysis
4	Definition of assessment objectives	On the basis of step 3, it was necessary to concretely define the operational objectives of the assessment process. Agreement on the basic categories of assessment was reached.
5	Outline of validation methods for each assessment objective	This step provided input to the key elements of the validation plan and was covered for each assessment objective: - what indicators were used, - the reference case against which success was measured (or "project baseline"), - how "success" was defined, and - what methods were used (e.g. quantitative surveys, technical measurements, qualitative interviews). This step comprises the preparation of the Draft Evaluation Plan (Project Milestone M3.1), its review and update as well as the preparation of the Final Evaluation Plan (Project Deliverable D3.1)

Step	Description	Explanations
6	Tool Development	Following the agreement on the methods (tools) to be used for evaluation purposes, questionnaires, interviews, automatic counts, and monitoring campaigns were developed. Each of the tools was linked to specific indicators identified and defined previously (step 5)
7	Local Evaluation Planning	Documents (Evaluation Guideline Document, HEAVEN Tool Book) to support local evaluation planning in terms of: - tool development, - appraisal group and evaluator selection, - sampling methods, - preparation of local evaluation plans, - data analyses, etc. In addition, input from Local Verification Plans as well as verification measurements was used to by Local Evaluation Managers in order to prepare Local Evaluation Plans.
8	Data Gathering	After completion of tool development, data were gathered using these tools in all sites during the project's large scale demonstration phase. A validity check of the data was performed initially by the Local Evaluation Managers. The independent Project Evaluation Manager further checked data for consistency.
9	Data Analysis	Data gathered during the large scale demonstration (documentation) was used as input to the Evaluation Report. Following validity and consistency checks in step 8, all data (quantitative and qualitative) were analysed by the independent Evaluation Manager. An analysis of European added value conducted Site-specific as well as overall results were derived and reported in the Evaluation Report.

Figure 10: Steps in the Evaluation Process



4.2 Methodology

4.2.1 Impacts

Common impacts, indicators, and assessment methods are the key elements of evaluation. Without them, no evaluation would be possible. The HEAVEN Evaluation Team spent a considerable amount of time selecting, defining, and discussing these key elements.

With the centrepiece of HEAVEN evaluation – the common evaluation basis – in mind, agreement was reached on impacts, indicators, and assessment methods as described below.

Impacts: Intended or unintended effects brought about by an application

Impacts were defined as changes or effects brought about by an application resulting from its implementation in an experimental or real application, whether intended or unintended.

A practical approach was chosen in identifying impacts that were expected to arise through HEAVEN. Potential impacts considered non-measurable, unrealistic to achieve within the life-time of the project, or marginal in their effect were excluded from further discussion at early stages of the evaluation planning process. The Evaluation Team identified the following five impacts:

Five HEAVEN 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

A detailed description of each impact and accompanying assessment objectives is provided in chapter 3.3 of project deliverable D3.1 - the Final Evaluation Plan (Annex 7).

4.2.2 Indicators

The HEAVEN Evaluation Team identified twenty-four indicators. Data for these indicators was gathered during the large scale demonstration phase lasting from April to October 2002.

24 indicators identified by Evaluation Team

The majority of these indicators were applicable in all HEAVEN sites and were, therefore, considered common indicators. All indicators were thoroughly described in fact sheets (see also project deliverable D3.1 - Final Evaluation Plan) based on the nine-point structure presented in the indicator fact sheet template below (table 5)

Table 5: Indicator Fact Sheet Template

Impact:	**Name (impact #)**
Indicator category:	**#.#: Name**
Number:	**#.#**
Indicator:	**Name**
Relevance:	Explanation of, for example, the indicator's relevance for project goals, expectations and direction of indicator, contribution to measuring the impact, other background info.
Definition of key terms:	Precise definition of any concepts and terminology the indicator is based on, for example, what is equivalent to 100%, what is "efficiency" etc.
Involved appraisal groups:	Description of affected users and non-users.
Methods:	Explanation how measurements will be made, what tools will be used, etc.
Reference case:	Description and explanation as to which situation the measurement is compared to.
Operational issues:	Description of any other points regarding measurement.
Success criterion:	Definition as to what is viewed as success in precise and operational terms.
References to other indicators:	Listing of similar indicators and/ or brief explanation of differences to similar indicators.
Site-specific issues:	Explanation, for example, why an indicator cannot be measured in a certain site, why certain site-specific measurement conditions apply, etc.

Table 6 lists all identified indicators by impact and reveals to which indicators a HEAVEN site provided evaluation data. Due to some site-specific limitations and circumstances, it was not possible to apply all indicators at all sites (compare also indicator fact sheet descriptions in project deliverable D3.1 – Final Evaluation Plan).

Table 6: HEAVEN indicators by impacts and sites

Ind. Nr.	Indicator	Berlin	Leicester	Paris	Prague	Rome	Rotterdam
Impact 1 : Enhanced Description of Current Environmental Situation							
1.1	Increased coverage of the traffic and roadside pollution network	⊗	✓	✓	✓	✓	✓
1.2	Increased grid resolution	⊗	⊗	✓	✓	✓	✓
1.3	Accuracy of roadside description (air)	✓	✓	✓	✓	✓	✓
	Accuracy of roadside description (noise)	✓	✓				
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	✓	✓				
1.7	Increased efficiency of noise pollution description[5]	--	--	--	--	--	--
1.8	Noise roadside emission: Length of network	✓	✓				
Impact 2 : Enhanced Environmental Scenario Analysis							
2.1	Increased coverage of the traffic and roadside pollution network (air)	⊗	✓	✓	✓	✓	⊗
	Increased coverage of the traffic and roadside pollution network (noise)	✓	✓				
2.2	Increased grid resolution used in modelling	⊗	⊗	✓	✓	✓	✓
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 3A : Improved Access and Quality of Environmental Information for Professional Users							
3A.1	Improved time resolution	✓	⊗	✓	✓	✓	✓
3A.2	Reduced delivery time	✓	⊗	✓	✓	✓	✓

[5] Indicator 1.7 was not applied within the framework of HEAVEN. Unlike originally planned, it was not impossible to apply monetarisation to "measure" indicator 1.7, since "the time taken for trained staff to produce source emission noise levels for every required line source" could be derived. In other words, there was no reference case for increased efficiency of noise pollution description (which was to be expressed in time savings for staff to produce them).

Ind. Nr.	Indicator	Berlin	Leicester	Paris	Prague	Rome	Rotterdam
3A.3	Increase in usefulness (interviews)	✓	✓	--	✓	✓	✓
3A.4	Increased efficiency of daily/ weekly bulletin	--	--	✓	--	--	--
Impact 3B : Improved Access and Quality of Environmental Information for Public Users							
3B.1	Improved time resolution	✓	⊗	✓	✓	✓	✓
3B.2	Reduced delivery time	✓	⊗	✓	✓	✓	✓
3B.3	Increase in usefulness (questionnaires)	✓	✓	✓	✓	✳	✓
3B.4	Increased efficiency of daily/ weekly bulletin	--	--	✓	--	✳	--
Impact 4 : Improved Institutional Co-operation							
4.1	Increased quality of co-operation (interviews)	✓	✓	--	✓	--	✓
4.2	Increase in time-efficiency of information exchange	✓	✓	--	✓	--	✓
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:

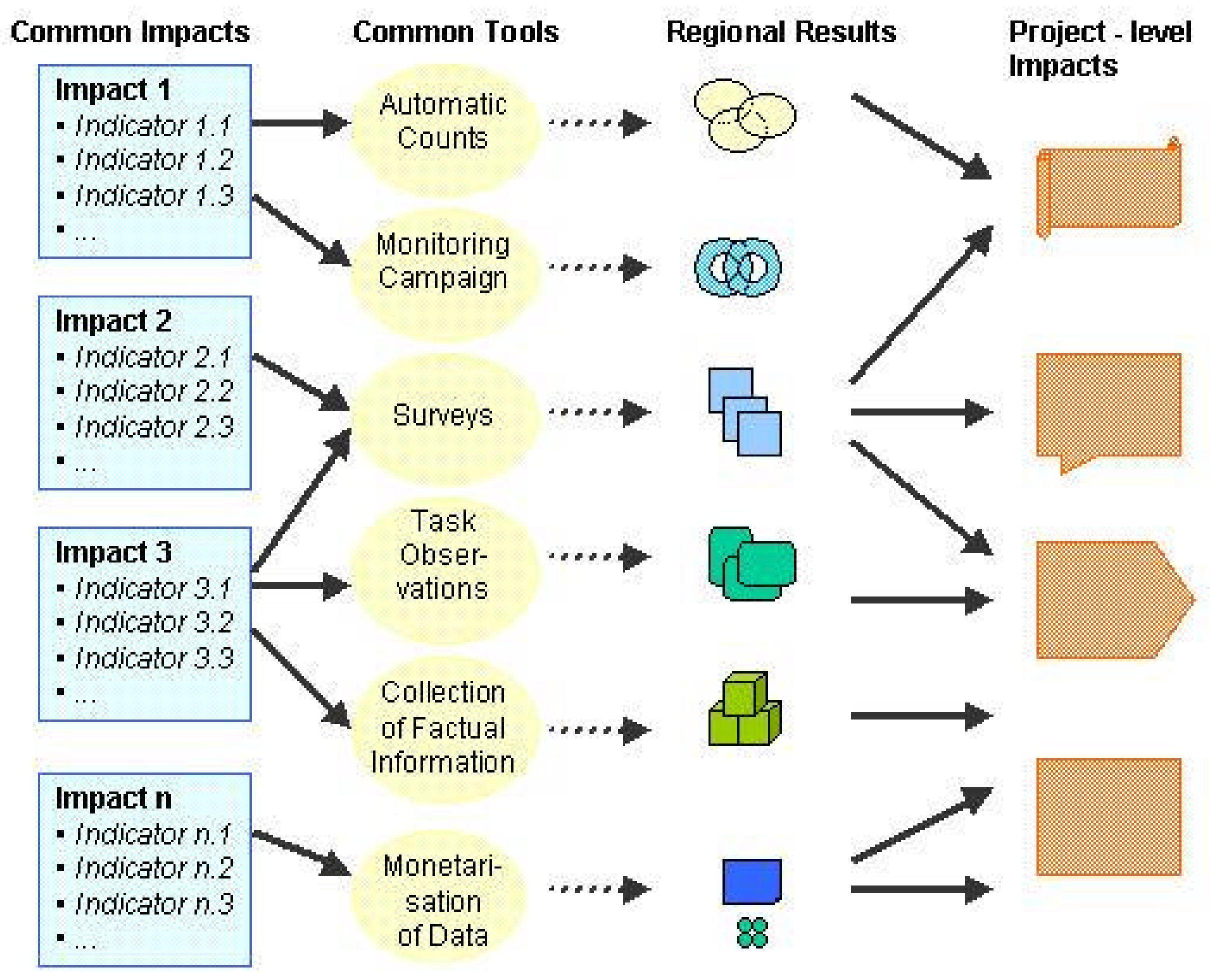
✓	Indicator will be applied.
⊗	No new development within the framework of HEAVEN, since impact has already been achieved in the past.
✳	In Rome, the municipality is the only authority allowed to disseminate environmental information to the public. The municipality decide not to disseminate data from the HEAVEN system to the general public during the project. The HEAVEN system in Rome will constitute the core of a larger system from which data will be disseminated to the public.
	Within HEAVEN, noise pollution was a specific concern only in the cities of Berlin and Leicester.

4.2.3 Common Measurement Tools

Efficient and co-ordinated approach for indicator "measurement"

While indicators were described in a systematic way within the context of the impacts they aim to measure, it was important during the practical exercise to achieve an efficient and co-ordinated approach towards actual measurement of related indicators in all HEAVEN sites. Therefore, common operational evaluation tools were designed which enabled Local Evaluation Managers to approach their target groups in a co-ordinated manner and to save resources. The integration of these common tools in the process of operational evaluation is illustrated in figure 11.

Figure 11: Integration of Measurement Tools in the Evaluation Process



One tool can appropriately measure more than one indicator (e.g. a questionnaire can address a couple of divers issues). At the same time, one indicator may have to be measured by more than one tool (e.g. specific aspects of an indicator may require an in-depth inter-view with key decision makers, but may have to consider responses to a more simply designed questionnaire addressed to a larger group of public users).

Measurement methods identified for each indicator

For each indicator, suitable methods of measurement were identified (compare deliverable D3.1 - Final Evaluation Plan, chapter 3.5), including a characterisation of targeted appraisal groups.

Tool Categories

Tools are defined in the Final Evaluation Plan in overview form (compare deliverable D3.1 - Final Evaluation Plan, pp. 69-71).[6] The following categories of tools were applied during the course of the HEAVEN large scale demonstration phase:

- Automatic Counts
- Monitoring Campaign
- Surveys
- Task Observations
- Factual Information Collection

Automatic Counts: WP3 defined a specific set of requirements for automatic measurement of data related to processing time (e.g. time for producing a specific modelling result or delivery time (e.g. time lapse for data transport from measurement unit to data repository).

Monitoring campaigns in the context of air quality and noise model calibration

Monitoring Campaigns: In the context of the calibration of air quality and noise models, it was necessary to undertake monitoring campaigns. To assess the quality of a predicted model, outputs from the respective environmental models were compared with monitored data. To enable this comparison, the appropriate monitoring equipment (e.g. noise monitors, air quality monitoring stations) needed to be available for a pre-defined period and placed at the selected test sites according to definitions in respective regulations. The results of the monitored data were evaluated and finally compared with the modelled data.

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[6] In project deliverable D3.1, i.e. the Final Evaluation Plan (pp.69-71), common evaluation tools included verification-specific tools as a possible tool category in HEAVEN evaluation. During the brainstorm meeting in Paris, it became apparent that there are no verification-specific tools to be applied in HEAVEN evaluation. Instead, a new category “monitoring campaigns” was introduced in order to accurately measure indicators 1.3 air and 1.3 noise. In addition, monetarisation (a classical process of socio-economic research of assigning monetary values to, for example, time gains due to a more efficient process of delivering information. The primary objective of monetarisation would have been to determine costs and benefits of HEAVEN system introduction. The main input data were time savings observed due to system introduction) was not used as a tool in HEAVEN evaluation.

Surveys: Questionnaires are one of the standard tools of empirical social research and are commonly summarised under the category "survey." However, in the context of HEAVEN evaluation, the more specific understanding was that questionnaires were mainly concerned with the collection of opinions, stated preferences or judgements on quality from direct users of the DSS rather than large groups from the general public. In five of the six HEAVEN sites public users had the opportunity to complete questionnaires concerning the usefulness of environmental information disseminated through the HEAVEN system (in Rome, environmental data is not made public and, for this reason, a user questionnaire was not circulated to the public).

public user questionnaire

The Evaluation Team obtained valuable information from the questionnaires, allowing for an assessment of:

- The overall situation before HEAVEN (as a reference case) as well as after HEAVEN
- The HEAVEN information acceptance among public users, including perceptions of the quantity and quality of environmental information
- Frequency of use
- User profiles

Task Observations: The execution of routine tasks (for example the delivery of a daily/ weekly bulletin) was expected to change significantly through HEAVEN. Members of appraisal groups were asked to record themselves or alternatively allow observation during task completion. The focus of task observations was on time needed to complete a given task (e.g. without/ with HEAVEN).

Task observations focussing primarily on gains in time efficiency

Collection of Factual Information: Two categories of "factual" information were collected:

1) simple facts which could only be collected manually usually without involving an appraisal group directly (e.g. documentation of the traffic network length, determination of the grid resolution)

2) qualitative "surveys," i.e. in-depth interviews with (political) decision makers, key personnel, and specific groups of end users

These **interviews** were undertaken in a semi-structured manner: an interview guideline outlined a briefing to the interviewee, kick-off and prompting questions and key issues for which statements were collected, as well as a common format for recording and analysing responses.

Detailed interview guidelines provided to Local Evaluation Managers

Interviews were conducted in all sites and comprising interviews of members of local authorities and (political) decision makers as well as other professional users. The interviews were intended to provide information from these key stakeholders in order to assess:

- the perceived change in quality of institutional co-operation as a result of HEAVEN system introduction, in particular the perceived increase in the quality of co-operation between departments and agencies involved in the abatement of air emissions and noise
- the perceived change in usefulness of the provided environmental information
- Satisfaction with time-efficiency of information exchange
- Perceived increase in the quality and usefulness of data entered in a common repository
- Perceived increase in usefulness for urban planning

4.2.4 Data Gathering and Analysis

Throughout the large scale demonstration phase, evaluation data was gathered in the six HEAVEN sites by means of fourteen data gathering tools, i.e. three automatic counts, one survey (public user questionnaire), four interviews for professional users, two monitoring campaigns five task observations, and one factual information collection.

14 data gathering tools used

An important consideration for the data analysis was the fact that the evaluation was based on commonality (see chapter 4.1.3). The high number of indicators and the complexity of the topics in question lead to a large amount of data to be compared across sites.

Each Local Evaluation Manager conducted a validity check of the site data submitted. In addition, the members of the "Data Analysis and Interpretation Team" checked the validity of the data and ensured that the required format was followed (whenever necessary, Local Evaluation Managers were asked to comply with the format of data submission as outlined in the HEAVEN Tool Book).

Although considerable amount of data has been collected to build up the empirical database of this Evaluation Report, three major shortcomings have to be borne in mind when interpreting these data:

(1) Despite the ambition of commonality, it was not possible for all data submissions to follow a common format, since, for example, different units, demonstration areas differing in size and "conditions", etc. applied to the various HEAVEN sites.

The quality of the data gathered was low compared to the expectations of the Evaluation Team and lead to an unanticipated amount of work in re-formatting the data and in conducting even more thorough validity and consistency checks prior to the actual data analysis.

(2) The amount of public user questionnaires and interviews of professional users submitted by Local Evaluation Managers was unexpectedly low. A total of 138 public user questionnaires were submitted by five HEAVEN cities.[7] Among these 138 questionnaires, 75 came from Rotterdam. That is equivalent to 54% of all questionnaires. The overall analysis across all sites is, therefore, heavily skewed towards responses from Rotterdam. This circumstance is considered in the evaluation.

(3) Comparably, the return of interviews was lower than anticipated. In addition, it was apparent that some interviews (including all from Prague) were not conducted as personal interviews. Evidence for this was that none of these interviews contained responses to "open questions" (seeking individually formulated answers).

Table 7 provides an overview of the amount of questionnaires and interviews submitted for evaluation purposes by the Local Evaluation Managers.

[7] No questionnaire data were available from Rome, where only the municipality is allowed to make environmental information public.

Table 7: Amount of questionnaires and interviews by site

Surveys	Berlin	Leicester	Paris	Prague	Rome	R'dam	Total
Public user questionnaire	13	12	27	11	---	75	138
Interviews of professional users to assess the usefulness of the environmental information	8	10	---	12	9	6	45
Interviews of authority members (+ political decision makers)	2	3	---	4 (+2)	---	6	15 (+2)
Interviews of professional users to assess the increased quality and usefulness of data entered in the common repository and scenario calculation	11	---	---	4	4	6	25

The low number of questionnaires and interviews also had to be considered in the presentation of evaluation results. Only for Rotterdam that submitted seventy-five public user questionnaires, a presentation of results in percentage terms was statistically justifiable. Results derived from questionnaire data from other cities needed to be expressed in absolute terms. This was also the case for all results derived from interview data.

5 Detailed Evaluation Results

Evaluation results are presented in the order of the five identified impacts of HEAVEN. Each impact has between two and eight different indicators for which data was gathered and analysed. At the end of each impact chapter, brief summaries are provided.

Assessment of indicator and impact achievements are provided using the following categories:

Assessment	Indicator level	Impact level
++	Success criterion achieved	Impact achieved
+	Success criterion partly achieved	Impact partly achieved
o	Success criterion not achieved	Impact not achieved
?	Insufficient data to allow assessment of indicator achievement	Insufficient data to allow assessment of impact achievement

Similarly, the quality of data provided by the Local Evaluation Managers of the six HEAVEN sites for data analysis is assessed according to the following scheme:

Assessment	Quality of data
★★★	High-quality data sufficient to assess indicator achievement
★★	Medium-quality data providing satisfactory basis to assess indicator achievement
★	Low-quality data difficult to assess indicator achievement
---	Poor-quality data insufficient to assess indicator achievement

While the evaluation of HEAVEN, as a whole, stands in the forefront of data analysis, evaluation results for the individual sites are presented as appropriate.

A complete overview of impacts and related indicators as well as data gathering tools is provided in chapters 4.2.1 to 4.2.3.

5.1 Description of current environmental situation (Impact 1)

One of the main objectives of HEAVEN was to provide a better description of the environmental situation mainly caused by traffic in European cities. Impact 1 addresses this objective. This description, merging monitoring and modelling systems, was focused on traffic, noise and air pollutants emissions and air quality concentrations. It was intended to achieve a more accurate and extensive description of near real time environmental situations, according to EU directives.

Assessment Objectives – Impact 1:

- Better tools (updated intervals, accuracy of the description, improved resolution, etc.)
- More extensive description (size of the domain covered, number of parameters, etc.)

5.1.1 Coverage of the traffic and roadside pollution network (indicator 1.1)

HEAVEN intended to achieve a more extensive description of current environmental situations, mainly caused by traffic. In this context, indicator 1.1 assessed the increase in network coverage available for real time traffic and air quality concentrations data due to the implementation of the HEAVEN system.

Indicator Achievement: ++

Data Quality: ★★★

HEAVEN Sites Involved:

- Leicester
- Paris
- Prague
- Rome
- Rotterdam

Data description :

Indicator 1.1 measured the length of the traffic network for which traffic or air pollution data were available. The evaluation was based on the automatic count on the length of the network, expressed in kilometres, covered by the HEAVEN system, i.e. for which traffic or air quality data were available in real-time.

The evaluation was conducted for traffic, PM10 concentrations (24-hour-value), NO_2 (1-hour-value), CO (8-hour-value) and C_6H_6 (annual). Table 8 below depicts the lengths of the networks described in the five HEAVEN sites concerned with this indicator.

Table 8: Length of network described before and after HEAVEN

Length of network (expressed in km)		Leicester	Paris	Prague	Rome	Rotterdam
Traffic	length before	7	850	0	-	75
	length after	71	20000	714	161	75
PM10 (24 h)	length before	7	10	0	-	0
	length after	71	3360*	714	161	75
NO_2 (1 h)	length before	7	16	0	-	0
	length after	71	3366*	714	161	75
CO (8 h)	length before	7	16	0	-	0
	length after	71	3366*	714	161	0
C_6H_6 (annual)	length before	-	10	-	-	0
	length after	-	20000	-	161	75

* A new modelling tool delivering 1h-air quality concentrations has been implemented in Paris for the HEAVEN demonstration period. This implementation has concerned a 3350 km length subnetwork.

At this stage, this modelling approach has been implemented only for a first evaluation without any real time permanent exploitation. However, this modelling approach should be implemented on an extended network after final evaluation.

In the real time mode, air pollution emissions data are available on an hourly basis for PM10, NO_X, CO, CO_2, VOC_S and C_6H_6 for 20,000 km of network.

Table 9 presents the multiplying factors for the increase in network descriptions due to HEAVEN. In cases where no data were available prior to HEAVEN, any improvement is indefinite (∞).

Table 9: Increase in network description due to HEAVEN

Increase in description	Leicester	Paris	Prague*	Rome*	Rotterdam
Traffic	X 10	X 23	∞	∞	no increase
PM10 (24 h)	X 10	na	∞	∞	∞
NO_2 (1 h)	X 10	na	∞	∞	∞
CO (8 h)	X 10	na	∞	∞	no increase
C_6H_6 (annual)	na	X 2000	na	∞	∞

* For Prague and Rome, no data available before HEAVEN.

… For Paris, emissions data available for 20,000 km of network and six pollutants. No data before HEAVEN.

Analysis :

The success criterion defined by the Evaluation Team was achieved if the length of network available increased through the duration of the HEAVEN project.

Improved data description in terms of network length

The success criteria have been generally achieved for most of the cities involved. For three cities (Rotterdam, Rome and Prague) for which no data was available for some parameters before HEAVEN, the success criteria are especially impressive.

Leicester increased the length of network description for traffic, PM10, NO_2, and CO by a factor of ten, thereby clearly achieving the respective success criteria.

In Paris, ambiguous results concerning the achievement of success have been achieved. HEAVEN allowed for a spectacular extensive description of the traffic and traffic emissions for six pollutants in real time on a broad network. However, the implementation of the hourly real-time description of air quality concentrations has not been successfully achieved.

5.1.2 Grid resolution (indicator 1.2)

The HEAVEN project is expected to provide a better and more frequent description of current environmental situations. Besides an extended geographic coverage of the traffic network, a more precise description of environmental situations, i.e. background air quality, was achieved through more accurate and efficient environmental modelling, and consequently through better grid resolution. Indicator 1.2 allowed for the evaluation of improvements in the near real time description of the environmental impacts for background locations.

Indicator Achievement: O

Data Quality: ★★

HEAVEN Sites Involved:

- Paris
- Prague
- Rome
- Rotterdam

Data description :

This indicator measured grid resolution modelling and was evaluated quantitatively at least for NO_2 and O_3. The evaluation was based on the grid size, associated to the spatial resolution, used for the background modelling.

Table 10: Increase in grid resolution

Increase in grid resolution	Paris	Prague	Rome(1)
NO_2	X 2	∞*	∞*
O_3	X 1	na	na

(1) For Rome, background modelling involves also PM10, CO_2 and C_6H_6. The grid size and the number of cells available are the same as for NO_2.

* No reference value before HEAVEN.

Table 11: Increase in cell numbers

Increase in cell numbers	Paris	Prague	Rome
NO_2	X 1.4 (900)*	∞ (172800)	∞ (4096)
O_3	X 1.4 (900)	na	na

* Number of cells modelled.

Table 12: Grid size by pollutant

Grid size by pollutant (in km)	Paris	Prague	Rome
NO_2	3 X 3	0.05 X 0.05	0.06 X 0.04
O_3	6 X 6	na	na

In Rotterdam, there was no real time monitoring of background concentrations before HEAVEN. Annual average background concentrations were available for static modelling. In an urban and industrial area of approximately 300 square kilometres, five measuring stations were available yielding hourly information.

During the HEAVEN project, four additional temporary measuring stations were equipped for model fine-tuning and validation. One of these sites was a background station.

After HEAVEN, the ring road which was covered by the HEAVEN project surrounded an urban area of approximately 200 square kilometres. In this area, three permanent background stations were available. Background concentrations were not modelled but were measured. The HEAVEN DSS was linked to two permanent real-time monitoring sites. Depending on the wind, one of the sites was chosen for model calculations.

Analysis :

The Evaluation Team defined as success criterion the increase of grid resolution during HEAVEN, i.e. the reduction of grid cell sizes.

Only four of the HEAVEN cities were practically involved in this indicator. In Berlin and Leicester, no new development had been implemented in the framework of HEAVEN. In Rotterdam, the background concentrations were not modelled in real time but based on direct measurements in the demonstration area.

For Paris, Prague and Rome, HEAVEN brought new developments in NO_2 background modelling allowing success for this indicator. Grid size and number of cells described have been significantly improved.

For O_3 background, the 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.

From a global point of view, the achievement gained through HEAVEN for background modelling was only a “mixed” success. Several reasons could be underlined:

“mixed” success for background modelling

- HEAVEN focused first on emissions and “proximity” problems induced by traffic;
- Background modelling was mainly a must for huge agglomerations having chronic air pollutants problems;
- Background modelling, even of primary interest, supposes the control and availability of complex modelling tools and of the necessary data, related to traffic and other emissions. It supposes also the availability of boundary conditions.

5.1.3 Accuracy of roadside description (indicator 1.3 air)

Indicator Achievement: ✚

Data Quality: ★★★

HEAVEN Sites Involved:

- Berlin
- Leicester
- Paris
- Prague
- Rome
- Rotterdam

The HEAVEN project is expected to contribute to an enhanced description of the environmental situation. By itself, HEAVEN was not dedicated to the development of new air pollution models, either related to background locations or roadside. However, the quality of the description, i.e. the accuracy, delivered by the integrated modelling chains, developed within the HEAVEN framework was evaluated.

The accuracy of the current environmental situation description was evaluated by comparing the model outputs with observed air quality data.

An evaluation period of about two weeks for PM10 (24 hours), NO_2 (1 hour), CO (8 hours) and C_6H_6 (annual) and for two different roadside typologies had been suggested as a minimal approach.

In the case of background pollution, the implementation of such evaluation was difficult in the HEAVEN context. It would have been a real research subject by itself. Such a validation could be done more easily for roadside air quality description.

Similar to indicator 1.1, the roadside air pollutant concentrations were evaluated according to the EU definitions provided by the directive 1999/30 on ambient air quality (European Commission, 1999a).

Data description :

Indicator 1.3 is based on the comparison between observed and modelled data for a specific location.

Success criterion based on European air quality directive 1999/30

The criterion of success concerning the accuracy was based on the annex VIII of the directive 1999/30. This annex provides specific guidance concerning the minimal accuracy requirements related to modelled description of air quality.

According to this annex, success is achieved if the average difference between modelled and observed data is less than 50% for all data and each specific pollutant (CO, PM10 and C_6H_6). For the NO_2 hourly data, success is achieved if the average difference is less than 60%.

In order to provide complementary information about the collected observed and modelled data, other statistical parameters were also provided. This complementary information, in addition to the basic evaluation criteria, allowed a more precise description of the modelling chains performances.

Concerning the roadside locations, if available, the following data were described as follows:

Denoting obs_t and mod_t as the observed and modelled values at time t, for each pollutant and each site :

- Number of observed data describes the number of elementary data available.
- Average obs., obs, is the arithmetical average of the observed data during the period of experiment.
- Average mod., mod, is the arithmetical average of the modelled data during the period of experiment.

The normalised difference between obs_t and mod_t, at each time t was denoted $diff_t$:

$$diff_t = \frac{mod_t - obs_t}{obs_t}$$

The success criterion was based on the absolute average difference.

$$\text{Abs.av.dev} = \text{average} \quad diff_t$$

Success was reached if abs.av.dev. < 50 % for CO, PM10 and C_6H_6
< 60 % for NO_2

- The maximal absolute difference describes the maximal difference between obs_t and mod_t for a specific t time :

$$\text{Max.abs.dev.} = \max \quad diff_t$$

- Standard dev. described the standard deviation of $diff_t$.

- Bias was computed as :

$$bias = \frac{obs - mod}{obs}$$

➲ Coef. Cor. was the coefficient of correlation linking the observed and modelled data.

Results :

For each city involved in the evaluation for this specific indicator, tables summarising the statistical data are provided in annex 10 of this Evaluation Report. A summary table 13 is provided below.

According the Final Evaluation Plan (project deliverable D3.1), these results are generally restricted, to roadside evaluations. For Paris however, considering the strong developments achieved regarding background modelling, evaluation results were also provided for the background location.

Table 13: Summary of accuracy of roadside and background description

Absolute average deviation (%)	Success criterion	Berlin	Leicester	Paris	Prague	Rome	Rotterdam
NO_2 (hourly) Roadside locations	< 60 %	40	67	na	11* (2 stations)	42* (2 stations)	32* (2 stations)
PM10 (24 hours) Roadside locations	< 50 %	14	12	na	na	na	11* (2 stations)
CO (8 hours) Roadside locations	< 50 %	26	30	na	21	47* (2 stations)	na
C_6H_6 (annual) Roadside locations	< 50 %	3	na	7* (2 stations)	na	83* (2 stations)	46* (2 stations)
NO_2 (hourly) Background locations	< 60 %	-	-	34* (20 stations)	-	-	-
O_3 (hourly) Background locations	< 60 %	-	-	46* (11 stations)	-	-	-

* average value

Analysis :

Indicator 1.3 had to be considered as a key indicator. It focused on the quality, i.e. the accuracy, of the data delivered by the HEAVEN chain for air quality.

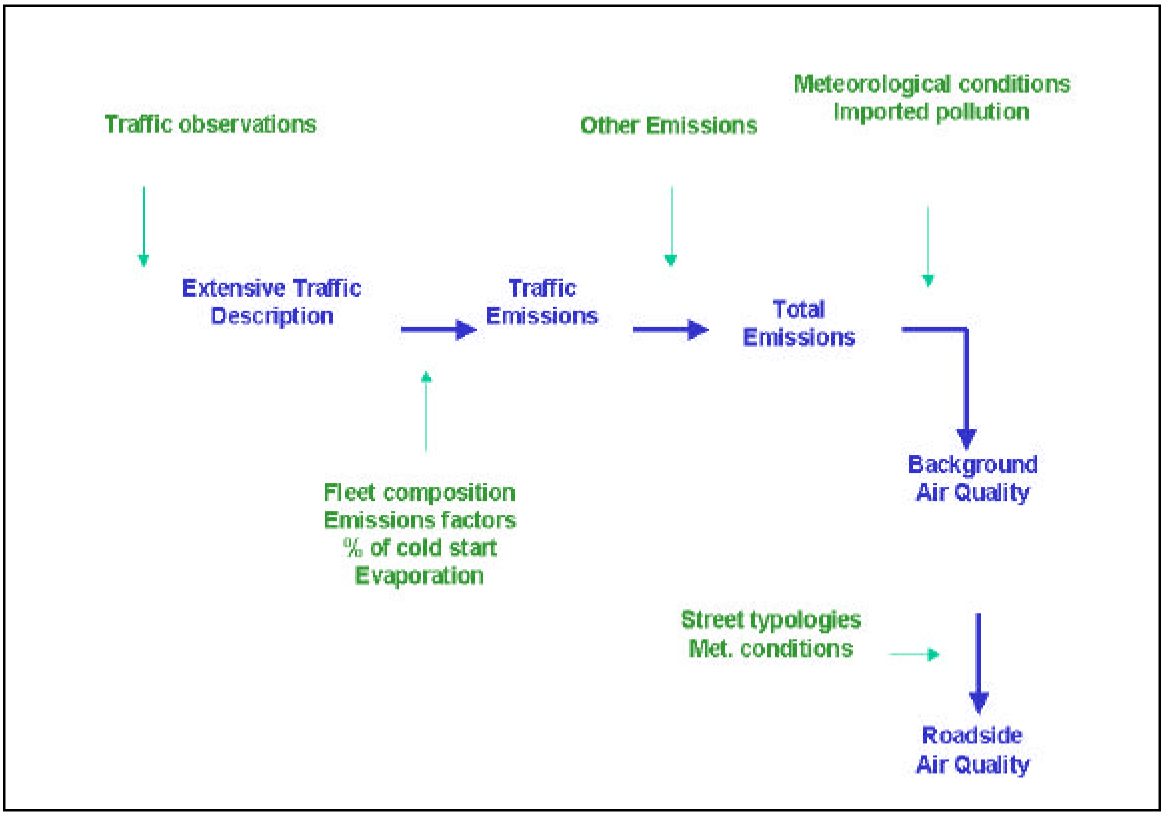
Integration of integrated modelling chain a core challenge

However, once again, it has to be underlined that the aim of HEAVEN was not the development of new air quality modelling tools. The core challenge was the incorporation of an integrated modelling chain going from traffic description to air quality concentration. This chain, more especially for the air quality concentration description, was based on already existing tools. In case of non-satisfactory modelling tools, the flexibility of the HEAVEN chain allowed an easy update.

The question of the quality of the modelling chain also had to be considered as, not only linked to the models directly implemented, but also to the quality of the various data feeding the chain (traffic description, meteorology, etc.).

The following figure underlines in more detail the various parameters of influence:

Figure 12: Modelling chain



According to the success criterion provided by the European directive 1999/30 related to air quality, the results showed a good achievement for this indicator based on the data received. Most of the cities reached the target for at least two pollutants.

Most cities reached target for at least two pollutants

Paris was a specific case. As explained above, if traffic and emissions are described in real time, developments related to the hourly roadside concentrations description were not achieved. Only the annual data were available. However, Paris was also a specific case concerning the description of the background concentrations for NO_2 and O_3 on an hourly basis. In addition, for a large number of monitoring stations, this description also fulfilled the European criterion.

From a more general point of view, the analysis of other statistical parameters going beyond the basic European criterion delivered a more contrasted picture regarding the model accuracy performances.

The analysis of the bias, standard deviations and maximal hourly errors clearly showed that there was still room for improvement concerning air quality modelling and related input data. Summary tables for each city in this regard are provided in annex 10 of this Evaluation Report.[8]

[8] It should also be noted that more information on the activities of the HEAVEN cities in investigating the adequacy of the models was reported in project deliverable D8.7 to D8.12 (Demonstration Reports). In the respective chapters 4 of these reports, each city presented the detailed results of their investigation.

5.1.4 Accuracy of roadside description (indicator 1.3 noise)

Indicator 1.3 assessed the accuracy of the HEAVEN system when predicting noise levels due to traffic at roadside locations.

Indicator Achievement: ✚

Data Quality: ★★

HEAVEN Sites Involved:
- Berlin
- Leicester

Data Description:

Cities were asked to directly measure noise levels at sites within their HEAVEN demonstration areas within defined day, evening and night periods. These values were then compared to output from the respective HEAVEN models. The following assessment criteria were used:

- Over 95% of the noise levels ($L_{Aeq,\ 1\text{-hour}}$) predicted by the HEAVEN model should be within ± 2.0dB(A) of measured values at the roadside. The $L_{Aeq,\ 1\text{-hour}}$ level may be considered as the equivalent continuous sound level, which contains the same amount of acoustic energy as a fluctuating level (i.e. the traffic noise) measured over the same time period (i.e. 1-hour).
- L_{DAY}, $L_{EVENING}$, L_{NIGHT} and L_{DEN} levels calculated from the $L_{Aeq,\ 1\text{-hour}}$ data should be within ± 2.0dB(A) of the corresponding values calculated from the measured data. A description of L_{DAY}, $L_{EVENING}$, L_{NIGHT} and L_{DEN} levels may be found in the EC Directive on assessment and management of environmental noise (Directive 2002/49/EC).
- A linear regression analysis of modelled $L_{Aeq,\ 1\text{-hour}}$ levels vs. monitored levels should show a correlation coefficient of above 0.70. The correlation coefficient provides a measure of the degree of the relationship between two variables. A score of 1.0 indicating that one variable increases in a straight-line relation with the other.

Monitoring locations had to be above a certain height (3.5 metres) and at least two metres away from adjacent buildings. Weather conditions for monitoring had to be dry, with little or no wind.

Table 14: Accuracy of roadside description - noise

Pollutants	Monitoring campaign data	Berlin	Leicester
Noise	% Results within ± 2.0 dB(A)	N/A	87.5
$L_{Aeq,\ 1\text{-hour}}$	% > 95%?	No	No
Noise	All results within ± 2.0 dB(A)	No	Yes
L_{DAY}, $L_{EVENING}$, L_{NIGHT}, L_{DEN}			
Noise	Correlation Coefficient, R	0.84	0.97
$L_{Aeq,\ 1\text{-hour}}$	R > 0.70?	Yes	Yes

Analysis:

Leicester provided data two surveys, each of 12-hours duration, for a total of 24 $L_{Aeq,\ 1\text{-hour}}$ measurements. The results from Leicester were generally satisfactory, with a very high correlation coefficient achieved. However, the limited number of results obtained meant that the failure of three model results to be within ± 2.0 dB(A) of the measured values led to a failure to meet the HEAVEN criteria. Subsequent analysis of these results showed that:

- All modelled results were within ± 2.5 dB(A) of the measured values.
- The results that failed this criterion were generally associated with low traffic flows during the night-time periods.

As a result of these findings the Leicester model is being reviewed to improve traffic modelling during the night and to improve emissions corrections for low traffic flows.

The result that all L_{DAY}, $L_{EVENING}$, L_{NIGHT} and L_{DEN} levels met the success criterion is encouraging, showing that the modelling approach used may be of benefit in meeting the requirements of the new EC Directives on assessment of environmental noise.

In Berlin the analysis was carried out on two days (22 August 2002 and 4 September 2002).

On both days hourly measurements were taken for each hour of the day and compared to the modelled results. Thus, the dataset for the evaluation consisted of 48 values.

The modelled values were constantly above the measured values and exceeded those by an average of more than 2 dB(A). In Berlin, the analyses on the reasons for those deviations are still under way. It is, however, assumed that one reason was that higher noise emissions for trucks were anticipated than actually occurred. In the demonstration area, a large share of “light trucks” with comparably fewer emissions was observed, leading to an overestimation of noise pollution.

5.1.5 Frequency of update intervals regarding air quality (indicator 1.4)

The HEAVEN project was expected to provide a “near real time” description of the current environmental situation in order to improve both the access and the quality of environmental information. This improvement was mainly based on the near real time description of traffic which contributes to increase the frequency of update intervals regarding air quality.

Indicator Achievement: ✚

Data Quality: ★★★

HEAVEN Sites Involved:

- **Berlin**
- **Paris**
- **Prague**
- **Rome**
- **Rotterdam**

Indicator 1.4 contributed to the evaluation of the “near real time” definition term, from a technical point of view. This “near real time” term was evaluated as the time needed between the observation of the environmental situation and its description provided by the simulation tools.

The indicator related only to the frequency of update intervals related to the technical performance of the modelling system. It did not apply to the frequency of update intervals regarding air quality information access for professional and public users, described by indicators 3A2 and 3B2 (see chapter 5.3.2).

Data description:

Indicator 1.4 was expressed as a period of time. The situation observed prior to HEAVEN was used as reference case.

Focus on roadside descriptions

The indicator focused on roadside description (PM10, NO_2, CO, C_6H_6). For ad hoc cities, the evaluation concerns also the background pollution.

Table 15: Increased frequency of update intervals

Increase frequency Success (yes/no) Frequency (before/after)	Berlin	Paris(1)	Prague	Rome	Rotterdam
PM10 (roadside)	Yes (5 years / 6 months)	na	Yes (na / 1 hour)	Yes (na / 1 hour)	Yes (5 years / 1 hour)
NO_2 (roadside)	Yes (5 years / 6 months)	na	Yes (na / 1 hour)	Yes (na / 1 hour)	Yes (5 years / 1 hour)
CO (roadside)	Yes (5 years / 6 months)	na	Yes (na / 1 hour)	Yes (na / 1 hour)	na
C_6H_6 (roadside)	Yes (5 years / 6 months)	Yes (na / 80 min)		Yes (na / 1 hour)	Yes (5 years / 1 hour)

Increase frequency Success (yes/no) Frequency (before/after)	Berlin	Paris(1)	Prague	Rome	Rotterdam
O_3 (background)	-	Yes (na / 1 hour)		na	Yes
NO_2 (background)	-	Yes (na / 1 hour)		na	Yes
SO_2 (background)	-	-	Yes (na / 1 hour)	-	-

(1) For Paris, the hourly roadside description is under completion. The traffic emissions for the whole traffic network were available with an 80 minutes delivery time (no data before HEAVEN).

Analysis :

The success criterion was the increase of the update intervals, i.e. the reduction of the time between the environmental situation and its description by the simulation tools.

Frequency concerning technical update intervals broadly increased

The results showed a good achievement for this indicator, which was a core indicator of HEAVEN evaluation. The frequency concerning the technical update intervals broadly increased, particularly for roadside locations. It has to be underlined that very often, before HEAVEN, there was no reference case, i.e. the data were technically not available.

The situation was more contrasted for the background locations. Here, the situation only improved for less than 50% of the parameters.

5.1.6 Efficiency of air quality description (indicator 1.5)

HEAVEN was expected to provide an improved description of environmental situation through an innovative use of simulation tools and more classical monitoring devices. In this context, "efficiency" could be expressed as a more accurate description of the current environmental situation without an extended monitoring network. In another way, both numerical tools and monitoring networks contributed to enhance the description of the current environmental situation. However, this enhancement was mainly gained through accurate and enhanced numerical tools. This increased efficiency was expected to be an innovative and positive impact of the HEAVEN project.

Indicator Achievement: ++

Data Quality: ★★★

HEAVEN Sites Involved:

- Berlin
- Leicester
- Paris
- Prague
- Rome
- Rotterdam

Data description :

Indicator 1.5 was a logical combination of indicators 1.1, 1.2, 1.3, and 1.4 in the event that no new measurement happened. The success criterion was the logical score of the following combinations :

- at least two success criteria of indicators 1.1 to 1.4 achieved;
- no significant increase in monitoring stations (less than 20% of new monitoring stations in the demonstration area).

Table 16: Increased efficiency of air quality description

Efficiency of air quality description	Berlin	Leicester	Paris	Prague	Rome	Rotterdam
Increased coverage of traffic and roadside pollution network	-	yes	yes	yes	yes	yes
Increased grid resolution	-	-	yes	yes	yes	na
Accuracy of roadside description	yes	yes	yes	na	yes	yes
Increased frequency of update intervals regarding air quality	yes	-	yes	yes	yes	yes
Less than 20% of news monitoring stations	yes	yes	yes	yes	yes	yes
Increased efficiency	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**

Analysis :

Increased efficiency of air quality description in all cities

HEAVEN definitely allowed for an increased efficiency of air quality description. All the cities improved the description of their local environmental situation through an efficient combination of simulation tools and monitoring devices.

It was one of the major HEAVEN outcomes to demonstrate that an extensive and precise description of environmental problematic could be reached by the efficient development of simulation tools built on an existing monitoring "backbone". In addition, this approach allowed for the test of prospective scenarios.

A monetary analysis, which was clearly out of the framework of the evaluation plan, could also be of interest.

5.1.7 Frequency of update intervals regarding noise quality (indicator 1.6)

Indicator 1.6 assessed whether the introduction of the HEAVEN system has led to a reduction in the time taken to produce noise emissions data for the road network, based on real-time traffic information.

Indicator Achievement: ++

Data Quality: ★★

HEAVEN Sites Involved:

- Berlin
- Leicester

Data Description:

Cities were asked to record the times taken to generate noise emissions data for roads within their demonstration areas using techniques available prior to implementation the HEAVEN system for a number of weekdays. The average of these times was then compared to the time taken using the HEAVEN system.

Results:

Table 17: Delivery time for real-time noise emission data before and after HEAVEN

Pollutants	Delivery time for real-time noise emission data	Berlin	Leicester(1)
Noise	Delivery time before HEAVEN	2 days	440 minutes
	Delivery time after HEAVEN	10 minutes	20 minutes
	Assessment of the improvement through HEAVEN?	Significant	Significant

(1) For Leicester no real-time noise emissions modelling was undertaken prior to the HEAVEN project. The time given in the above table represents the time required to manually produce noise emissions levels using an external traffic database (the Instrumented City Facility at the University of Leeds). See section 5.2.4 for a more detailed analysis of the benefits of the HEAVEN system in Leicester in relation to noise.

Analysis

For Leicester, a significant change in the time required to produce real-time noise emissions was noted. The process changed from one requiring labour intensive extraction of required traffic data from text files and data manipulation through use of excel spreadsheets, to an almost fully automatic process. The actual time required to produce roadside emissions levels through use of the HEAVEN system was almost negligible, with the vast bulk of the delivery time after HEAVEN (20 minutes in Leicester, 10 minutes in Berlin) being due to operator inexperience in collating information from the from the relevant system reports.

5.1.8 Increased efficiency of noise pollution description (indicator 1.7)

Indicator Achievement: ?

Data Quality: ---

HEAVEN Sites Involved:

- **Berlin**
- **Leicester**

Indicator 1.7 was originally intended to provide a monetary analysis of the benefit achieved through the implementation of the HEAVEN system in the production of the noise pollution description. Given that no real-time modelling of noise levels took place in either city prior to the HEAVEN project, one might expect that the introduction of the HEAVEN system might actually give rise to an economic penalty to the operating institution, without considering a more detailed analysis taking into account the usefulness of the new data arising from the system.

For the city of Leicester it is expected that the real-time information from the HEAVEN system should provide data that can be used outside of the Area Traffic Control centre, in order to aid planning activities in other departments, for example Leicester's Pollution Control Department (PCD).

The current procedure in Leicester is for the PCD to put the responsibility of acoustic monitoring or modelling onto any developer. PCD would recommend an acoustic consultant should be appointed. The specific role of the PCD would be to provide advice to the consultant and to appraise whether the monitoring surveys that they undertake are appropriate. Staff time spent by PCD is generally used in assessing the report submitted by, and liasing with the developer, architect, consultant and planning officer rather than carrying out any noise level measurements or computation themselves.

The introduction of the HEAVEN system noise model may help to speed up the processing of applications from developers. Modelled data could be provided to developers or used to confirm measured data.

Also, the HEAVEN system should in the future provide very easy access to information regarding façade noise levels that could be presented at the policy stage of the governing process. Therefore, the system could enable the local authority to be more proactive in identifying specific Greenfield sites or target buildings. The impact of the introduction of Traffic management initiatives could also be assessed more rapidly at the design and planning stage.

Finally in conclusion, a major benefit of the availability of the AVTUNE resulting from HEAVEN was in providing traffic noise emissions maps to be used in strategic planning and traffic management and in the future to enable the responsibilities set out in the recent EC Directives to be met.

5.1.9 Noise roadside emission: Length of network (indicator 1.8)

Indicator Achievement: ++

Data Quality: ★★

HEAVEN Sites Involved:
- Berlin
- Leicester

Indicator 1.8 assessed the increase in network coverage available for real-time noise emissions modelling due to the implementation of the HEAVEN system.

Data Description:

Cities were asked to provide the length of traffic network available for real-time modelling prior to and post HEAVEN implementation. Success was deemed to have been achieved it the length of network available increased through the duration of the HEAVEN project.

For noise, a secondary criterion was that real-time data should be available for all major links within the demonstration area. A major link was defined as one consistently carrying over 200 vehicles per hour during the day.

Table 18: Traffic network length (noise) before and after HEAVEN

Pollutants	Traffic network length	Berlin	Leicester
Traffic description Noise	Traffic network length (in km) before HEAVEN	0	0 (1)
	Traffic network length (in km) after HEAVEN	545 (2)	78.5 (3)
	Length after / length before > 0 ?	Yes	Yes

(1) No real-time noise modelling was undertaken in Leicester prior to the HEAVEN project.

(2) The figure quoted for Berlin is the length of the traffic network for which online traffic data is available. At these locations, online modelling for noise emissions and concentrations can be carried out.

(3) Includes all real-time SCOOT and TRIPS links in the Leicester network, data for a further 382.5km of links is currently available through TRIPS alone. However, these links all use default settings for road type, gradient and road surface. There are 6.4km of real-time links in the Leicester HEAVEN demonstration area for which traffic data is available from SCOOT/TRIPS, with a further 8.2km available through TRIPS modelling only. Only these links could be considered as adequately calibrated in the model.

Table 19: Percentage coverage of real-time links in demonstration areas before and after HEAVEN

Pollutants	Percentage coverage of real-time links in demonstration areas	Berlin	Leicester
Traffic description Noise	Percentage coverage of real-time links in Demonstration Area before HEAVEN	0	0
	Percentage coverage of real-time links in Demonstration Area after HEAVEN	100 (1)	100 (2)
	Percentage after / percentage before > 0 ?	Yes	Yes

(1) Figure describes the network length where potentially near real-time noise pollution can be modelled.

(2) All 24 real-time SCOOT links were covered within the AIRVIRO model.

Analysis:

The success criteria have been achieved in Berlin and Leicester by default with real-time noise emissions modelling now taking place where previously there was none. Work is ongoing in adding network coverage as well as checking and calibrating link information outside of the HEAVEN demonstration area.

5.1.10 Summary

Impact 1
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.

Increased network coverage

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 NO_2 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 O_3 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.

Good achievements concerning accuracy of roadside description

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, NO_2, CO, and C_6H_6). 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.

Quasi real-time noise modelling

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.

5.2 Environmental scenario analysis (Impact 2)

One of the main objectives of HEAVEN was to allow the analysis of environmental effects of Traffic Demand Management Strategies (TDMS) scenarios. Impact 2 addresses this objective, over both short and long term time scales, by the integration of tools and data. HEAVEN was expected to enhance such analyses by improving the spatial and temporal description of environmental parameters.

Assessment Objectives:

- Better tools (updated intervals, accuracy of the description, improved resolution, etc.)
- More extensive description (size of the domain covered, number of parameters, etc.)
- Reduced time needed to produce environmental descriptions based on TDMS.

5.2.1 Coverage of the traffic and roadside pollution network (indicator 2.1 air)

Indicator Achievement: ++

Data Quality: ★★★

HEAVEN Sites Involved:

- Leicester
- Paris
- Prague
- Rome

HEAVEN aimed to offer an enhanced description of the environmental impacts not only in near real time but also in longer term scales, in the framework of "offline" scenarios analysis. Indicator 2.1 was the symmetrical to indicator 1.1 in this context

Data description :

Indicator 2.1 measured the length of the traffic network for which traffic or air pollution data are available. The evaluation was based on the automatic count on the length of the network, expressed in kilometre, covered by the HEAVEN system, i.e. for which traffic or air quality data were available for "offline" scenarios analysis. This evaluation is done for traffic, PM10 concentrations (24-hour-value), NO_2 (1-hour-value), CO (8-hour-value) and C_6H_6 (annual).

Success was achieved if the length of network available increased through the duration of the HEAVEN project.

Table 20: Length of network

Length of network (expressed in km)		Leicester	Paris	Prague	Rome
Traffic	length before	7	850	0	-
	length after	71	20000	714	161
PM10 (24 h)	length before	7	10	0	-
	length after	71	3360*	714	161
NO_2 (1 h)	length before	7	16	0	-
	length after	71	3366*	714	161
CO (8 h)	length before	7	16	0	-
	length after	71	3366*	714	161
C_6H_6 (annual)	length before	-	10	-	-
	length after	-	20000	-	161

* A new modelling tool delivering 1h-air quality concentrations has been implemented in Paris for the HEAVEN demonstration period. This implementation has concerned a 3350 km length subnetwork.

At this stage, this modelling approach has been implemented only for a first evaluation without any real time permanent exploitation. However, this modelling approach should be implemented on an extended network after final evaluation.

The emissions data related to NO_X, CO, PM, CO_2, VOC_S and C_6H_6 are available in real time for 20000 km of network in Paris.

Table 21: Increase in network length by city

Increase in description	Leicester	Paris	Prague*	Rome*
Traffic	X 10	X 23	∞	∞
PM10 (24 h)	X 10	na	∞	∞
NO_2 (1 h)	X 10	na	∞	∞
CO (8 h)	X 10	na	∞	∞
C_6H_6 (annual)	na	X 2000	na	∞

* For Prague and Rome, no data available before HEAVEN.
For Paris, emissions data available for 20000 km of network and 6 pollutants.

Analysis :

The success criteria were globally achieved for most of the cities involved. For two cities (Rome and Prague) for which no data was available for some parameters before HEAVEN, the success criteria were especially impressive.

The success was more contrasted in Paris. Here, HEAVEN allowed for a spectacular extensive description of the traffic and traffic emissions for six pollutants in real time on a broad network. However, the implementation of the hourly real-time description of air quality concentrations was not successfully achieved.

5.2.2 Coverage of the traffic and roadside pollution network (indicator 2.1 noise)

Indicator Achievement: ++

Data Quality: ★★

HEAVEN Sites Involved:

- Berlin
- Leicester

Indicator 2.1 assessed the increase in coverage available for modelling the environment within a city due to implementation of the HEAVEN system. With regards to noise in HEAVEN this translated into the length of traffic network covered for which noise emissions data was available from both static and dynamic sources.

Data Description:

Cities were asked to provide the length of traffic network available for real-time modelling prior to and post HEAVEN implementation. Success was deemed to have been achieved if the length of network available increased through the duration of the HEAVEN project.

Table 22: Traffic network length before and after HEAVEN

Pollutants	Traffic network length	Berlin	Leicester
Traffic description Noise	Traffic network length (in km) before HEAVEN	0	0
	Traffic network length (in km) after HEAVEN	545 (1)	461 (2)
	Length after / length before > 0 ?	No	Yes

(1) Figure quoted for Berlin was the length of the traffic network for which online traffic data was available. At these locations, online modelling for noise emissions and concentrations could be carried out. During the HEAVEN demonstration, the model was only applied at a few locations and the model has only been calibrated for the Beusselstrasse demonstration area.

(2) Figure quoted for Leicester was for TRIPS links with default AIRVIRO road type, road gradient and surface type assignments. So far, only 14.6km of links within the demonstration area have been checked and calibrated.

Analysis:

Success has been achieved in Berlin and Leicester by default. No network modelling capability for noise existed prior to the HEAVEN project. As noted in chapter 5.1.8, work to enter, check and calibrate links outside of the HEAVEN demonstration area is ongoing. As this work progresses the total length of network available for noise scenario modelling should eventually approach that of the network available for air pollution modelling. The overall network lengths for both air and noise pollution modelling will also increase (and average network arc length decrease) in Leicester in early 2003, when Ordnance Survey road centre line data is substituted for the current TRIPS link data, to produce a combined OS/TRIPS[9] road database for Leicester.

[9] TRIPS is a transport planning software package which stands for Transport Improvement Planning System. OS/TRIPS is a term used Leicester-specific term used within HEAVEN referring to a version of the HEAVEN system combining data from TRIPS with geographically accurate road centreline data supplied by Ordnance Survey, UK.

5.2.3 Grid resolution used in modelling (indicator 2.2)

The HEAVEN project was expected to provide a better and more frequent description of current environmental situations. Besides an extended geographic coverage of the traffic network, a more precise description of environmental situations, i.e. background air quality, was to be achieved through more accurate and efficient environmental modelling, and consequently through better grid resolution. This achievement was expected both for real time description and in "offline" modes for scenario analysis.

Indicator 2.2 was the symmetrical of indicator 1.2 in "offline" modes. It allowed the evaluation of the improvement in "offline" modes of the environmental impacts for background locations.

Indicator Achievement: O

Data Quality: ★

HEAVEN Sites Involved:

- Paris
- Prague
- Rome
- Rotterdam

Data description :

Indicator 2.2 measured grid resolution modelling and was evaluated quantitatively at least for NO_2 and O_3. The evaluation was based on the grid size, associated to the spatial resolution, used for the background modelling in "offline" modes.

The success criterion was the increase of grid resolution during the HEAVEN project, i.e. the reduction of grid cells size.

Table 23: Increase in grid resolution

Increase in grid resolution	Paris	Prague	Rome[(1)]
NO_2	X 2	∞*	∞*
O_3	X 1	na	na

(1) For Rome, background modelling involves also PM10, CO_2 and C_6H_6. The grid size and the number of cells available were the same as for NO_2.

* No reference value before HEAVEN.

Table 24: Increase in cell numbers

Increase in cell numbers	Paris	Prague	Rome
NO_2	X 1.4 (900)*	∞ (136000)	∞ (4096)
O_3	X 1.4 (900)	na	na

* Number of cells modelled.

Table 25: Grid size by pollutant

Grid size by pollutant (in km)	Paris	Prague	Rome
NO_2	3 X 3	0.1 X 0.1	0.06 X 0.04
O_3	6 X 6	na	na

Analysis :

As for indicator 1.2, from a global point of view, the achievement gained through HEAVEN for background modelling in "offline" modes was only a mixed success.

Only half of the HEAVEN cities were practically evaluated. For Rotterdam, in "offline" modes, data from a specific monitoring station were used for model calculations.

For the evaluated cities, the criterion was only achieved for NO_2 background modelling.

The reasons underlined in indicator 1.2 are still pertinent (see chapter 5.1.2). More than for indicator 1.2, background modelling for the test of local scenarios was of major interest only for NO_2, due to the massive secondary character of O_3 and its continental dimension.

5.2.4 Time to produce environmental descriptions regarding air quality based on scenario analysis (indicator 2.3)

Description :

The HEAVEN project was supposed to not only enhance the description of real time environmental situations but also to increase the capability of scenario analysis. Indicator 2.3 was related to the evaluation of this capability. It measured the time spent to produce environmental description and scenario analysis with the HEAVEN DSS and compared it to the average time spent to produce the same description before the HEAVEN DSS implementation.

Indicator Achievement: ++

Data Quality: ★★

HEAVEN Sites Involved:

- Berlin
- Leicester
- Paris
- Prague
- Rome
- Rotterdam

Five basic "black and white" reference scenarios involving crucial parameters had been defined to be tested.

These reference scenarios were :

five "black and white" scenarios tested

- 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).

Data description :

Indicator 2.3 was based on the comparison of time spent to produce scenario analysis before and after HEAVEN.

The success was achieved if the time spent had been reduced through the implementation of the HEAVEN DSS.

In addition to this quantitative estimate concerning the time spent, a qualitative description of the results obtained is presented in annex 9 to this Evaluation Report. These scenario results were only indicative and their local assessment the responsibility of the respective cities concerned. The precise analysis of these scenario results was clearly beyond the scope of the Evaluation Report.

The results of the scenarios can be observed as an indication of the sensitivity of the models. In the respective chapters 4 of project deliverables D8.7 to D.12 (Demonstration Reports), each HEAVEN city reported on the detailed results of their scenario calculations.

Table 26: Reduced time to produce environmental descriptions

Reduced time Success (yes/no) Time spent (before/after)	Berlin	Leicester	Paris	Prague	Rome	Rotterdam
Speed Reduction	Yes (- / 4 hours)	Yes (- / 3 hours)	Yes (2months / 2days)	na	Yes (1week / 15min)	No (30min / 30min)
Truck ban	Yes (- / 1 hour)	Yes (- / 4 hours)	Yes (2months / 2days)	na	Yes (1week / 15min)	No (30min / 30min)
Two wheelers ban	na	na	Yes (2months / 2days)	na	Yes (1week / 15min)	na
No traffic	Yes (- / 1 hour)	na	Yes (2months / 2days)	na	na	Yes (1hour / 45min)
Advanced legislation	Yes (- / 4 hours)	na	Yes (2months / 2days)	na	Yes (1week / 15min)	Yes (30min / 5min)

Analysis :

From a general point of view, the results show a large achievement for this indicator based on the data received.

The implementation of the HEAVEN DSS and its related tools allowed for most of the cities involved a new and efficient capability concerning the test of various scenarios. In addition to the enhanced description of the current environmental situation, this was one of the other major effects of HEAVEN.

The HEAVEN cities were able to test various scenarios involving different strategies of traffic management in reduced time. This was a key output for the local decisions makers.

The different scenario results provided by the cities are annexed (annex 9). While not all the scenarios planned were tested, a clear picture of the capabilities gained by each city became available.

The comparison of the results by itself was more difficult. Based on the tools available, a huge amount of work concerning the development of homogeneous scenario description lies ahead.

Rotterdam was a specific case. Already prior to HEAVEN, the city had the capability for efficient of scenario descriptions.

No data had been received from Prague.

5.2.5 Time to produce environmental descriptions regarding noise quality based on scenario analysis (indicator 2.4)

Indicator 2.4 assessed the change in the time required to produce a description of noise emissions across the HEAVEN demonstration area through the implementation of the HEAVEN system.

Indicator Achievement: ++

Data Quality: ★★

HEAVEN Sites Involved:

- Berlin
- Leicester

Data Description:

Cities were asked to record the time taken to produce long term average (yearly) noise emissions data for a number of standard scenarios, using methods available prior to the HEAVEN project and the HEAVEN system itself.

Success was deemed to be achieved if there was an overall decrease in the time taken to produce each individual scenario.

Table 27: Time spent to produce description of noise emissions by scenario before and after HEAVEN

Scenario	Time spent to produce descriptions of noise emissions by scenario	Berlin	Leicester(1)
Speed reduction	Time spent before HEAVEN	5 hours	2 days
	Time spent after HEAVEN	3 hours	2 hours
	Time after < time before ?	yes	yes
Heavy duty vehicles	Time spent before HEAVEN	5 hours	2 days
	Time spent after HEAVEN	1 hour	2 hours
	Time after < time before ?	yes	yes
Passenger cars (Berlin) Base 2001 (Leicester)	Time spent before HEAVEN	5 hours	2 days
	Time spent after HEAVEN	1 hour	4 hours
	Time after < time before ?	yes	yes

(1) For Leicester no noise scenario modelling was undertaken prior to the HEAVEN project. The times given in the above table represents the estimated time required to manually produce scenarios levels using an external traffic database (the Instrumented City Facility at the University of Leeds).

Analysis:

Both Leicester and Berlin achieved a substantial reduction in the time taken to produce an assessment of traffic noise emissions within their demonstration areas. It should be noted however that the indicator for Leicester is rather artificial, given that such an activity had not been undertaken prior to the HEAVEN project.

5.2.6 Summary

HEAVEN achieved impact 2 - enhanced environmental scenario analysis.

Impact 2
Achievement: ++

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.

Efficient and useful tool for analysis 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 NO_2 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 NO_2.

Five so-called "black and white" scenarios comprising different strategies of traffic management were tested within HEAVEN[10]:

- 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.

Time to produce assessments reduced

[10] Results of the scenario analysis are summarised in annex 9 to this Evaluation Report.

HEAVEN proved to be a suitable tool for scenario test in a time-efficient manner i.e. requiring a reduced amount of time (compared to the situation prior to HEAVEN).

Development of homogeneous scenarios lies ahead

The challenge that lies ahead now is the development of homogeneous scenarios based on the tools HEAVEN provides.

5.3 Access and quality of environmental information (Impact 3)

Separate impact assessment for professional users and public users

The Evaluation Team defined as an expected impact of HEAVEN improved access and quality of environmental information. This impact represented the user's view of the results obtained by the HEAVEN system. The impact was divided into:

- impact 3A (for professional users) and
- impact 3B (for public users).

It was expected that both the user's access to and the quality of environmental information would improve through HEAVEN. These improvements referred to the availability of the information in a form desired by the users (i.e. geographic, media, and event-specific information), but also to general user friendliness, timeliness of the presentation of data, and usefulness of the information. Another aspect of the (expected) improved access and quality of information related to the guaranteed delivery of information.

As a means of measuring this impact, the HEAVEN sites produced a common daily/ weekly bulletin. This bulletin was intended as a common product across the sites providing one-page information on topics defined by the Task Forces Air and Noise.

Assessment Objectives:

- Measurement of time improvements related to update intervals
- Measurement of changes in duration between observation and presentation of environmental information to the users
- Documentation of perceived usefulness of environmental information
- Documentation of perceived efficiency of daily/ weekly bulletin

5.3.1 Time resolution (indicator 3AB.1)

Indicator Achievement: ++

Data Quality: ★★★

HEAVEN Sites Involved:

- Berlin
- Paris
- Prague
- Rome
- Rotterdam

The HEAVEN project was expected to improve both the access and the quality of environmental information for professional and public users. The improvement of the user's access refined to a better temporal description of the current environmental situation.

Time resolution was understood as the finest temporal description of the air pollution patterns technically obtained after the development of the HEAVEN system. If a system broadcasted three times a day a background air pollution map concerning the one-hour concentrations values, its time resolution is one hour.

Indicator 3.1 evaluated this time resolution. It was estimated quantitatively for roadside and background air quality. The time resolution available was described independently for professional users (3A1) and public users (3B1).

Data description :

Indicator 3.1 was expressed as a period of time. The situation observed prior to the implementation of HEAVEN served as the reference case.

Results for professional users :

Table 28: Improved time resolution - professional users

Improved time resolution Success (yes/no) Before/after	Berlin	Paris[1]	Prague	Rome	Rotterdam[2]
PM10 (roadside)	Yes 1 year / 1 hour	Yes - / 1 year	Yes - / 1 hour	Yes - / 1 hour	Yes 1 year / 1 hour
NO_2 (roadside)	Yes 1 year / 1 hour	Yes - / 1 year	Yes - / 1 hour	Yes - / 1 hour	Yes 1 year / 1 hour
CO (roadside)	Yes 1 year / 1 hour	Yes - / 1 year	Yes - / 1 hour	Yes - / 1 hour	No 1 year / 1 year
C_6H_6 (roadside)	Yes 1 year / 1 hour	Yes - / 1 year	na	Yes - / 1 hour	Yes 1 year / 1 hour
O_3 (background)	na	Yes - / 1 hour	na	na	No 1 hour / 1 hour
NO_2 (background)	Yes 1 year / 1 hour	Yes - / 1 hour	Yes - / 1 hour	na	No 1 hour / 1 hour

(1) For Paris, hourly description achieved through modelling for the roadside location under completion. The traffic emissions were described on an hourly basis for the whole traffic network.

(2) For Rotterdam, hourly description achieved through monitoring for the background locations.

Results for public users :

Table 29: Improved time resolution – public users

Improved time resolution Success (yes/no) Before/after	Berlin	Paris[1]	Prague	Rome	Rotterdam[2]
PM10 (roadside)	Yes 1 year / 1 hour	Yes - / 1 year	na	na	Yes 1 year / 24 hrs
NO_2 (roadside)	Yes 1 year / 1 hour	Yes - / 1 year	Yes - / 1 hour	na	Yes 1 year / 1 hour
CO (roadside)	Yes 1 year / 1 hour	Yes - / 1 year	Yes - / 1 hour	na	No 1 year / 1 year
C_6H_6 (roadside)	Yes 1 year / 1 hour	Yes - / 1 year	na	na	Yes 1 year / 24 hrs
O_3 (background)	na	Yes - / 1 hour	na	na	No 1 hour / 1 hour
NO_2 (background)	na	Yes - / 1 hour	Yes - / 1 hour	na	No 1 hour / 1 hour

(1) For Paris, hourly description achieved through modelling for the roadside location under completion. The traffic emissions were described on an hourly basis for the whole traffic network.

(2) For Rotterdam, hourly description achieved through monitoring for the background locations.

Analysis :

The results showed a good achievement for this indicator. For professional and public users, the time resolution had been quite systematically improved for the air quality information related to the roadside concentrations.

The situation was more contrasted for the background locations. It only improved for less than 50% of the parameters. Once again, background description dd not appear as the main achievement of HEAVEN.

It should also be underlined than the improvement in time resolution had been achieved to a lesser extent for the public than for the professional users.

5.3.2 Delivery time (indicator 3AB.2)

The HEAVEN project was expected to provide a "near real-time" description of the current environmental situation in order to improve both the access and the quality of environmental information for professional and public users.

Reduced delivery time was understood as the time needed to produce an up-to-date description of the air pollution levels before and after HEAVEN. This time included traffic data collection, modelling computation and map, charts production allowing the presentation to ad-hoc users.

Indicator 3.2 measured the time elapsed between the observation of environmental situation to presentation to users and the reduction in terms of time due to HEAVEN. Indicator 3A.2 focused on professional users, indicator 3B.2 on public users.

Indicator Achievement: ✚

Data Quality: ★★

HEAVEN Sites Involved:

- Berlin
- Paris
- Prague
- Rome
- Rotterdam

Data description :

Indicator 3AB.2 was expressed as a period of time. The situation observed prior to HEAVEN was used as the reference case.

The success criterion was the reduction of the delivery time.

The indicator focuses on roadside description (PM10, NO_2, CO, C_6H_6). For Paris and Prague, the evaluation concerned also the background pollution.

Results for professional users :

Table 30: Reduced delivery time for professional users

Reduced delivery time Success (yes/no) Delivery time before/after	Berlin	Paris(1)	Prague	Rome	Rotterdam
PM10 (roadside)	Yes 10 hrs / 10 min	na	Yes - / 15 min	Yes - / 15 min	Yes 3 months / 105 min
NO_2 (roadside)	Yes 10 hrs / 10 min	na	Yes - / 15 min	Yes - / 15 min	Yes 3 months / 105 min
CO (roadside)	Yes 10 hrs / 10 min	na	Yes - / 15 min	Yes - / 15 min	na
C_6H_6 (roadside)	Yes 10 hrs / 10 min	Yes - / 80 min	na	Yes - / 15 min	Yes 3 months / 105 min
O_3 (background)	-	Yes - / 1 hour	na	na	na

Reduced delivery time Success (yes/no) Delivery time before/after	Berlin	Paris[1]	Prague	Rome	Rotterdam
NO_2 (background)	-	Yes - / 1 hour	na	na	na
SO_2 (background)	-	-	Yes - / 15 min	-	-

(1) For Paris, the hourly roadside description is under completion. The traffic emissions for the whole traffic network were available with an 80 minutes delivery time (no data before HEAVEN).

Results for public users :

Table 31: Reduced delivery time for public users

Reduced delivery time Success (yes/no) Delivery time before/after	Berlin	Paris[1]	Prague	Rome	Rotterdam
PM10 (roadside)	Yes 10 hrs / 10 min	na	na	na	Yes 3 months / 120 min
NO_2 (roadside)	Yes 10 hrs / 10 min	na	Yes - / 15 min	na	Yes 3 months / 120 min
CO (roadside)	Yes 10 hrs / 10 min	na	Yes - / 15 min	na	Yes 3 months / 3 months
C_6H_6 (roadside)	Yes 10 hrs / 10 min	Yes - / 80 min	na	na	Yes 3 months / 120 min
O_3 (background)	-	Yes - / 1 hour	na	na	na
NO_2 (background)	-	Yes - / 1 hour	na	na	na
SO_2 (background)	-	-	-	-	-

(1) For Paris, the hourly roadside description is under completion. The traffic emissions for the whole traffic network were available with an 80 minutes delivery time (no data before HEAVEN).

Analysis :

The results showed a good achievement for this indicator. For professional and public, the delivery time generally improved for the air quality information related to the roadside concentrations.

Generally reduced delivery time

The situation was more contrasted for the background locations. It only improved for fewer than 50% of the parameters. However, as mentioned above, background description did not appear as the main achievement of HEAVEN.

It should also be underlined that the improvement in delivery time had been less achieved for the public than for the professional users.

The general assessment for indicator 3AB.2 was closely related to the assessment related to 3AB.1.

5.3.3 Usefulness (indicator 3AB.3)

Indicator Achievement: ++

Data Quality: ★

HEAVEN Sites Involved:

- Berlin
- Leicester
- Paris
- Prague
- Rome (profess. users)
- Rotterdam

While the individual aspects of usefulness depend on the subjective view a user has on HEAVEN, for evaluation purposes usefulness encompasses the completion of day-to-day tasks in terms of effectiveness, efficiency, accuracy, reliability, completeness, relevance, etc.

The analysis of usefulness was based on questionnaire and interview data. Responses from both, public and professional users, were considered and where appropriate a comparative analysis between the two user groups is presented.

138 public user questionnaires were submitted by five HEAVEN cities. No questionnaire data were available from Rome, where only the municipality is allowed to make environmental information public.

Among the 138 questionnaires, 75 came from Rotterdam. That is equivalent to 54% of all questionnaires. The overall analysis across all sites is, therefore, heavily skewed towards responses from Rotterdam. This circumstance is considered in the evaluation.

Only the quantity of questionnaires received from Rotterdam allowed for a description of site-level results in percentage terms. For the analysis of public user questionnaires from Paris (27), Berlin (13), Leicester (12), and Prague (11), results were reported in absolute terms, for example 20 out of 26 public users.

Paris used an online questionnaire similar, but not identical, to the common HEAVEN public user questionnaire. However, key questions were the same in both questionnaires, so that an analysis of the respective responses from Paris was included in the analysis of evaluation results.

In Berlin, a technical flaw in the initial phase of the large scale demonstration did not allow for users to access the public user questionnaire, a circumstance that can partially explain the low number of completed questionnaires.

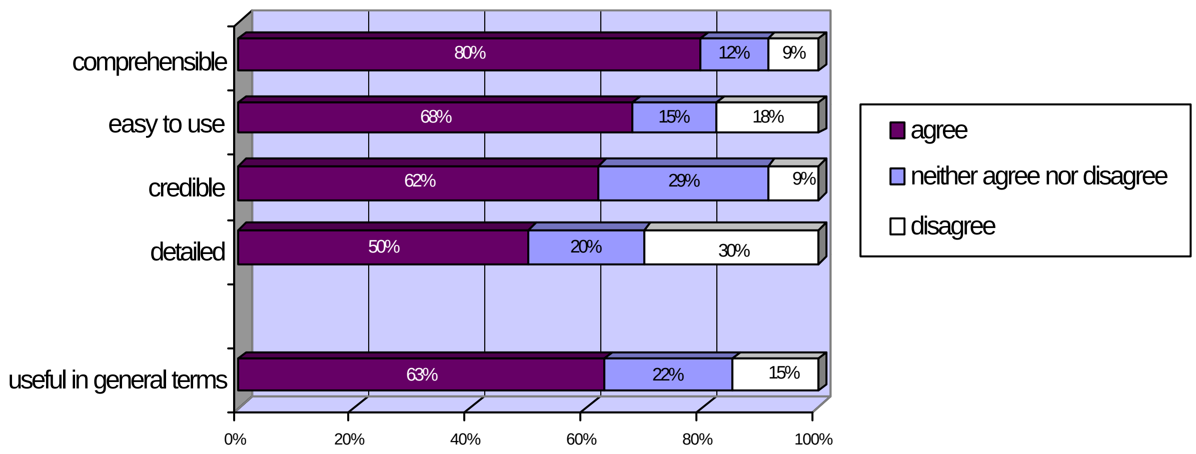
Acceptance of HEAVEN information

Among public users, the acceptance of HEAVEN information was fairly high. The information provided was perceived as comprehensibly by 80% of all public users, and roughly two out of three (68%) were satisfied with the information's ease of use.

The site-specific results, however, showed some notable deviations from the overall result. In Rotterdam, 89% of all public agreed (60% absolutely and 29% partially) that the information provided through the HEAVEN is comprehensible. Taking into account that 55% of all questionnaires analysed were from Rotterdam, the high level of overall satisfaction with comprehensibility of information can be explained. The comparable low level of agreement (5 out of 13 users) concerning the comprehensibility in Berlin did hardly affect the overall result, since only 9% of all submitted questionnaires were from Berlin.

A similar picture was drawn for the easiness of use. Overall 68% said that HEAVEN information was easy to use. Among public users from Rotterdam 76% agreed to this statement, while, for example, among the Berlin users only 5 out of 13 agreed.

Figure 13: Acceptance of HEAVEN information among public users



n=136 and 137, respectively

Overall the majority of public HEAVEN users (63%) perceived the information provided as useful. Relatively high approval rates for comprehensibility and easiness of use could be attributable to the way information is presented, i.e. the web site design, the functionality of the interface, etc. In contrast, comparable low acceptance when asked about the credibility (62%) and the detail of the information (50%) could be observed. This could be a problem of the data (source) itself. In particular, credibility of information appears to be a general problem. The relatively low level of detail can also be interpreted as the desire among public users to obtain additional information, for example, about particular streets or areas of the city or about certain other aspects of interest to individuals, such as health effects, which have not been included in the HEAVEN information yet.

Effect on users' travel choice

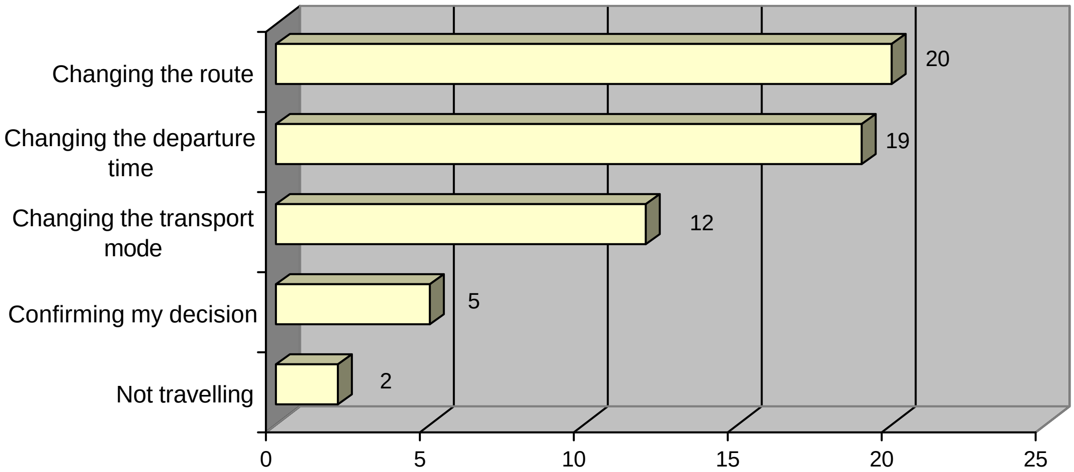
Public users were asked in what way the information provided through HEAVEN might have affected their travel choice. 40 out of 111 public users[11] responded. This is a considerable effect, particu-

[11] This particular question was not asked in the Paris user questionnaire.

larly taking into account that 57% of all users who completed the questionnaire were first time users.

Figure 14 below presents the (pre-defined) impacts on user's travel choices.

Figure 14: Impact of HEAVEN information on user's travel choice



n=40 (98 missing)

82% off all public users used the information received at least "sometimes" to make a decision regarding their travel choice.[12]

12 Asked whether they had used, in the past, the received information (via HEAVEN) for their travel choice, 12% of the public users responded "never", 6% "rarely", 26% "sometimes", 28% "often", and 29% "always". It needs to be considered that public user responses are heavily skewed towards Rotterdam users who made up 54% of all public users completing the questionnaire.

5.3.4 Efficiency of daily/ weekly bulletin (indicator 3AB.4)

Indicator Achievement: ✚

Data Quality: ★★

HEAVEN Sites Involved:
- Berlin
- Leicester
- Paris
- Rotterdam

The Evaluation Team agreed early on in the project that in each site a daily or weekly bulletin would be produced with key environmental information about, at least, meteorology, traffic, noise, roadside and current air quality situation. The time it took to produce such a bulletin would be an indication of efficiency.

Since professional and public users have different expectations regarding the content of a bulletin, each site had the option to prepare separate bulletins for the two user group.

In addition to allowing an assessment of time efficiency (in producing a bulletin), a bulletin represents a useful by-product of HEAVEN. The HEAVEN sites Berlin, Leicester, Paris, and Rotterdam developed bulletins for their users and submitted respective evaluation data for analysis, while Rome and Prague did not.

Table 32: Update frequency and time required to produce bulletin

Bulletin	Site	Update frequency	Time spent before HEAVEN	Time spent after HEAVEN	Success (yes or no)
Public users	Berlin	weekly	no reference	1 hour	yes
	Leicester	daily	infinite	1 hour 15 minutes	yes
	Paris	daily	no reference	1 hour	yes
	Rotterdam	hourly/daily	infinite	2 hours	yes
Professional users	Berlin	weekly	no reference	1 hour	yes
	Leicester	daily	infinite	1 hour 15 minutes	yes
	Paris	daily	no reference	1 hour	yes
	Rotterdam	hourly	infinite	1 hour 45 minutes	yes

As shown in table 32, none of the four sites had produced bulletins prior to HEAVEN so that no reference for time efficiency existed. It took between one and two hours depending on the site to produce a bulletin, i.e. a reasonably short amount of time. The success criterion was achieved by default.

Table 33 below shows the types of data that are included as well as the time required to include these data in the bulletin. While, in particular, Berlin and Rotterdam[13] included only specific types of data in their initial bulletin version, the bulletins from Leicester and Paris

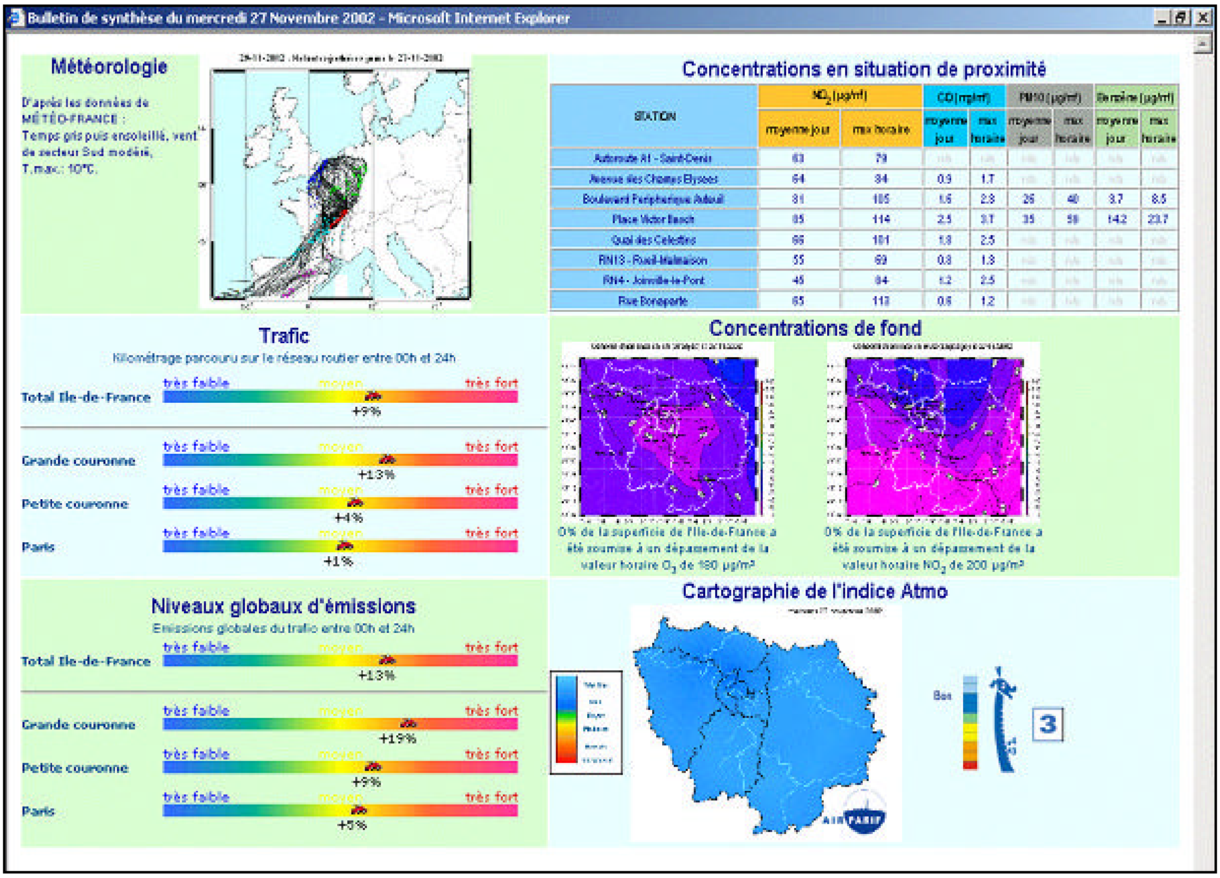
[13] The HEAVEN website in Rotterdam provided hourly and daily maps of roadside air pollution. In addition, a “movie” displayed the last 24 hourly values

already comprised a wide range environmental data. Figure 15 shows an example of a bulletin produced in Paris.

Table 33: Types of data and time required to produce for bulletin

Site	Berlin		Leicester		Paris		Rotterdam	
Time	without HEAVEN	with HEAVEN	without HEAVEN	with HEAVEN	without HEAVEN	with HEAVEN	without HEAVEN	with HEAVEN
Meteorological data	----	----	not done	10 min.	not done	10 min.	----	----
Emissions data	----	----	not done	15 min.	not done	30 min.	----	----
Air pollution background data	----	----	not done	75 min.	not done	60 min.	infinite	120 min.
Air pollution roadside data	not done	60 min.	not done	75 min.	not done	10 min.	----	----
Noise data	not done	60 min.	not done	not in bulletin	n/a	n/a	n/a	n/a
Traffic	----	----	----	----	no reference	40 min.	----	----
Bulletin structure and links	----	----	not done	15 min.	----	----	----	----

Figure 15: HEAVEN Daily Bulletin Paris – 27 November 2002



5.3.5 Summary

Impact 3
Achievement: ++

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.

Improved time resolution and reduced delivery time

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.

HEAVEN news bulletin a useful by-product of evaluation exercise

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.

5.4 Institutional co-operation (Impact 4)

Direct users of HEAVEN included departments and agencies related to traffic/ transport, environment, health, and urban planning. It was expected that the co-operation between these institutions would improve through HEAVEN.

Improved co-operation can be reviewed in quantitative and in qualitative terms. Quantitative improvements occur if an increased amount of physical data is exchanged between institutions, but also in the case of time-efficiency improvements in the exchange of information. In qualitative terms, institutional co-operation is improved if, for example, fewer conflicts arise, trust increases, new joint initiatives and new inter-departmental work arrangements are being established, access to data is facilitated, or common “tools” are being used.

Assessment Objectives:

- Documentation of perceived changes in quality of co-operation
- Measurement of quantitative improvements in information exchange between HEAVEN institutions

5.4.1 Quality of co-operation (indicator 4.1)

Indicator Achievement: ✚

Data Quality: ★

HEAVEN Sites Involved:
- Berlin
- Leicester
- Prague
- Rotterdam

The data basis for analysing the quality of institutional co-operation was extremely weak. It was originally envisaged to assess the HEAVEN system and its impacts on institutional co-operation in terms of, for example, fewer conflicts, increased trust between involved parties, new joint initiatives, new interdepartmental work arrangements, facilitated access to data, or the common use of tools across departments or institutions. The small amount of data available for analysis (seventeen interviews) did not allow for any quantitative analysis of institutional co-operation. However, almost all interviewees from Berlin (two), Leicester (three), and Rotterdam (six) stated improved quality of institutional co-operation.[14] Since the interviews contained a number of "open" questions, a few examples are stated below:

Statements reveal improved institutional co-operation

- Asked about the effects of HEAVEN with regard to institutional co-operation, a user from a traffic and transport department in Berlin stated that "more direct contact between desk officer, joint involvement in other EU projects, better co-operation with respect to certain tasks (e.g. citizens complaints), and enhanced exchange of technical traffic- and pollution-related data". The same user pointed out that "The Heaven project revealed a better understanding of different expert views on common issues within same departments at different policy levels (especially city-district). In consequence, a better planning process has been established."
- "HEAVEN is helping to more effectively disseminate information to decision makers from officer level." (a user from the traffic and transport department in Leicester)
- "HEAVEN has given us a collaborative tool amongst multidisciplinary teams to help achieve the policy objectives." (a user from the traffic and transport department in Leicester)
- A user from a Dutch environmental department stated that "The province has given us the assignment to perform the tasks. The effect of HEAVEN is that the share of traffic in air pollution has become more clear and the attention for traffic related air pollution in policy development has increased."
- According to a Dutch user from a traffic and transport department, HEAVEN affected basic work arrangements as follows: "Before HEAVEN we did not know all the people involved in traffic related air pollution. Now we have direct con-

[14] Neither the four interviews of authority members nor the two interviews of decision makers "conducted" in Prague contained any responses to "open questions".

tact and get direct information. It is now easier to contact these people also for other issues outside HEAVEN." Another user from the Netherlands (from an environmental department) added that "The communication and mutual understanding of each others goals has improved."

5.4.2 Time efficiency of information exchange (indicator 4.2)

Indicator Achievement: ++

Data Quality: ★

HEAVEN Sites Involved:
- Berlin
- Leicester
- Prague
- Rotterdam

In interviews[15], the members of local authorities were asked their perception about time efficiency changes due to the introduction of the HEAVEN system.

The majority of interviewees (from Berlin, Leicester, Prague and Rotterdam) stated that time efficiency improved due to HEAVEN in terms of:

- transport-related information exchange
  (ten out of twelve responses)
- environment (air quality)-related information exchange
  (twelve out of thirteen responses)
- environment (noise)-related information exchange
  (four out of seven responses)
- drawing-up scenarios
  (nine out of ten responses)

Time efficiency gains stated by interviewees

Due to the low number of interviews submitted for evaluation, these positive results lack statistical significance. Nevertheless, they are a (weak) indication for improved time efficiency of information exchange resulting from HEAVEN. These results are complemented by the following statements provided in the interviews with local authority members from Rotterdam and Berlin (examples only):

- For the first time transport planning has access to near-real time traffic and environmental data. From a transport planner's point of view (however) the improvement is not so significant as static data would also be a reliable source for scenarios (a user from the traffic and transport department in Berlin)

[15] As stated in chapter 5.4.1, only fifteen members of authorities from four different HEAVEN sites and two decision makers in Prague were interviewed.

- HEAVEN has been one of the triggers to establish the online connection with Rijkswaterstaat[16].(a user from a Dutch urban planning department)
- HEAVEN has laid the foundation for a more structured exchange of environmental data. We now directly supply traffic data to the other departments. I can now do scenario calculation by myself. Before I had to depend on other organisations. (a user from a Dutch traffic and transport department)
- In a blink of an eye you get the overview of traffic data (a user from a Dutch environmental department)
- I can now get the information out of the system. Before I had to call somebody (a user from a Dutch environmental department)
- Online access to web-base interface on air quality and noise modelling results are important time saving factors (a user from an environmental department in Berlin)

foundation for a more structured exchange of environmental data

Time efficiency could be expressed in terms of monetary savings ("time is money"). This analysis was, however, beyond the scope of the HEAVEN project.

[16] Rijkswaterstaat is an executive organisation of the Dutch Ministry for Traffic and Transport.

5.4.3 Summary

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 view-point 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

5.5 Support of urban planning on an environmental basis (Impact 5)

Urban planning requires a variety of data and information. Strategic urban planning on an environmental basis, in particular, makes use of transport, transport strategy, environmental, and meteorological data in conjunction with different transport strategies. HEAVEN was expected to increase the support of urban planning by accumulating these specific data in a common data repository. The structured data would then be usable in a flexible manner in order to support decision making.

Assessment Objectives:

- Measurement of data quantity entered in common repository
- Documentation of perceived quality of data structure and storage
- Documentation of perceived usefulness for strategic planning

5.5.1 Amount of data entered in common repository (indicator 5.1)

Indicator Achievement: ++

Data Quality: ★★★

HEAVEN Sites Involved:
- Berlin
- Leicester
- Paris
- Prague
- Rome
- Rotterdam

The HEAVEN project was expected to increase the support for urban planning by accumulating specific data related to the environmental situation. In this context, all HEAVEN sites provided information concerning the amount of data available.

Data description

The quantitative evaluation of the common repository focused on the main HEAVEN products. For air pollution, the main data sets obtained through HEAVEN were related to air pollutants traffic emissions, background and roadside concentrations.

For each item, the annual potential data availability was evaluated, taking into account the pollutants described, the geographical elementary description and the time resolution.

Table 34 below shows a comparison of the amount of traffic emission, background concentration, and roadside concentration data available before and after HEAVEN. In Berlin, for example, X 8760 stands for 8760 times larger amount of traffic emission data after HEAVEN compared to the situation prior to HEAVEN.

Table 34: Amount of data available - comparison before and after HEAVEN

before / after HEAVEN	Berlin	Leicester	Paris	Prague [(1)]	Rome	Rotterdam
Traffic Emissions	X 8760 (262 M)*	= (152 M)*	X 10048 (1708 M)*	∞ (<1 M)*	X 1284 (25 M)*	X 1379 (1 M)*
Background Concentrations	X 203 (18 M)*	= (<1 M)*	X 2 (24 M)*	∞ (1 M)*	na	X 1.2 (<1 M)*
Roadside Concentrations	X 8760 (262 M)*	na	X 170 (26 M)*	∞ (6 M)*	X 744 (143 M)*	X 1380 (1 M)*

(1) For Prague, no data available before HEAVEN.

* Number of data available annually (expressed in millions of elementary data).

Table 35 below depicts the types of data available in each HEAVEN site.

Table 35: Types of data available by city

Types of Data		Berlin	Leicester	Paris	Prague	Rome	Rotterdam
Traffic Emission Data	NO_X	✓	✓	✓	✓	✓	✓
	CO	✓	✓	✓	✓	✓	
	C_6H_6	✓					✓
	VOC_S			✓		✓	
	PM10	✓	✓	✓	✓	✓	✓
	CO_2			✓			
	SO_2		✓		✓		
Background Concentration Data	NO_X		✓				
	NO_2	✓	✓	✓	✓		✓
	PM10	✓	✓				✓
	O_3		✓	✓			✓
	CO		✓				
	C_6H_6						✓
Roadside Concentration Data	NO_2	✓		✓	✓	✓	✓
	PM10	✓		✓	✓	✓	✓
	CO	✓		✓	✓	✓	✓
	C_6H_6	✓		✓	✓	✓	✓
	SO_2				✓		

Analysis:

Strong increase in air pollution data available

The result analysis showed a strong increase in the air pollution data available. Therefore, the success criteria were achieved.

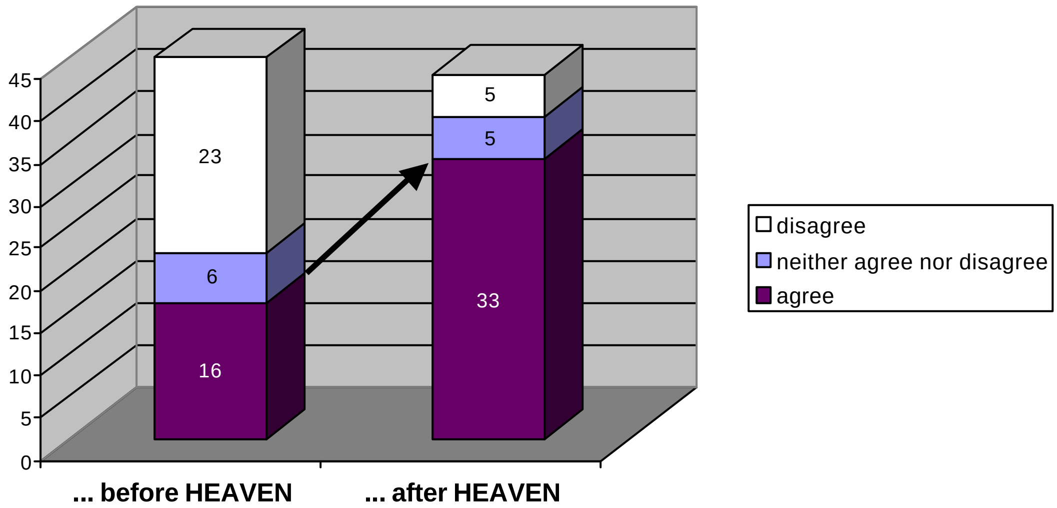
It has to be underlined that the increase was more important for data related to emissions than to concentrations. Obviously, the modelling chain going from traffic to traffic emissions is easier to implement and control. More than air pollutants concentrations, the availability of emissions data was of major interest for urban planners and decision makers.

User perceptions confirmed data increase

In this context, it was observed that the satisfaction levels concerning the quantity of environmental information[17] accessible improved significantly among both, professional users as well as public users (see figures 16 and 17 below), after HEAVEN compared to the situation prior to the system implementation.

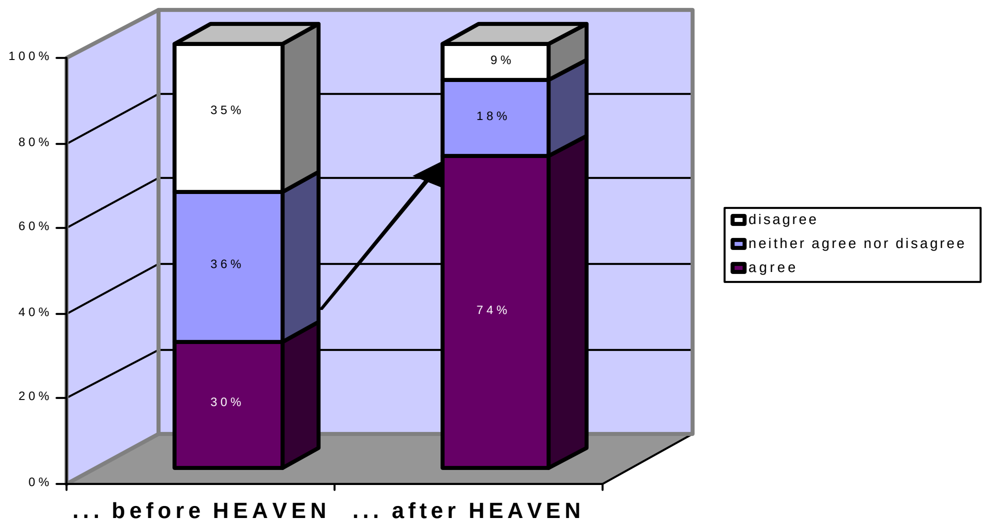
[17] Questionnaires and interviews referred, in general terms, to environmental information rather than merely air pollution data, thus including, for example noise data.

Figure 16: Amount of environmental information accessible - satisfaction among professional users before and after HEAVEN



before: n=45 (0 missing); after: n=43 (2 missing)

Figure 17: Amount of environmental information accessible - satisfaction among public users before and after HEAVEN



before: n=138 (0 missing); after: n=137 (1 missing)

The amount of data available (see table 34) could only be partly explained by the size of the cities involved.

5.5.2 Usefulness for urban planning, including quality of data structure and storage of common repository (indicator 5.2)

Indicator Achievement: ✚

Data Quality: ★

HEAVEN Sites Involved:

- Berlin
- Leicester
- Prague
- Rome
- Rotterdam

HEAVEN was expected to increase the support for urban and strategic planning by allowing the efficient test for urban planners of various scenarios of development, in particular involving traffic.

As already described in chapter 5.2.4, HEAVEN enabled local decision makers in a time-efficient manner to test various scenarios involving different strategies of traffic management.

Indicator 5.2 concentrated on the assessment of usefulness and quality of information in scenarios, including comprehensiveness, level of detail, credibility). The information was to be obtained by means of interviews with planners in departments responsible for urban planning issues.

The Evaluation Team defined as success criterion the confirmed (in interviews) increase in reliability and usefulness of HEAVEN scenarios for urban planners.

Data description and analysis

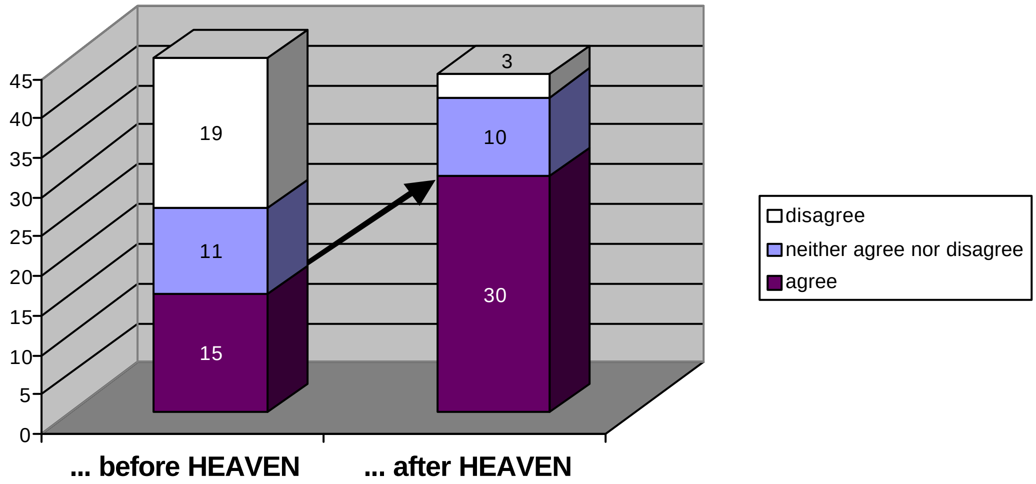
The analysis was based on seventy interviews of professional users from Berlin (19), Leicester (10), Prague (16), Rome (13), and Rotterdam (10). Forty-five of these interviews were specifically geared to assess the usefulness of environmental information provided through HEAVEN. The additional twenty-five interviews were conducted with professional users to assess the increased quality and usefulness of data entered in the common repository and scenario calculation. Despite the differences between the interview types, both interviews contained a few commonly formulated general questions.[18]

It had to be considered that the relatively low number of interviews as well as the relatively short time of actual availability of HEAVEN system limited the evaluation of usefulness for urban planning. However, the analysis revealed some indicative and positive results.

As depicted in figure 18, the quality of environmental information accessible through HEAVEN significantly increased in the perceptions of professional users. For public users, a similar picture was drawn. The satisfaction with the quality of environmental information increased from 29% prior to HEAVEN to 54% after HEAVEN.

[18] The common questions in the two interviews concerned user's perceptions of quantity and quality of information provided through HEAVEN as well as of intentions for future use of HEAVEN.

Figure 18: Quality of environmental information accessible - satisfaction among professional users before and after HEAVEN

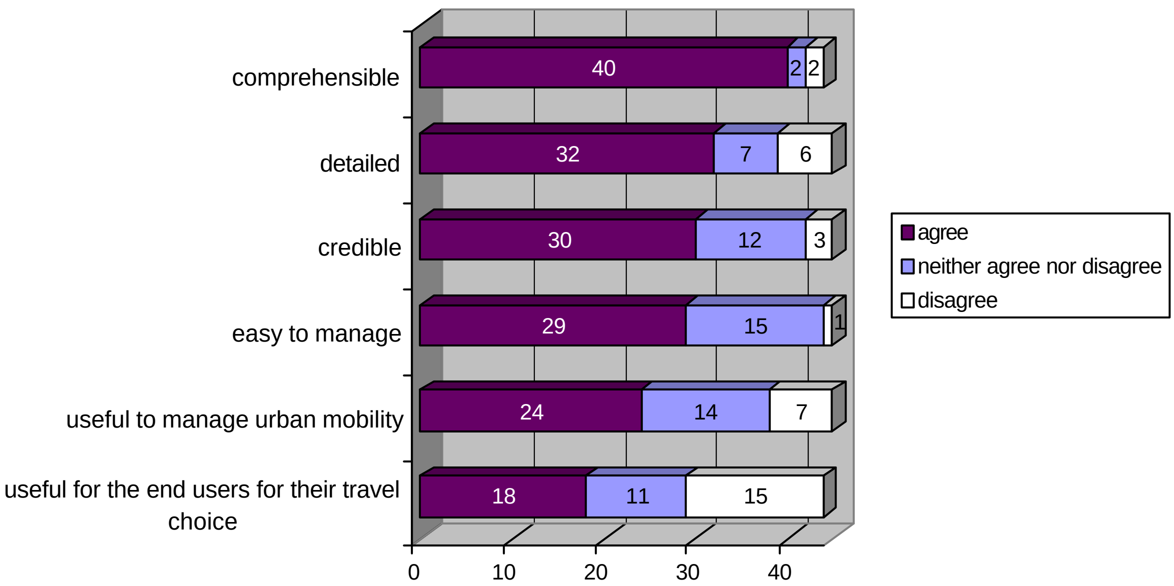


before: n=45 (0 missing); after: n=43 (2 missing)

In the views of professional users, it was revealed that HEAVEN was able to provide information in a comprehensible manner (see figure 19 below). Roughly two out of three professional users perceive the information provided as detailed, credible, and easy to manage.

Despite the fact that only two out of five professional users perceived the HEAVEN information as useful for the end user's travel choice, 82% of all public users used this information at least once to alter or confirm their decision to travel.

Figure 19: HEAVEN information acceptance among professional users



n=45; 44, respectively (max. 1 missing)

Responses were (only) slightly positive when referring to usefulness to manage urban mobility. Among the still existing weaknesses, some (five) professional users mentioned that layout and usability of the information platform (respective Internet site) needed to be further improved. Most identified weaknesses, however, concerned information concerning the scope of information, specific topics, and additional means of information delivery. In the following, a few "typical" statements are listed:

Scope of information:

- "Enlarge the system by including more highways in the region/province" (a user from Rotterdam)
- "The focus is on national highways; there is too little information on urban roads" (a user from Rotterdam)
- "I think it will be necessary to extend the system to the whole city" (a user from Rome)
- "HEAVEN has to be extended to a city-wide information system for traffic-related noise and air quality data" (a user from Berlin)

Specific topics:

- "The relation between emissions and health could be better addressed, especially on the website for the general public" (a user from Rotterdam)
- "Pollen counts (are missing)" (a user from Leicester)
- "Make a more clear distinction between environmental and health information. Not all the environmental information presented now is relevant for health" (a user from Rotterdam)
- "I think that to improve the system more detailed information should be given on background pollution and meteorological information" (a user from Rome)
- "There is no on-line traffic load map" (a user from Prague)

Means of information delivery:

- "Information are currently only via stationary information platforms (PC/Internet) available; one should add other modes of communication for example WAP or onboard navigation system" (a user from Berlin)
- "(…) by using VMS signs, showing comparative journey times between cars and buses" (a user from Leicester)

Alternative means of information delivery suggested by those interviewed included road signs, newspapers, radio, television, flyers, GPS-systems, WAP/SMS, and e-mail.

Interviews revealed that users were satisfied with the information in the common repository (and the HEAVEN scenarios). However, in order to be more useful for planning activities, it was suggested to add more data to the repository and to facilitate the procedures to enter data.[19] A user estimated it would take a minimum of two years for the system to run in order to build up a sufficiently large database (useful for the production of zoning maps that are used for planning).

When the system has gathered more information it will be useful for the production of zoning maps that are used for planning. For this the system has to run for two years to build up a sufficiently large database

In summary, the perceptions of professional users revealed that HEAVEN's usefulness, in particular related to urban planning. However, there is still room to improve the current system in terms of usability, amount of data, content, coverage (scope), topics covered, as well as by applying additional means of information delivery.

[19] Accordingly for the purpose of scenario calculation, interviewees suggested to add more indicators and to facilitate the procedure to add further scenarios.

5.5.3 Summary

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

Impact 5
Achievement: ✚

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.

Increased amount of data available in 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.

Improved quality of data

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.

6 Recommendations

70 recommendations derived from evaluation results

Based on the evaluation results presented in the previous chapter of this report, seventy recommendations were derived.

Table 36 below provides an overview of all recommendations structured according to the four anticipated reader types (stakeholders) of this report and four thematic issues.

The key thematic issues identified are:

Recommendations structured around 4 thematic issues

A: Improving the information base;

B: Enhancing information delivery;

C: Strengthening institutional co-operation; and

D: Increasing scope and relevance.

Each of the four key thematic issues is further detailed into individual sub-sections, for example A1 to A5. Recommendations are explained and described in a comprehensive manner according to these sub-sections.

The recommendations are tailored to the four anticipated reader types (stakeholders) of this Evaluation Report:

- HEAVEN partners for further roll-out activities they may envisage;
- Potential take-up partners for new implementations based on the experiences made and lessons learned in the HEAVEN project;
- The European Commission for setting up future programmes, initiatives, projects, etc.; and
- Evaluation professionals interested in methodological issues for future assessments.

Table 36: Recommendations by stakeholders and thematic issues

Thematic Issues		Recommendations			
		HEAVEN Partners: Further Roll-Out	Take-Up Partners: New Implementation	European Commission: Future Initiatives	Evaluation Professionals: Future Assessments
A. Improving the information base	A1 Air quality and noise assessment	A1.1 Reinforce the development of air quality assessment by combined use of monitoring and modelling tools	A1.2 Consider that savings in infrastructure investments will (over) compensate for system implementation costs	A1.3 Support promotion of HEAVEN as a system helping to save infrastructure investment costs (especially in CEE)	A1.4 Support integrated monitoring and modelling and thereby future model evaluation
	A2 Scenarios	A2.1 Improve the HEAVEN knowledge base by calculating and calibrating more scenarios	A2.2 Define needs for basic scenarios before starting implementation	A2.3 Provide sufficient resources to allow for an extension of the evaluation scope to include qualitative scenario analysis	A2.4 Promote evaluation of comparable scenarios in target cities
	A3 Geographic "resolution" and area of description	A3.1 Evaluate the feasibility of increasing resolution and the size of the domain described (following user requests)	A3.2 Define appropriate levels of initial geographic resolution, but be aware that user expectations will grow quickly with a functioning system		
	A4 Product bundling	A4.1 Define different releases of the HEAVEN product for different types of implementation sites	A4.2 Establish clearly the needs and expecta-tions on the DSS beforehand	A4.3 Promote the use of scalable and open modular systems	A4.4 Ensure comparability of different "sizes" (of HEAVEN) in the evaluation exercise
	A5 Modelling approach	A5.1 Reinforce roadside accuracy description; apply integrated modelling tools		A5.2 Promote the development of tool improvement related to roadside description	

Thematic Issues		Recommendations			
		HEAVEN Partners: Further Roll-Out	Take-Up Partners: New Implementation	European Commission: Future Initiatives	Evaluation Professionals: Future Assessments
B. Enhancing information delivery	B1 Effectiveness	B1.1 Re-assess user needs in order to maintain high effectiveness of the system features and capabilities	B1.2 Ensure a thorough user needs assessment for the new implementation area		
	B2 Efficiency	B2.1 Identify areas where efficiency could be increased with modest effort (or in a resource-efficient way)	B2.2 Consider that significant efficiency gains can be made when calculating implementation costs	B2.3 Ensure that sufficient resources are allocated to allow for thorough monetarisation of benefits and costs (CBA) in future project/programme evaluations	B2.4 Consider monetarisation as a powerful argument, but take into account that it requires sufficient time, data etc.
		B2.5 Define an internal training programme in using HEAVEN products	B2.6 Involve future users in development and arrange for successful training		
		B2.7 Further develop methods and tools to gather model input data	B2.8 Consider state-of-the art (HEAVEN) data structure	B2.9 Support expansion of the information base, harmonisation and standardisation	
		see also section C below			
	B3 User friendliness	B3.1 Build on experiences and emphasise user friendliness and understandability of complex issues	See B1.2	B3.2 Promote initiative to harmonise and standardise information delivery	B3.3 Conduct intermediate usability analysis

Thematic Issues		Recommendations			
		HEAVEN Partners: Further Roll-Out	**Take-Up Partners: New Implementation**	**European Commission: Future Initiatives**	**Evaluation Professionals: Future Assessments**
	B4 Information to the public	B4.1 Consider using the HEAVEN bulletin as a "marketing tool" for sustainable transport policies	B4.2 Analyse information needs of stakeholders carefully	B4.3 Emphasise the need for active information to the public	B4.4 The bulletin provides a good example where evaluation needs can positively influence product development
		B4.5 Increase the scope and allow customisation of the bulletin ("my HEAVEN")	B4.6 Follow an extendable and open concept for information delivery		
		B4.7 Consider additional means of information delivery	See B4.7	B4.8 In promoting new means of information delivery take into account emerging technologies (IST)	
		B4.9 Further develop methods of assessment to personal exposure to pollution			

	Thematic Issues		Recommendations			
			HEAVEN Partners: Further Roll-Out	Take-Up Partners: New Implementation	European Commission: Future Initiatives	Evaluation Professionals: Future Assessments
C. Strengthening institutional co-operation	C1	Horizontal (sectoral) co-operation on the local level	C1.1 Continue to address inter-institutional co-operation as a key issue	C1.2 Inter-institutional co-operation is greatly supported by HEAVEN, but requires the pro-active and continued support of high-level decision makers	C1.3 Emphasise the need of institutional issues in technology development	C1.4 Assess institutional issues thoroughly and use also some quantitative indicators (in addition to a broad qualitative approach)
	C2	Vertical co-operation (across layers of government)	C2.1 Increase level vertical co-operation and use as support for local policy	C2.2 Use involvement to attract funding	C2.3 Support process	
	C3	Regional co-operation	C3.1 Enforce regional dimension of traffic management by embedding authorities of the surrounding regions	C3.2 Invite regional representatives to become part of the development process		
	C4	Non-governmental stakeholders	C4.1 Continue to involve non-governmental stakeholders in further HEAVEN activities	C4.2 Involve non-governmental stakeholders in new implementations		

Thematic Issues		Recommendations			
		HEAVEN Partners: Further Roll-Out	Take-Up Partners: New Implementation	European Commission: Future Initiatives	Evaluation Professionals: Future Assessments
D. Increasing scope & relevance	D1 Continued Evaluation	D1.1 Arrange for continued evaluation of key aspects based on a detailed analysis of current results	D1.2 Arrange for an at least twelve-month long demonstration to be evaluated	D1.3 Emphasise the need of sufficient time for evaluation in future projects	D1.4 Efficiency gains are difficult to be measured in a short demonstration period; a longer term approach is required
			D1.5 Involve personnel with good experience in evaluation	D1.6 Consider an ex-post evaluation of projects	
			D1.7 Measure progress regularly concentrating on key goals and using suitable tools		
	D2 Support of EU Directives	D2.1 Use HEAVEN as a planning and assessment tool to set up local air quality and noise action plans	See D2.1	D2.2 Support the promotion of HEAVEN as a suitable tool to meet the requirements of the air quality legislation	
	D3 Integrated "THE Policies"	D3.1 Extend HEAVEN to address in a more integrated way the definition of policies on transport - health - environment ("THE") or "well being"	D3.2 Conceive HEAVEN as a tool for data integration beyond the specific issues of air quality	D3.3 Communicate the results of HEAVEN to EU and international working groups and fora (e.g. "THE PEP" Transport, Health and Environment Pan-European Pro-grammes)	D3.4 Consider evaluating the benefits of data integration

Thematic Issues		Recommendations						
		HEAVEN Partners: Further Roll-Out		**Take-Up Partners: New Implementation**		**European Commission: Future Initiatives**		**Evaluation Professionals: Future Assessments**
D4	Wider policy implications	D4.1	Consider inclusion of new assessment topics beyond the scope of HEAVEN	D4.2	Expand the scope of HEAVEN to other types of emitters	D4.3	Promote the development and use of common indicators and clearly identified environmental targets	…
		D4.4	Identify the feasibility of environmental benchmarking (using HEAVEN tools)					
D5	EU level take-up (and beyond)	D5.1	Refine the exploitation plan, giving suitable roles to HEAVEN Partners	D5.2	Establish close contact with a comparable HEAVEN Partner as "mentor" in the take-up process	D5.3	Provide increased support to take-up and experience pro-grammes; initiate these where not existent	
		D5.4	Consider participation in take-up and experience exchange programmes					

6.1 Improving the information base (A)

A1: Air quality and noise assessment

A1.1 Reinforce the development of air quality assessment by combined use of monitoring and modelling tools

A1.2 Consider that savings in infrastructure investments will (over) compensate for system implementation costs

A1.3 Support promotion of HEAVEN as a system helping to save infrastructure investment costs (especially in CEE)

A1.4 Support integrated monitoring and modelling and thereby future model evaluation

The Framework Directive encourages cities to use the combination of monitoring and modelling when assessing air quality.

HEAVEN has successfully demonstrated the combined use of monitoring and modelling tools and thereby the information base for air quality assessment. However, it is recommended that HEAVEN partners reinforce the assessment tool development, for example, in terms of optimising the monitoring network, in order to further improve assessments. The consideration of noise data alongside air quality data will improve the idea of an integrated assessment.

The proven HEAVEN system is recommended for take-up for other municipalities or regional agglomerations (coping with air quality impairments and noise).

Savings in infrastructure costs

From an economic point of view, potential take-up partners should keep in mind that their spendings for system implementation infrastructure will be offset by savings in infrastructure costs. In this context, the European Commission is encouraged to promote the take-up of the HEAVEN system. The Central and Eastern European (CEE) accession countries may represent a particular well-suited market for HEAVEN take-up activities, not least due to the experiences gained through the project in Prague. In addition, system take-up will allow for potential comparisons across pan-European sites.

In supporting integrated monitoring and modelling, the lessons learned within HEAVEN in using evaluation “tools” will save time in future assessments and model evaluations.

A2: Scenarios

A2.1 Improve the HEAVEN knowledge base by calculating and calibrating more scenarios

A2.2 Define needs for basic scenarios before starting implementation

A2.3 Provide sufficient resources to allow for an extension of the evaluation scope to include qualitative scenario analysis

A2.4 Promote evaluation of comparable scenarios in target cities

An enhanced environmental scenario analysis was one of the major impacts of HEAVEN. Evaluation revealed that the implementation of the DSS and its related tools offered a new and efficient capability to test scenarios involving different traffic management strategies.

Feed more scenarios into the system

Using the fundamental structure HEAVEN laid out, it is now imperative to feed more scenarios into the system in order to further improve the knowledge base for decision makers. This task concerns the original HEAVEN partners as well as others who intend to use the HEAVEN system in the future.

Prior to system implementation, potential take-up partners should conduct a user needs analysis in order to determine which basic scenarios their users require. A user needs analysis should also identify "hot spot" areas and reveal the most urgent problems to be tackled. In this context, practicalities of scenario implementation should be explored and their potential impacts be estimated.

Within HEAVEN an analysis of scenario results was beyond the scope of the evaluation exercise. However, with one of the main tasks ahead being the development of homogeneous scenario descriptions, qualitative scenario analyses are necessary. Therefore, the European Commission is encouraged to provide sufficient resources to allow for an extension of the evaluation scope.

In future programmes (or projects / initiatives) involving qualitative scenario analyses, evaluators need to promote the evaluation of comparable scenarios across target cities. However, they need to be aware that certain scenarios may not be appropriate for all cities, and, in general terms, need to ensure that scenario outputs are compatible.

A3: Geographic "resolution" and area of description

A3.1 Evaluate the feasibility of increasing resolution and the size of the domain described (following user requests)

A3.2 Define appropriate levels of initial geographic resolution, but be aware that user expectations will grow quickly with a functioning system

Geographic resolution a key issue in environmental assessment

In any environmental assessment the geographic resolution is a key issue which influences the quality and the quantity of the results as well as the efforts needed to obtain the desired results.

On the one hand, there is the wish to have the area under investigation covered with a fairly high spatial resolution. This is especially appropriate for built-up areas where traffic is the main emission source. On the other hand, a high resolution calls for input data (e.g. topography) with the same degree of resolution.

Applying the modelling process to huge data sets representing a high spatial (and temporal) resolution calls for high-end hard- and software solutions to process these data in a given update interval. Moreover, the quantity of results provided by such investigations will increase significantly.

HEAVEN has significantly improved the geographical resolution especially when roadside emission and air quality are concerned. In any case, an optimisation towards the size of the areas of investigation, the desired geographical (and spatial) resolution and the efforts to process and evaluate the results is required.

One option is to use "nested" models to identify problem locations across network (global level), prior to more detailed modelling (local level).

There remains a need to ensure that geographic and related information is supplied in appropriate formats. The HEAVEN system will have to deal with information supplied in a wide range of formats from diverse systems. National mapping and information/database standards should be adhered to.

A4: Product bundling

A4.1 Define different releases of the HEAVEN product for different types of implementation sites

A4.2 Establish clearly the needs and expectations on the DSS beforehand

A4.3 Promote the use of scalable and open modular systems

A4.4 Ensure comparability of different "sizes" (of HEAVEN) in the evaluation exercise

HEAVEN successfully developed and demonstrated a DSS enabling the evaluation of environmental effects of TDMS in large urban areas. After completion of the project, commercial exploitation of this proven (by means of the evaluation exercise) system is now intended, and the European Commission is encouraged to promote the further use of HEAVEN as a scalable and open modular system.

Modular approach

Much like in the six HEAVEN cities, different pre-conditions and circumstances will need to be considered in each potential take-up cities, for example, in terms of traffic volume, fleet composition, meteorological situations, etc.

Therefore, HEAVEN partners should follow a modular approach and define different releases of their "product" customised to the needs of the different types of potential implementation sites.

Take-up partners themselves, on the other hand, need to identify the needs and expectations on the DSS by the various stakeholders, such as traffic engineers, urban planners and environmental officers. Based on these needs and expectations, a consolidated view (on the DSS) should be reached prior to system implementation.

HEAVEN made considerable efforts to ensure commonality (in terms of impacts, indicators, and assessment methods) in its evaluation exercise. "Commonality" as an approach to evaluation is recommended for future comparable assessments

A5: Modelling approach

A5.1 Reinforce roadside accuracy description; apply integrated modelling tools

A5.2 Promote the development of tool improvement related to roadside description

Nowadays, environmental models play a key role in the assessment of impacts of traffic on air quality and noise in urban areas. In contrast to point related monitoring campaigns the application of appropriate and accurate models allows for a far better spatial coverage of an area or even the whole city. Moreover, modelling is the only technique which offers the possibility to evaluate the likely effects of planned TDMS prior to their costly implementation. The calculation and evaluation of well defined short- and long term scenarios supports tactic and strategic decisions and provides a concrete perspective for sustainable development for cities.

adequacy and accuracy of applied models essential for effective decision support

In the context of environmental modelling, the adequacy and accuracy of the applied models is essential for effective decision support. Basically the whole integrated modelling chain needs to meet certain quality criteria (e.g. those criteria set out in the Framework Directive). It is noteworthy to stress that beyond the model itself required input data (e.g. emission factors, fleet composition, topography, meteorology) have a significant influence on the outcome of the modelling results.

In HEAVEN, considerable efforts have been undertaken to select the appropriate models, to investigate and improve the quality of these models and apply them under real-life conditions in the demonstration phase of the project. In future activities these effort need to be continued in order to ensure that the description of the environmental situation in urban areas becomes more accurate.

6.2 Enhancing information delivery (B)

B1: Effectiveness

B1.1 Re-assess user needs in order to maintain high effectiveness of the system features and capabilities

B1.2 Ensure a thorough user needs assessment for the new implementation area

In the analysis of questionnaires and interviews, HEAVEN users had the opportunity to express what the main weaknesses of the system and the means of information delivery were. While not a user needs analysis, this evaluation exercise revealed that professional users as well as public users had clear expectations in terms of the type of information they desire (health, traffic volume, more detailed data, etc.) and suggested additional means of information delivery ranging from TV, radio, and road signs to WAP and SMS.

Re-assessment of user needs

Therefore, it is recommended to the HEAVEN partners to frequently re-assess the needs of their users and thereby to maintain the high effectiveness of the system features and capabilities. In such a user needs analysis, HEAVEN partners always need to bear in mind that the public and professional users have differing needs.

Investments in integration, as defined in the HEAVEN system, are cost effective if they are consistent with the needs of the users. Stakeholders who will use and benefit from the system should drive the design and implementations. Hence, potential take-up partners are encouraged to conduct a thorough user needs analysis in the implementation area prior to system implementation.

B2: Efficiency

B2.1 Identify areas where efficiency could be increased with modest effort (or in a resource-efficient way)

B2.2 Consider that significant efficiency gains can be made when calculating implementation costs

B2.3 Ensure that sufficient resources are allocated to allow for thorough monetarisation of benefits and costs (CBA) in future project/programme evaluations

B2.4 Consider monetarisation as a powerful argument, but take into account that it requires sufficient time, data etc.

B2.5 Define an internal training programme in using HEAVEN products

B2.6 Involve future users in development and arrange for successful training

B2.7 Further develop methods and tools to gather model input data

B2.8 Consider state-of-the art (HEAVEN) data structure

B2.9 Support expansion of the information base, harmonisation and standardisation

Optimisation of monitoring network to increase efficiency

Evaluation revealed that one of the major improvements in efficiency was clearly the possibility to assess the environmental impacts of various traffic measures prior to their costly implementation. Another area was the efficient exchange of data across departments involved in transport and environment. Moreover, the optimisation of monitoring networks though the application of the HEAVEN DSS would also increase efficiency. HEAVEN partners are encouraged to identify areas where efficiency could be increased in a resource-efficient way in the future.

Since the system was successfully demonstrated and the HEAVEN cities committed themselves to operate the system beyond the lifetime of the project training courses for the staff of the departments involved would improve the efficiency of the use of the DSS. Within HEAVEN, large gains in efficiency were made in the analysis of noise scenarios in Leicester as staff became more familiar with the system.

Experiences gained in HEAVEN have shown that the development of system (or take up) is best achieved by means of a participatory approach. Once the system is place in a take-up location, continuous training should be offered to the users. The integration in HEAVEN brings together models across a number of disciplines, namely traffic, planning, transport operations, air quality, noise, exposure and health. For this reason it will be essential to offer appropriate cross-disciplinary training.

Investment in training of staff has to also consider the continued evolution of the system in response to the availability of additional data streams or to response to new government directives etc.

The European Commission should ensure sufficient funding to conduct monetary analyses. If applied in a project setting (evaluation in monetary terms), the relatively high costs to conduct monetary analyses need to be considered. In addition, it could be difficult to collect appropriated data in the required format to allow monetarisation to take place, in particular if no ideal base case is available to allow direct comparisons. On the other hand monetarisation (cost benefit analysis) could provide powerful arguments for the efficiency of a system.

HEAVEN partners are encouraged to further develop methods and tools to gather model input data. These data would “feed” the environmental models (topography, fleet composition) and ensure an appropriate evaluation (for example demographic data) of the modelling results which is usually a time consuming and costly process. Improvement in methods to gather such data would make the application of the HEAVEN system more efficient. Examples include the collection of street typologies through the use of satellite data and the assessment of regional/local vehicle fleet compositions through automatic numberplate recognition.

Standardised consistent data structure

At the heart of the HEAVEN system is a database. It is essential that a standardised consistent data structure will be maintained across all users and providers involved with the HEAVEN

Finally, it is recommended that the European Commission supports the expansion of the information base, harmonisation and standardisation. Efficiency gains in this regard require the complete co-operation of all stakeholders.

B3: User friendliness

B3.1 Build on experiences and emphasise user friendliness and understandability of complex issues

B3.2 Promote initiative to harmonise and standardise information delivery (indices)

B3.3 Conduct intermediate usability analysis

Information delivery to the user requires the consideration of the user needs. Evaluation revealed that the amount of data increased, a fact that as confirmed by the perceptions of all users (professional and public). In addition, the perceived quality of data increased among both user groups. In this sense, HEAVEN was successful in delivering data to its users and to make clear and explain complex issues.

Evaluation also revealed that some users require more functionality of the information platform; others made suggestions to the design of the platform, etc. Users would quickly loose interest (in HEAVEN) if information was not delivered in a user-friendly way. Therefore, it is important that HEAVEN partners build on the experiences they gained through interaction with their users during the project.

A consequence of taking the user's needs into account could be to customise presentation of data to different user groups with different interest in the data provided (for example public users versus professional users).

The European Commission is encouraged to promote standardisation (across countries). Indices are a means of comprehensive information delivery, however, they need to be understandable, meaningful, use the same units (standardisation), simply aim to have the same meaning to all users.

Intermediate user needs analysis required

In future projects, intermediate usability analysis should be integrated in the workplan, thereby allowing for adjustments still during the lifetime of the project.

B4: Information to the public

B4.1 Consider using the HEAVEN bulletin as a "marketing tool" for sustainable transport policies

B4.2 Analyse information needs of stakeholders carefully

B4.3 Emphasise the need for active information to the public

B4.4 The bulletin provides a good example where evaluation needs can positively influence product development

B4.5 Increase the scope and allow customisation of the bulletin ("my HEAVEN")

B4.6 Follow an extendable and open concept for information delivery

B4.7 Consider additional means of information delivery

B4.8 In promoting new means of information delivery take into account emerging technologies (IST)

B4.9 Further develop methods of assessment to personal exposure to pollution

News bulletin as marketing tool

The news bulletin was a side-product of the HEAVEN evaluation exercise and could be used as a “marketing tool” for sustainable transport policies. It represented a useful means to disseminate air quality (and noise) information to professional as well as to public users. A particularly useful example of a news bulletin was the one created by the project partners in Paris. It emphasises the need for further development and use of the news bulletin in future HEAVEN-related projects or activities..

Evaluation showed that users are interested in receiving information that is directly related to their personal environment (i.e. the situation in their neighbourhood, the effect on their personal health, etc.). HEAVEN partners should consider customisation of the news bulletin or the information platform, in general. This would allow users a “my HEAVEN” perception. “Cookies” or similar technology could be used to define a personalised website.

The evaluation experience shows that take-up partners of the HEAVEN system need to consider the information needs of the users. In Leicester for example, the idea of having a noise emissions section within the bulletin was actually dropped through limited perception of its usefulness. Users were less concerned with absolute noise levels or emission levels, than with the effects on their health or on the value of their properties.

In general, evaluation revealed that methods of assessment to personal exposure to pollution needed to be developed.

HEAVEN take-up actions should follow an extendable and open concept for information delivery. It should be considered to disseminate information by means alternative to the Internet-based information platform. While the Internet provide an ideal medium for information delivery, evaluation revealed that users demand information to be delivered also by the alternative means of road signs, newspapers, radio, television, flyers, GPS-systems, WAP/SMS, and e-mail.

In this context, the European Commission should promote “new” means of information delivery. In doing so, they will need to take emerging technologies and, in general, the dynamics of the fast moving IST-environment into account.

6.3 Strengthening institutional co-operation (C)

C1: Horizontal (sectoral) co-operation on the local level

C1.1 Continue to address inter-institutional co-operation as a key issue

C1.2 HEAVEN supports inter-institutional co-operation, but requires pro-active and continued support of high-level decision makers

C1.3 Emphasise the need of institutional issues in technology development

C1.4 Assess institutional issues thoroughly and use also some quantitative indicators (in addition to a broad qualitative approach)

Improved institutional co-operation between transport and environmental departments was a major goal of HEAVEN.

HEAVEN suitable tool to improve institutional co-operation

While the data base was relatively weak (in terms of amount of questionnaires and interviews available), evaluation nevertheless revealed the potential of HEAVEN to be a suitable tool to improve institutional co-operation. After some experience was gained by the involved HEAVEN partners, a critical analysis of remaining barriers for institutional co-operation is needed.

In the future assessments, the use of quantitative indicators, in addition to a broad qualitative approach, should be encouraged in order to ensure a sufficient database.

Evaluation has shown that technical tools and a common database are the pre-requisite to improve institutional co-operation. However, effects on institutional co-operation are more long-term to be measured with confidence (an argument also for ex-post evaluation). In evaluation, it also needs to be taken into account that trustful and institutionalised forms of co-operation are usually difficult to achieve and that the "human factor" can become a major barrier to IT-use.

The European Commission is encouraged to emphasise the need of issues in technology development. A joint process of tool development / integration and common set-up / maintenance of databases supports institutional co-operation.

Positive experiences of "champions", i.e. those most advanced in terms of institutional co-operation, must be made part of the mainstream through high-level (political decision makers') commitments for pro-active co-operation.

C2: Vertical co-operation (across layers of government)

C2.1 Increase level of vertical co-operation and use as support for local policy

C2.2 Use involvement to attract funding

C2.3 Support process

Local action plans to be produced

Air quality directives formulate the need for action plans to be transposed into national legislation (new legislation makes a case for additional funding and other support). National and regional governments should be interested to use advanced cities, such as those that participated in HEAVEN, as good examples in order to increase the level of vertical co-operation.

Air quality and noise problems, however, are not locally-limited problems. These are regional issues that require a wider (than local) institutional co-operation.

European Commission should support the process and help to raise awareness among member states and Committee of the Region representatives.

C3: Regional co-operation

C3.1 Enforce regional dimension of traffic management by embedding authorities of the surrounding regions

C3.2 Invite regional representatives to become part of the development process

Regional dimension of air pollution and noise

Tackling air pollution and problems with noise are concerns with a regional dimension. Close interactions between inner cities and surrounding areas are well known.

Within HEAVEN, the cities of Paris and Leicester already successfully involved authorities of the surrounding region(s). Other cities should follow these examples and enforce a regional dimension of traffic management.

In order to strengthen the urban/regional co-operation in take-up areas, regional representatives could be invited to become part of the development process.

C4: Non-governmental stakeholders

C4.1 Continue to involve non-governmental stakeholders in further HEAVEN activities

C4.2 Involve non-governmental stakeholders in new implementations

TDMS are based on a “carrot” (e.g. “good” public transport) and “sticks” (e.g. access restrictions) approach. Awareness raising and broad consultation activities are instrumental in making this dual approach understandable and acceptable. In this context, consultations must involve public, private, and popular sectors (interest groups) with a particular focus on non-governmental organisations.

Raising user awareness and acceptance

The continued involvement of non-governmental stakeholders in further HEAVEN activities and implementations (and decision making?) will contribute to user awareness and acceptance. Evaluation has already shown HEAVEN can become a tool to convince the public, for example to change travel behaviour, especially when health information is included.

6.4 Increasing scope and relevance (D)

D1:	Continued evaluation

D1.1 Arrange for continued evaluation of key aspects based on a detailed analysis of current results

D1.2 Arrange for an at least twelve-month long demonstration to be evaluated

D1.3 Emphasise the need of sufficient time for evaluation in future projects

D1.4 Efficiency gains are difficult to be measured in a short demonstration period; a longer term approach is required

D1.5 Involve personnel with good experience in evaluation

D1.6 Consider an ex-post evaluation of projects

D1.7 Measure progress regularly concentrating on key goals and using suitable tools

HEAVEN will be used after the end of the project. The evaluation of the HEAVEN system should not end with the completion of this project and its Evaluation Report. When HEAVEN will be further developed by previous project partners or implemented by new partners, arrangements should be in place for continued evaluation of, at least, key aspect. Apparently, methodology and experiences gained in the HEAVEN evaluation could be utilised.

During the evaluation exercise, it became evident that a short (six month) demonstration phase was a constraining factor. Take-up partners should consider a minimum of twelve months demonstration phase for evaluation, since this would not only cover all seasons and thereby meteorological conditions, but would also allow for the system to make its effects (more) visible. Only in such a longer demonstration period, efficiency gains will be measurable in a suitable way.

Ex-post evaluation to be considered

The European Commission should emphasise that personnel with experience in evaluation are involved in upcoming projects (for example take-up activities). They should also stress the need for sufficient time for evaluation in future projects and even consider an ex-post evaluation of projects or entire programmes. This is particularly true for IST-projects where many effects of technologies and systems developed will only be completely visible in the long run (few years).

D2: Support of EU Directives

D2.1 Use HEAVEN as a planning and assessment tool to set up local air quality and noise action plans

D2.2 Support promotion of HEAVEN as a suitable tool to meet the requirements of the air quality legislation

Air quality and noise action plans need to be set up by local authorities as laid out in the respective European Commission Directives. HEAVEN can be utilised as a planning and assessment tool to set up such local plans.

Increasingly sophisticated knowledge base

With an increasingly sophisticated knowledge base as a foundation for action plans, there will be the need to refine "tool boxes" over time. In addition, the simulation of complex effects may prove necessary before action plans are transformed into official policy-style documents. Evaluation showed that HEAVEN can be a suitable tool to support these needs. The European Commission is, therefore, encouraged to promote HEAVEN as such a tool.

D3: Integrated "THE Policies"

D3.1 Extend HEAVEN to address in a more integrated way the definition of policies on transport - health - environment ("THE") or "well being"

D3.2 Conceive HEAVEN as a tool for data integration beyond the specific issues of air quality

D3.3 Communicate the results of HEAVEN to EU and international working groups and fora (e.g. "THE PEP" Transport, Health and Environment Pan-European Programmes)

D3.4 Consider evaluating the benefits of data integration

THE: Transport Health Environment

"THE PEP"[20], i.e. the Transport, Health and Environment Pan-European Programme, was adopted at the second high-level meeting on Transport, Environment and Health in Geneva, 5 July 2002. It brings together and focuses the UNECE (United Nations Economic Commission for Europe) and WHO - World Health Organisation/ Europe activities on key priorities:

- integration of environmental and health aspects into transport policies and decisions,
- the shift of the demand for transport towards more sustainable mobility,
- urban transport issues.

HEAVEN clearly addressed the transport and environment as its key issues. Health issues were not yet covered in a sufficient manner. However, the system proved feasible to integrated all three aspects, and health effects are intended to be included in the future to a larger extent.

All partners of the project, including the European Commission, should make an effort to communicate the positive results obtained in HEAVEN to "THE PEP" as well as to other working groups and fora.

Current and future HEAVEN partners are encouraged to extend the system as a "module" in a much larger strategic information system to address such complex issues as transport, environment and health in an integrated and efficient manner.

20 Source: PEP website (www.unece.org/the-pep)

Therefore, HEAVEN should be conceived as a suitable tool for data integration beyond the specific issues of air quality. In Leicester, one project aim was to integrate the existing air quality system with a noise model and provide the platform for TDMS evaluation. When assessment can be achieved for traffic, air pollution and noise, it is important that the objectives against which the scenarios are to be evaluated are clearly specified as the different components of performance may be in conflict.

In general, it is a major challenge to achieve changes in transport demand patterns, while at the same time maintaining economic growth, inward investment, etc.

The evaluation of benefits of data integration is a non-trivial and may require different weights to reflect the relative importance of the diverse sources of data and their relative levels of accuracy.

D4: Wider policy implications

D4.1 Consider inclusion of new assessment topics beyond the scope of HEAVEN

D4.2 Expand the scope of HEAVEN to other types of emitters

D4.3 Promote the development and use of common indicators and clearly identified environmental targets

D4.4 Identify the feasibility of environmental benchmarking (using HEAVEN tools)

The HEAVEN system does not need to be limited to air quality and noise. It is capable of including new assessment topics which go beyond the scope of the completed project, such as assessing the effects of traffic congestion and ambient air quality on inward investment.

HEAVEN expandable to other types of emitters

The scope of HEAVEN could be expanded to other types of emitters, such as industry, airports, households, etc. By doing so, decision makers will have available a more complete picture ranging from the inclusion of all emitters of interest to effects.

It could be considered to enhance the scope and relevance of HEAVEN by identifying the feasibility of environmental benchmarking by means of HEAVEN tools. In this context, the European Commission should consider promoting the development and use of common indicators and clearly identified environmental targets.

D5: EU level take-up (and beyond)

D5.1 Define a concrete exploitation plan, giving suitable roles to HEAVEN Partners

D5.2 Establish close contact with a comparable HEAVEN Partner as "mentor" in the take-up process

D5.3 Provide increased support to take-up and experience programmes; initiate these where not existent

D5.4 Consider participation in take-up and experience exchange programmes

Prague a HEAVEN promoter in CEEC

HEAVEN has already produced an exploitation plan for the project as a whole. In order to enable and facilitate take-up nationally and internationally, each city should define its own exploitation plan clearly highlighting the particular strengths of this city. In this sense, Prague could adopt the role of being a promoter for HEAVEN in fellow Central and Eastern European Countries.

Accordingly, take-up partners should establish close working relationships with a HEAVEN "mentor" city which is most suitable to their needs and requirements. Apparently, such a role required a considerable, but rewarding, effort for the HEAVEN "mentor" cities. In addition to take-up activities, it is recommended that HEAVEN cities as well as other project partners participate in experience programmes.

The European Commission could play in important role in organising and supporting the EU level (or even world-wide) take-up process. Consideration should be given to HEAVEN in existing take-up activities or programmes.

7 Conclusions

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 are 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.[21]

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

Table 37: 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	**++**
<u>Impact 3A: For professional users (i.e. everybody but the public)</u>	++
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	+*
<u>Impact 3B: For public users</u>	++
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]

Impact	Achievement
2: The low number of questionnaires and interviews, respectively, hampered the analysis.	
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.

Impact 1 Achievement: +

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

Increased network coverage

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 NO_2 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 O_3 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.

Good achievements concerning accuracy of roadside description

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, NO_2, CO, and C_6H_6). 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.

Quasi real-time noise modelling

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.

HEAVEN achieved impact 2 - enhanced environmental scenario analysis.

Impact 2 Achievement: ++

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.

Efficient and useful tool for analysis 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 NO_2 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 NO_2.

Five so-called "black and white" scenarios comprising different strategies of traffic management were tested within HEAVEN[22]:

- 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).

Time to produce assessments reduced

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.

[22] Results of the scenario analysis are summarised in annex 9 to this Evaluation Report.

Impact 3
Achievement: ++

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.

Improved time resolution and reduced delivery time

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.

HEAVEN news bulletin a useful by-product of evaluation exercise

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 4
Achievement: ✚

HEAVEN partially achieved impact 4 – improved institutional co-operation.

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.

Only few interviews available for analysis

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.

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 a suitable tool to improve institutional co-operation

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.

Impact 5 Achievement: ✚

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.

Increased amount of data available in 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.

Improved quality of data

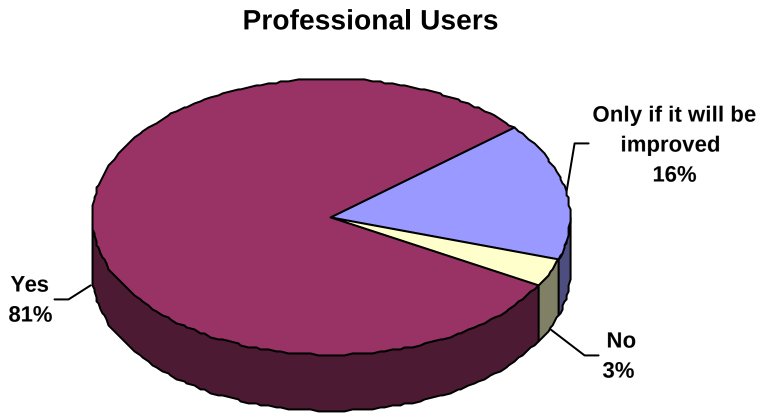
In addition to the perceived quantity of data available, their quality significantly improved in the views of professional and public users as a consequence of the HEAVEN system introduction.

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.

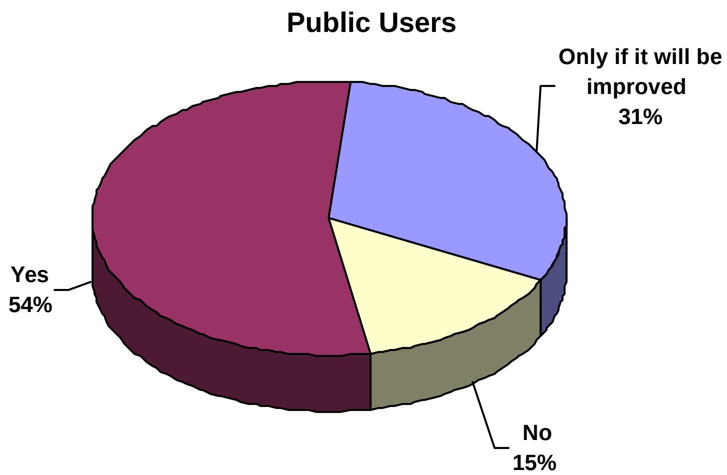
While being a successful project, it is clear that HEAVEN should be further improved. As seen in figure 20, many professional users (16%) as well as public users (31%) stated that they would only use HEAVEN in the future if it was improved. This Evaluation Report, therefore, formulated recommendations (see chapter 6) to:

- Improve the information base,
- Enhance information delivery,
- Strengthen institutional co-operation, and
- Increase scope and relevance

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



n=62 (8 missing)



n=109 (29 missing)

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.

Promising future for the system developed

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Abbreviations and Acronyms

Table 38: Abbreviations and Acronyms

Abbreviation and Acronym	Explanation
5FP	Fifth Framework Programme, also abbreviated FP5
6FP	Sixth Framework Programme, also abbreviated FP6
AC	Assistant Contractor within the HEAVEN consortium
AIRVIRO	An air quality management system supplied by the HEAVEN project partner SMHI
C	Co-ordinator within the HEAVEN consortium
C_6H_6	Benzene
CEEC	Central and Eastern European Countries
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DSS	Decision Support System
EU	European Union
HEAVEN	Healthier Environment through Abatement of Vehicle Emissions and Noise; IST project IST-1999-11244
IST	Information Society Technologies
IT	Information Technologies
L_{Aeq}	Equivalent continuous sound pressure level, expressed in terms of 'A-weighted' decibels
L_{DAY}, $L_{EVENING}$, L_{NIGHT}, L_{DEN}	New Europe wide noise assessment criteria, based on the weighted sum of L_{Aeq} levels throughout defined day, evening, night and whole 24h periods respectively.
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NOx	Nitrogen oxides, or NOx, is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colourless and odourless. However, one common pollutant, nitrogen dioxide (NO_2) along with particles in the air can often be seen as a

Abbreviation and Acronym	Explanation
	reddish-brown layer over many urban areas. Nitrogen oxides form when fuel is burned at high temperatures, as in a combustion process. The primary sources of NOx are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels. U.S. Environmental Protection Agency (http://www.epa.gov/air/urbanair/nox/what.html)
Pb	Lead
PC	Principal Contractor within the HEAVEN consortium
PM10	PM – particulate matte which passes through a size-selective inlet with a 50% efficiency cut-off at 10 µm aerodynamic diameter (Directive 1999/30/EC).
RTD	Research and Technology Development
SC	Sub-contractor within the HEAVEN consortium
SCOOT	Split Cycle Offset Optimisation Technique –The real-time urban traffic control system used in Leicester
SMS	Short Messaging System
SO_2	Sulphur Dioxide
TDMS	Transport Demand Management Strategy
TRIPS	TRIPS is a transport planning software package used in the HEAVEN city of Leicester. The abbreviation stands for Transport Improvement Planning System
VMS	Variable Message Sign
VOC	Volatile Organic Compound
WAP	Wireless Application Protocol
WP	Workpackage