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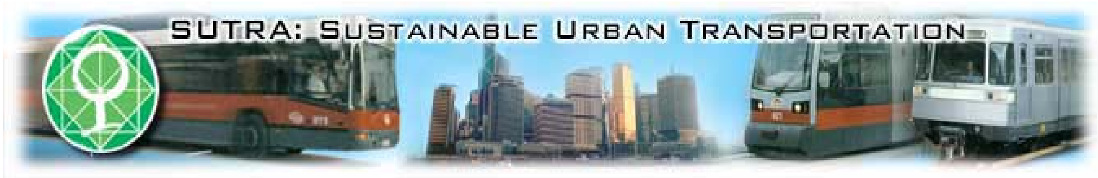

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Executive Summary

Transportation problems are among the most pressing strategic development problems in many cities, often a major constraint for long-term urban development in general. In SUTRA – Sustainable Urban Transportation (EVK4-1999-00006P) these problems are addressed with a consistent and comprehensive approach and planning methodology that helps to design strategies for sustainable cities. This includes an integration of socio-economic, environmental and technological concepts to improve forecasting, assessment and strategic policy level decision support. It uses traffic equilibrium modelling to evaluate alternative transportation policies, including multi-modal systems and their relations to land use, technological development, socio-economic development, and spatial and structural urban development in general.

The present report, "*D14 Cross-comparison and Benchmarking: general strategies for urban development*", represents the final deliverable of SUTRA Work Package 14. It describes and discusses a benchmarking exercise based on the quantification of an opportunely enlarged set of urban transport indicators for a suite of cities and urban agglomerates across Europe.

The choice of indicators is made coherently with the basic set already introduced and defined in "D.8 - Sustainability Indicators, the elaboration and comparison of scenarios" reported in "D.12 (Scenario analysis – city and summary report)" and D.13 "(Scenario comparison and multi-criteria assessment)".

Contents

1 Introduction

This report *D14: Cross-comparison and Benchmark: general strategies* is the final deliverable of Work package 14 of SUTRA – Sustainable Urban Transportation (EVK4-1999-00006P). This introductory section describes the overall content of the Report and how it fits into the overall strategy of SUTRA.

The primary objective of SUTRA is to develop a *consistent and comprehensive approach and planning methodology* for the analysis of urban transportation problems, that helps to design strategies for sustainable cities. 80% of the European Union's population live in urban areas. There is therefore a growing demand for an assessment of the quality of life and environmental impact in European cities.

The project is based on the elaboration of scenarios of urban development using transport, emission, air quality and energy system analysis models. Scenarios are defined for each of the cities participating in the project: a base line, a set of common and a set of city specific development strategies, in terms of demographic, socio-economic, spatial, and technological developments over the next thirty years are developed. The variation between the different scenarios and the different case studies are reflected and synthesized through an opportune set of sustainable transport indicators, whose definition was the aim of Work package 8: Sustainability Indicators.

In all European countries personal mobility has increased tremendously during the past decades due to economical and political changes. Economic wealth made travelling affordable to the majority of European citizens.
Reduced working hours resulted in higher time budgets for leisure time activities. Sub urbanisation and higher housing standards reduced the density of European cities. City functions like dwelling, work, shopping, leisure and recreation have been separated. Industrial and commercial centres, shopping malls and residential areas are been built in the periphery of the cities. As a consequence the number and average length of everyday trips is increasing.
Improved traffic means (e.g. vehicles, roads) were at the same time a necessary condition for absorbing the increased traffic loads and a cause of a further rise of traffic demand, since people tend to make longer journeys as soon as travelling becomes faster and more comfortable.

The increase of mobility was mainly realised by the use of the private car. This has resulted in traffic problems that threaten the quality of life: air pollution, traffic congestion, accidents, noise, and fragmentation of the landscape. The capacities of the road networks have reached their limits, a further expansion of private car use would result in reduced mobility and economic damage due to increasing congestion problems.

Progress towards a more sustainable transport system has become an imperative in the European Union (EU), as in many other parts of the world.

The Gothenburg European Council has singled out the transport sector as one of the four priority areas where sustainability policy development has to be put on a faster track. Achieving such progress requires better integration of environmental considerations into transport policy and a clear and quantitative picture of the sector and the way in which it is developing. These problems are most serious in urban areas because of the density of the population and have been aggravated by deficiencies of city planning in the past.

An informative representation of the complex dynamic in urban areas can be schematically obtained by means of an opportune set of indicators. The use of indicators of sustainable development does not only guarantee a rigorous conceptual framework for the analysis of each city, but also provides a powerful mean for cross-comparison ranking and benchmarking over a larger set of urban situations, and a powerful tool for communication.

1.1 Objectives

The primary objectives of WP 14 “Cross-comparison and benchmarking general strategies for urban development’ are:

- the identification, collection, homogenisation and comparative analysis of sustainable transport indicators that have been quantified for cities and urban agglomerates across Europe in order to describe the scenarios within a larger group of (current situation) cities in a sort of benchmarking exercise;
- a first step towards the identification of generic strategies for sustainable urban transport based on the comparative analysis of the most promising scenarios from each test application site;
- a first step towards the identification of promising strategies for sustainable urban transportation.

These objectives meet the requirements of the main aim of SUTRA, to develop a consistent and comprehensive approach and planning methodology for the analysis of urban transportation problems, that helps to design strategies for sustainable cities.

In particular, the report is organized as follows:

- an introduction to the problematic and methodology of urban benchmarking and cross-comparison (Section 2);
- a discussion of the main relevant sources of sustainability indicators, available in literature, that have been quantified on an urban scale (Section 3);
- a presentation of the criteria used for the selection and merging of the collected indicator data bases for European cities and urban agglomerates (Section 4);

- a report of cross-comparison and ranking analysis, aimed at a benchmarking exercise in the field of sustainable transport at urban level and its divulgation via an Internet interactive web page (Section 5).

The report ends with a literature review as well as conclusions and future outlooks (Section 8 and Section 6, respectively)

1.2 Description of work

Each SUTRA city test case has defined different scenarios which examine the current base line situation and a set of possible development strategies in terms of transportation by means of a set of modelling tools able to translate the evolution of the transportation system and the related environmental impacts in terms of an adequate set of sustainable transport indicators. These development scenarios reflect changes in terms of demographic, socio-economic, spatial and structural (land-use), and technological aspects for a 30-year horizon (2030).

A multi-criteria evaluation methodology has been chosen to analyse the obtained set of scenarios. Based on reference point optimisation, such an analysis makes it possible to rigorously and systematically compare a large set of indicators over a large set of cities and scenarios efficiently and effectively. This should ensure that the overall goal of deriving relevant policy strategies for planning a sustainable city can be achieved.

A set of indicators has been pre-defined in WP 8 and 10 according to the DPSIR structure. Indicators defining sustainability are a fundamental part of this analysis as they help to evaluate and measure progress, the distance to a chosen target and failure of plans or their implementation. They are especially important as a tool for cross-comparison over a large set urban scenarios.

This analysis and interpretation part of the project, has been accompanied by a **benchmarking exercise** where the promising scenarios are compared against a larger set of cities to find patterns and trends from which policy implications for the implementation of the optimal strategies can be identified. The methodology and the main results of this benchmarking exercise is the subject of the present report.

2 Benchmarking: background and methods

2.1 Background

Benchmarking is a practical tool for improving performance by learning from best practices and the processes by which they are achieved.
The potential of benchmarking as a tool to improve the quality, efficiency and sustainability of transport is considerable. Both public and private transport sectors can benefit from the systematic approach it provides to performance assessment and identification of best practice. Benchmarking also has an important role to play in defining transport policy and working towards achieving sustainable transport systems at local, regional, national and European levels.

The application of benchmarking in the transport sector demands criteria and methodologies which not only take into account quantitative data, but also qualitative data. Benchmarking is not only a tool to compare, for example, the number of buses that run on time in different cities, it also has the potential to be used to respond more effectively to passengers needs by assessing and comparing their experiences of the transport services where they live.

The opening up of the transport market to competition will increase the need of all actors, public and private, to evaluate and improve their performance in relation to the economic, social and environmental impact of transport on the citizens' of Europe.

2.2 Methods

The European Commission, Directorate-General Transport, and the European Conference of Ministers of Transport (ECMT) presented a Draft Communication on Benchmarking at a conference on “Transport Benchmarking: Methodologies, Applications and Data Needs”. The objective of the Communication is *to identify areas and examples for benchmarking and benchmarks and to initiate follow-up by other actors at policy (EU, national, regional, local) and market level (transport service providers, operators, customers) for a better exploitation of benchmarking as a tool for improving transport*.

The Communication identifies nine main benchmarking steps:

1. Identification of relevant objectives and areas
2. Selection of relevant dimensions
3. Identification of indicators and data needed
4. Data collection, analysis and assessment
5. Identification of benchmarks
6. Analysis of reasons for performance differences
7. Strategy development

8. Implementation
9. Monitoring of results

Deficiencies in the availability and quality of required data (step 4) have been found to be serious barriers in transport benchmarking, jeopardizing the success of several efforts made in this direction.

The Communication indicates that the application of benchmarking to transport policy will serve to identify 'potentials and possibilities for improving existing framework conditions for transport in order to increase the efficiency and sustainability of the transport system. In the context of promoting sustainable mobility, it states that *particular attention should be paid to the competitiveness of environmentally friendly modes and their integration with other modes. Benchmarking can support companies and policy makers in finding strategies to increase the position of these modes in the transport market*.

2.3 Key lessons learnt about the practical application of benchmarking methodology

A considerable amount of discipline is needed for benchmarking. It is necessary to **follow a defined methodological structure** based on the basic four steps: planning, analysis, integration, and action.

However, it is also necessary to **be open-minded** about ways to approach the basic steps. There are many possible approaches which can be taken and it is necessary to choose the one most suited to a particular exercise in consideration of the issue being addressed, the objectives of the exercise, the participants involved and their experience of benchmarking, the quality of the data available, and the expected outcome of the exercise.

It is important to encourage **multi-party involvement** (regulators, operators, users, planners etc.) in defining the objectives of a benchmarking exercise and agreeing on the necessary measures to implement its findings. Successful implementation depends on the willingness of all parties to contribute and cooperate.

Benchmarking should be linked to a **continuous learning process** based on **concrete action**. Benchmarks are not static and will change as best practices are identified and improved. Monitoring the implementation of an action plan will enable the identification of new improvement objectives and areas for benchmarking.

It is possible to benchmark with partners outside the transport sector, but **selecting a benchmarking partner must be done with care** and there must be clear reasons for the choice of partner. Many participants at the aforementioned conference “Transport Benchmarking: Methodologies, Applications and Data Needs” felt that they could learn more effectively and efficiently by benchmarking with partners within the transport sector.

Selling the benefits of benchmarking is one of the main challenges in gaining support and commitment for a benchmarking exercise. It is important to find a balance between presenting the ‘quick wins’ that can be gained from benchmarking and the benefits of long-term commitment to the process.

3 Cross-comparison and Benchmarking: Identification of indicators and data needed

Indicators are quantities that give a schematic and informative representation of the reality of complex systems. In the past, the use of indicators was forced to be extremely simple, since it was derived from few data and was based on limited scientific knowledge. Their relevance in assessing the state of certain system was not emphasized because it was assumed to be implicit or intuitive. When statistics was recognized as a science, the importance of indicators became crucial. The more data collection and availability increased, the more it became clear that indicators might be an effective tool to better understand and monitor complex systems. They became useful every time the performance of a system, the evolution of a process or the results of a particular action on a complex system, such as the environment, needs to be evaluated. They represent an empirical model of the reality, implicitly assuming that a complex phenomenon could be adequately represented by a limited number of variables. Under this point of view, the introduction of a set of indicators can be assimilated to the definition of a n-dimensional (where n is the number of indicators) coordinate system. The assumption is inherently made that, from a huge and continuous amount of data and information, a compact, comprehensible and reliable informative content can be extracted simply by projecting the system on this new frame of reference, whose coordinates are the indicators themselves. Any information that will not be picked up by the projection (while normal to the frame of reference) will be lost in this process of data compression. This means that a good set of indicators should be able to select most of the significant variance of the analysed data avoiding redundancies, while (contrary to statistical approaches as singular components) still keeping an immediacy in the straightforward interpretation.

After an overview of the set of indicators at the base of the SUTRA project, this section presents few international projects that, over the last decade were, or are still currently dedicated to the *quantification* of transport sustainability indicators on urban scale. Similar projects related to the *development* (i.e., not specifically to the *quantification*) of similar sets of indicators are not reviewed in this report, as they have already been analysed in the framework of Workpackage 8: *Sustainability Indicators* (see the final WP08 report).

The cities collaborating and involved in SUTRA (Thessalonica, Gdansk, Genoa, Geneva, Lisbon, Tel Aviv) differ widely in terms of culture, environmental conditions, size, economic structure, social composition and demography. Despite these differences they all face common challenges in their transportation system such as those relating to air quality, noise, traffic congestion, but also related issues such as economic competitiveness, mobility, employment, maintaining their deteriorating infrastructure and built environment while reducing social exclusion and promoting sustainable development.

The objective of the WP14 is a comparison of the indicator set describing the scenarios within a larger group of (current situation) cities in a cross-comparison and the benchmarking exercise.

This larger set have been chosen among European cities. All of them facing the same transport challenges as the SUTRA set of cities.

As a result of an intensive research on different European initiatives related to sustainable urban transport, some bibliography and internet resources and city administrations contacts, as well as the four main databases (UITP Millennium Cities Database for Sustainable Transport, Auto Oil II Programme, Urban Audit and Citizens' Network Benchmarking Initiative) at the base of the “knowledge Discovery” process are reported in dedicated sections.

3.1 The SUTRA set of indicators

The definition of a set of indicators was a key part of the SUTRA methodology, as it should:

- embrace all phases of SUTRA: from the definition of alternative scenarios for driving forces, to the assessment of their impacts and the consequent elaboration of policy responses;
- be suited for addressing the specific traffic urban issues dealt with in SUTRA.

The DPSIR framework, e.g. used by the EEA in TERM, fulfils the first condition and has therefore been taken as a reference. However, the specific set proposed in TERM has been updated to represent and measure the long-term urban issues studied by SUTRA, in particular:

- demographic issues (e.g., urban growth and ageing);
- economic issues (e.g., economic growth; services vs. manufacturing specialisation; role of high-tech activities);
- land-use issues (e.g., urban sprawl, degree of functional specialisation of neighbourhoods; centralisation of material services especially in retailing, development of suburban structures or the revitalisation of urban centres; implied spatial and temporal patterns of commuting);
- technological issues (e.g., role of employment exploiting information technologies; role of technological change in the transportation sector).

Furthermore, the set of indicators defined in the frame of the SUTRA project is specifically personalised to the tools of the project itself: while *Driving Forces*, and *Responses* indicators provide information that enters the SUTRA models system as inputs, *Impacts* and *Pressure* indicators are built on the basis of models output.

Consequently, the algorithms for the indicator evaluation (that have to be considered as an essential part of the definition of the indicator itself) are, in particular with respect to *Impacts* and *Pressure* indicators, strictly connected to the availability of the models embedded in the SUTRA methodology (i.e., MARKAL, VISUM, TRAM, VADIS, OFIS, etc) and to the added value of their predictive and interpretative power. The project specificity of this modelling approach, while gives an essential contribution in the scenario analysis and comparison (see the specific work packages D.12: “Scenario analysis – city and summary report” and D.13: “Scenario comparison and multi-criteria assessment”) limits the opportunity of finding comparable indicators in literature, i.e., indicators evaluated following *exactly* the same procedure in order to guarantee the *full* consistency of the data used in the benchmarking approach.

On the other hand, the set of indicators chosen for the **extended city list** in order to do a good benchmarking exercise, have been prepared from the analysis of the data bases found on an intensive research on different European initiatives related to sustainable urban transport, using alternative approaches and methodologies.

Due to the fact that the indicator sets found in literature did not matched exactly with the forms on the SUTRA Indicator list, a categorization have been made on our extended city list in order to suit as far as possible with the list defined by FEEM.

It can be useful to remember that the set of indicators used in SUTRA is given by the following quantities (see WP08 final report for further details):

DRIVING FORCES INDICATORS
Demography: size and ageing structure of the city population
1.a) Number of inhabitants
1.b) Percentage of population under 18
1.c) Percentage of population over 64
Land-use: spatial distribution of urban functions and resident population
2.a) Structural density
2.b) Functional distribution of urban functions
2.c) Index of mixed use

PRESSURE INDICATORS
Economy: relative wealth of the city and its economic structure
3.a) GDP per capita, expressed in current Euro price in PPP , relative to EU average
3.b) Percentage of employment in services over total employment
3.c) Percentage of employment on teleworking over total employment
Passengers transportation
4.a) total passenger transport demand per year (pass-km per year)
4.b) public passenger transport demand per year (pass-km per year)
4.c) average distance travelled in each year by each person (pass-km per capita)
Emission of CO_2, NO_X, VOC, CO, PM_{10}
5.a) total passenger transport emission in a year
5.b) passenger transport emission per capita in a year
5.c) passenger transport emission per pass-km in a year
5.d) percentage of private transport emission over total passenger transport emission in a year
Consumption of fossil fuels
6.a) total consumption of fossil fuels per capita in a year
6.b) percentage of passenger transport consumption of fossil fuels over total consumption in a year
6.c) percentage of private passenger transport consumption in total passenger transport consumption in a year

STATE INDICATORS
Atmospheric concentration of pollutants: NO_X, CO, PM_{10}, O_3
7.a) Peak concentration of pollutants
7.b) Annual average concentration of pollutants
7.c) Number of inhabitants under exposure (air quality standard, target value[1])
7.d) Exceedances of air quality standards (frequency of violations) only for ozone
Traffic noise levels
8.a) percentage of population exposed to noise above 65 dB(A) over total population
Stress indicators
9a.) crowding (hours per capita spent on overcrowded public transports in a year)
9.b) traffic jams (hours per capita spent yearly in traffic jams)
IMPACT INDICATORS
Primary (direct) costs of transportation system
10.a) estimate of the aggregate direct costs of transportation system in a year, per capita
10.b) estimate of the aggregate direct costs of transportation system in a year, per pass-km
Secondary (external) costs of transportation system
11.a) estimate of aggregate damage caused by transport in a year, per capita
11.b) estimate of aggregate damage caused by transport in a year, per pass-km
Mortality caused by pollution generated by transport
12.a) number of deaths (acute and chronic) in a year per capita
12.b) number of deaths (acute and chronic) in a year per pass-km
12.c) percentage of total costs
Morbidity caused by pollution generated by transport
13.a) number of days lost in a year, per capita
13.b) percentage of total costs
Accidents
14.a) total number of accidents with personal injuries in a year, per capita
14.b) total number of accidents with personal injuries in a year, per pass-km
14.c) percentage of total costs
Time loss for congestion
15.a) total time spent on travelling in congestion condition in a year, per capita
15.b) percentage of total costs

RESPONSE INDICATORS
Car occupancy rate
16.a) urban peak private car occupancy rate
16.b) urban average private car occupancy rate
Share of public/private transport
17.a) percentage of public transport over total passenger transport (% of total pass-km)
Penetration rates of new vehicle propulsion technologies
18.a.1) Penetration rates of Electric Vehicles in car fleet composition (% of fleet composition)
18.a.2) Penetration rates of Hybrid Electric Vehicles in car fleet composition (% of fleet composition)
18.a.3) Penetration rates of Fuel Cell Electric Vehicles in car fleet composition (% of fleet composition)

Table 1. Indicators defined by FEEM for SUTRA partners

3.2 UITP Millennium Cities Database for Sustainable Transport

Introduction

UITP has compiled a database involving 100 cities worldwide, known as the “Millennium Cities Database”, in collaboration with Professors Jeff Kenworthy and Felix Laube at Murdoch University. The data collected concerns demographics, economics and urban structure, the car population, taxis, the road network, parking, public transport networks (supply, use and cost), the mobility of individuals, the choice of transport mode and transport system efficiency and its environmental impact (travel times and costs, energy consumption, pollution, accidents, etc.). In total, 66 raw indicators (175 basic raw indicators) have been investigated in the 100 selected cities.

The “Millennium Cities Database” represents a remarkable step forward in ascertaining the economics of mobility in cities in the world. In producing this database and analysing the results obtained, UITP has provided itself with the means to develop a set of arguments in favour of sustainable mobility and public transport in order to advise international bodies and policy officials in the course of their reflections and actions.

The "Millennium Cities Database for Sustainable Transport" is a database of 100 of the world's cities, created by UIMP (International Association of Public Transport) in collaboration with Dr Jeff Kenworthy and Felix Laube of Murdoch University, Australia. The collected data looks at population, the economy and urban structure, the number of road vehicles, taxis, the road network, parking, public transport networks (offer, usage and cost), individual mobility and choice of transport mode, transport system efficiency and environmental impact (duration and cost of transport, energy consumption, accidents, pollution, etc.). In total, over 200 indicators have been collected for each of the 100 cities for the year 1995.

Cities	Cities	Cities
Western Europe	***Eastern Europe***	Abidjan
Graz	Prague	Casablanca
Vienna	Budapest	Dakar
Brussels	Krakow	Tunis
Copenhagen	Warsaw	Cape Town
Helsinki	Moscow	Johannesburg
Lille	Istanbul	Harare
Lyon	***North America***	***Middle East***
Marseille	Calgary	Tel Aviv
Nantes	Montreal	Tehran
Paris	Ottawa	Riyadh
Berlin	Toronto	***Asia***
Frankfurt	Vancouver	Manila
Hamburg	Atlanta	Bangkok
Düsseldorf	Chicago	Beijing
Munich	Denver	Hong Kong
Ruhr	Houston	Guangzhou
Stuttgart	Los Angeles	Shanghai
Athens	New York	Mumbai (Bombay)
Bologna	Phoenix	Chennai (Madras)
Milan	San Diego	New Delhi
Rome	San Francisco	Osaka
Turin	Washington	Sapporo
Amsterdam	***Latin America***	Tokyo
Oslo	Buenos Aires	Kuala Lumpur
Lisbon	Brasilia	Jakarta
Barcelona	Curitiba	Taipei
Madrid	Rio de Janeiro	Seoul
Stockholm	Salvador	Singapore
Bern	Sao Paulo	Ho Chi Minh City
Geneva	Santiago	***Oceania***
Zurich	Bogota	Brisbane
Glasgow	Mexico City	Melbourne
London	Caracas	Perth
Manchester	***Africa***	Sydney
Newcastle	Cairo	Wellington

Table 2. Millennium Data Base Cities

Selection of cities and geographic coverage

The cities studied are spread across every continent: 35 in Western Europe, 6 in Eastern Europe, 15 in North America, 10 in Latin America, 8 in Africa, 3 in the Middle East, 18 in Asia, and 5 in Oceania. All conurbation sizes are represented, from Graz in Austria (240,000 inhabitants) to the Tokyo metropolitan area (32.3 million inhabitants). 60 conurbations are located in developed countries and 40 in emerging and developing countries (see Table on next page).

The collected information is primarily quantitative in nature. Aspects that are difficult to quantify and, more conclusively, the opinions of city dwellers regarding their transport system, fall outside the study's scope. However, qualitative information about urban planning, traffic and parking and public transport have also been collected. The full list of the collected raw indicators is reproduced in Annex 1. A clear and precise manual defining data to collect was produced for the benefit of researchers and their correspondents in the cities surveyed. The quality of the data collected depends directly on how accurate the definitions of the data being researched are and the ease with which they can be understood.

The first difficulty faced involves setting the boundaries of conurbations. In some cases, the available data are compiled by administrative bodies whose confines do correspond to the most relevant metropolitan area for the mobility study. Adjustments had to be made where the study's optimal geographical area did not coincide with the area for which most of the data researched were available.

The metropolitan areas selected were defined with the utmost care and the list of districts or groups of districts included in the metropolitan area is specified. Another problem involved the age of the available statistics and surveys. Extrapolations were carried out to ensure that all data refer to 1995. These adjustments chiefly involve data concerning demographics/economics and the mobility of inhabitants compiled during censuses and periodic household surveys.

A significant proportion of the cities studied produced virtually all the data being investigated, albeit with the relating to the setting of metropolitan boundaries and the compilation year. However, these problems are generally fairly easy to resolve. The most commonly encountered difficulties involve data on the use of individual vehicles, taxis, public transport commuter rail services (difficulty in separating commuter services for the metropolitan area from inter-urban services that fall outside the study's scope), bus services (where these are spread among numerous private operators), average distances and travel time per journey.

It was also necessary to address difficulties posed by the lack of statistics, chiefly in certain cities in developing countries, and by the lack of enthusiasm of some of our local contacts. Assessments were necessary in order to resolve difficult cases. These have always been made with an eye to the overall consistency of the data as a whole in the knowledge that numerous crosschecks are possible between the assorted indicators collected.

The result is obviously not perfect, but it is considered the most comprehensive and reliable mobility data compilation produced to date. Every one of the pieces of data being researched was compiled from 84 cities out of 100. In the 16 other cities, the collection rate varied between 30% and 95%.

Latin America is the region where data compilation was the least comprehensive. The main reason is that the people in charge of the project did not have a network of correspondents or experience in Latin America comparable with the networks at their disposal in Europe, Asia or North America.

Jeff Kenworthy and Felix Laube (ISTP) took responsibility for the collection and verification of data featured in the “Millennium Cities Database”. Laura Foglia (Systra), Michelle Zeibots (ISTP) and the numerous correspondents on hand in several of the cities investigated also contributed to data collection. Jean VIVIER, Head of Programmes and Studies – UITP, verified the plausibility and consistency of the data passed on by Jeff Kenworthy and Felix Laube.

Collection year and duration of the database’s validity

1995 was chosen as the reference year. Since data collection began in April 1998, it was not possible to have more recent statistics available. Nevertheless, the economics of mobility are not the same as those of the Internet. They develop over time, like the evolution of cities themselves and the realisation of major transport infrastructures. It is reasonable to estimate that the length of validity of the data collected is over ten years for the cities in developed countries and is slightly less than ten years for developing cities with strong demographic and economic growth.

Nevertheless, periodic updates would be desirable as these would make it possible to introduce new cities and to track the evolution of mobility in the cities already investigated in terms of the urban planning and transport policies they are implementing. This continuous monitoring would be particularly useful in view of orientating the choices cities in developing countries must make in the face of rapidly growing car populations and motorised two-wheel vehicles.

Collection of Indicators

The following analysis is based on the indicators listed in the annex. According to the indicators, the number of cities taken into account varies from 84 (number of cities for which every piece of data was collected) to 100. For a given indicator, the average per geographical region is calculated using all the cities from which this indicator was collected.

3.3 Auto Oil II Programme

Introduction

A significant contribution to the development and quantification of sustainability indicators came from the Auto Oil Programme, arrived to the end of the second phase, that has been set up in order "to provide the technical input to the Commission's work on future vehicle and on fuel quality standards and related measures" (SENCO, 1999).
This project "was specifically intended to satisfy the requirements of Articles 3 and 9 of the proposed Directives on passenger car and petrol and diesel fuels respectively. These referred to the need to come forward with a strategy to meet the requirements of the Community air quality standards and related objectives at least cost" (Directive 98/69/EC; Directive 98/70/EC).

In particular, with reference to sustainable urban transport, an evaluation of the impact of the agreed auto-oil directives both in terms of the trends in emissions of the key pollutants and their impacts on future air quality was done in the second Auto-Oil programme (AOP-II), applying the so called "generalised empirical approach (GEA)" (European Environmental Agency, 2001). This work was performed under the responsibility of the European Environment Agency. The European Topic Centre on Air Quality (ETC/AQ), in collaboration with the European Topic Centre on Air Emissions (ETC/AE), carried out the work as part of the EEA work programme. The institutes contributing to the AOPII-GEA project were RIVM, University of Thessalonica, NILU, DNMI (all ETC/AQ), and TNO (ETC/AE).

The goal of the "Generalized Empirical Approach" was to estimate the size of the urban population living in cities within the European Union, which are not in compliance with air-quality objectives in future years and to estimate additional emission reductions needed to reach compliance.

In the "Generalized Empirical Approach" study, the air quality in about 200 urban agglomerations within the EU was calculated for a reference year (1990 or 1995) and for the year 2010, assuming the "Auto-Oil II" programme base case scenarios (SENCO, 1999). Simple robust tools were used: while the simplifications may obviously introduce additional uncertainties, the advantage of the approach lies in its consistency and sample size. It is this consistency, as a matter of facts, that allows for a generalisation of the results on the scale of the whole European Union.

The key parameter calculated is the urban background air pollution concentration, which is representative of the concentration in most of the urban area, with the exception of places under direct influence of close emission sources, such as street traffic. Averaging times for the calculated concentrations are in accordance with the air-quality objectives (European Environmental Agency, 2001). The calculated future air quality provides indications on the possible future frequency and severity of exceedance of air-quality objectives and on the fraction of EU urban population potentially exposed.

The air pollutants considered in the “Generalized Empirical Approach” study are sulphur dioxide (SO_2), nitrogen dioxide (NO_2), fine particulates (PM_{10}), lead (Pb), ozone (O_3), carbon monoxide (CO), and benzene; some results are also reported for benzo(a)pyrene (B(a)P). All these pollutants, except O_3, have been treated as “inert” and chemical degradation at the urban scale was neglected. NO_2 is a special case; its concentration is derived from the concentration of NO_x (handled as an inert species) using an empirical relationship. The calculations of ozone concentrations were carried out for a sub-set of 57 cities, including almost all cities with more than 500.000 inhabitants.

The calculated urban background concentrations in the set of 200 modelled cities were combined with urban population data to estimate the fraction of the urban population exposed to concentrations above agreed or proposed air-quality standards. For 2010, this fraction is calculated to decrease strongly compared to the reference year. The calculations indicate, however, that the air-quality standards will still be exceeded in the future; the most serious problems are exceedances of the short- and long-term objectives for PM_{10} and exceedance of the long-term objective for NO_2.

Selection of cities and geographic coverage

Air quality indicators were calculated in about 200 urban agglomerations within the EU. Since the Auto-Oil programme aimed at the development of traffic-related air quality improvement measures, no attempts was made to include all cities where exceedances might occur due to industrial emissions (industrial hot spots). The urban agglomerations were primarily selected on the base of their size (all conurbations with more than 250.000 inhabitants) and the availability of air-quality monitoring data. This brought to the selection of 120 cities. To these urban agglomerations were further added about 50 smaller towns that were characterized by reliable monitoring data. The selected cities cover almost 40% of the EU urban population.

The calculations of ozone concentrations were carried out for a sub-set of 57 cities, including almost all cities with more than 500.000 inhabitants. On a country basis, these 57 cities represent 55–100% of the population in cities selected for inert pollutant modelling.

For a subset of 10 cities (Athens, Berlin, Köln, Dublin, Helsinki, London, Lyons, Madrid, Milan, Utrecht) a specific urban impact assessment, was undertaken. In addition, the city of Reggio Emilia has been included within the Milan domain to enable the investigation of the impact of proposed measures downwind of a major city.

For each city the size of the urban area was estimated by the ETC on Land Cover. Basic input was the Corine land cover data set and the “major land cover types of Europe” (MLCT) data set. The MLCT data set was used, since Corine data are unavailable for some countries (UK, Sweden and Finland). In the evaluation of area, typical urban land cover classes were considered

(1.1.1 - continuous urban fabric, 1.1.2 - discontinuous urban fabric, 1.2.1 - industrial or commercial units, 1.4.1 - green urban area and 1.4.2 - sport and leisure facilities). When urban zones were less than 200 metres apart, they were assumed to be from the same urban agglomeration: the distance between some cities was so small that the urban agglomerations were "floating" together and, under this procedure, ended up to be merged into urban agglomerations. Specifically: Tyneside and Sunderland (United Kingdom), Rotterdam and Vlaardingen (the Netherlands), Mannheim and Ludwigshafen (Germany), Milano and Sesto San Giovanni (Italy), Essen, Duisburg, Bochum and Gelsenkirchen (Germany), Lens and Bethune (France). The procedure failed to produce a meaningful result for Helsinki. Helsinki is strongly fragmented and the automatic procedure is not able to make the correct linkage. The built-up area of the Helsinki agglomeration was set on 242 km^2.

The size of the built-up area is a critical parameter in air-quality modelling which is difficult to validate. Correlation between the Corine and the MLCT-based estimates of urban area is good, but the MLCT estimates are systematically 25–30% larger. Population densities were also calculated and analysed by the authors, that concluded that, in comparison to other estimates (e.g. made on the basis of urban questionnaires for the Dobris assessment), the used population densities appeared to be relatively high, although a large scatter was found. Since population data were in reasonable agreement, the urban area estimates may be too low and the authors suggested that further work on urban area characteristics, such as built-up area, was therefore required to reduce uncertainties.

Quantified indicators

The air pollutants considered in the “Generalized Empirical Approach” study are sulphur dioxide (SO_2), nitrogen dioxide (NO_2), fine particulates (PM_{10}), lead (Pb), ozone (O_3), carbon monoxide (CO), and benzene; some results are also reported for benzo(a)pyrene (B(a)P).

Urban emissions

Urban emissions were estimated using a top-down approach, proposed by the Topic Centre on Air Emissions (EEA, 1996). While this simple procedure is clearly approximate, it offers the advantage of providing consistent emission estimates for all selected cities in Europe.

Estimates were made on the basis of the national emissions per sector as given in the AOP II base case Version 5 scenario (SENCO, 1999) and detailed information on emissions from Corinair 90 at a NUTS 3 geographical level and a SNAP1 level of sector detail, available for SO_2, NO_x, CO and VOC.

The top-down approach is different for large point sources and for low-level area sources. Large point sources with known coordinates were allocated to a city when their distance to the city centre is less than the radius of the city.

The radius was estimated from the urban surface area approximating the city area to a circle.

For the area sources, the top-down approach involved scaling of NUTS-3 emission estimates to a local level through the use of indicators of the proportion of a particular activity occurring in the specified local area. For each city, the urban emission was estimated according to:

$$E_{city,group,90,X} = E_{NUTS3,group,90,X} \times \frac{S_{city,group}}{S_{NUTS3,group}}$$

where X is one of the pollutants SO_2, NO_x, CO or VOC,

$E_{city,group,90,X}$ is the urban emission of pollutant X related to specific economic sector (i.e. specific SNAP-code) for the reference year 1990,

$E_{NUTS3,group,90,X}$ is the NUTS-3 emission of pollutant X for this sector and

$S_{city,group}$ and $S_{NUTS3,group}$ are statistical indicators related to this sector at the urban and NUTS-3 level, respectively.

The population was used as a proxy for the statistical indicator for all sectors. Emissions from agriculture and nature were assumed to occur in rural areas and were excluded from the urban emissions.

For some pollutants (benzene, B(a)P, Pb and PM_{10}), disaggregated emissions on a NUTS-3-level were not available. For these components only national totals (reference year 1990) disaggregated at a SNAP1 level were available. To estimate urban emissions for these pollutants it was assumed that the geographical distribution at NUTS-3 level follows the distribution of one of the other pollutants. Urban emissions were then calculated by appropriate scaling.

All emissions are given in tonne/year; NO_x emissions are expressed as tonne NO_2 per year.

In estimating urban emissions for the 2010 base case, the urban emission were re-scaled by a factor reflecting projection for the emission of the pollutant under investigation at national level (SNAP1 level, obtained from SENCO base case Version 5). It should be noted that, under the used assumptions, urban emission scenarios simply follow national emission scaling: specific urban changes in population, built-up areas and in local conditions (e.g. traffic congestion; contribution of traffic emissions to total emissions) are simply disregarded, as this type of information was not considered could be available for individual cities. The baseline projected emissions for 2010 result in a large improvement in urban air quality. The top-down “Generalized Empirical Approach” to estimating urban emissions from national totals may not accurately reflect the actual situation in every city considered but comparison with emission data otherwise obtained from inventories nevertheless indicates that the approach is reasonably robust.

URBAN EMISSION INDICATORS (top-down approach - AOP-base case Version 5)	
SO_2 [Tonne/year]	reference case: year 1995
SO_2 [Tonne/year]	base case: year 2010
NO_x [Tonne NO2/year]	reference case: year 1995
NO_x [Tonne NO2/year]	base case: year 2010
CO [Tonne/year]	reference case: year 1995
CO [Tonne/year]	base case: year 2010
Pb [Tonne/year]	reference case: year 1995
Pb [Tonne/year]	base case: year 2010
Benzene [Tonne/year]	reference case: year 1995
Benzene [Tonne/year]	base case: year 2010
PM_{10} [Tonne/year]	reference case: year 1995
PM_{10} [Tonne/year]	base case: year 2010

Table 3 Auto Oil II urban emission indicators

Urban background concentrations

In the "Generalized Empirical Approach" study, the urban background concentrations from urban emissions were estimated by means of three complementary air pollution models:

- the cQ model (an empirical model which relates urban emissions to observed concentrations) for 'inert' species, where sufficient monitoring data were available;
- the UAQAM (urban air-quality assessment model - a dispersion model calculating annual average city background concentrations and exceedances of air-quality thresholds on an hourly or daily basis from actual meteorology and urban emissions) for 'inert' species in all cities;
- the OFIS (ozone fine structure) model, which was applied to calculate ozone concentrations for a limited number of cities (please note that OFIS is also one of the modelling tools at the base of the SUTRA approach);

it is recognised that the methodology of the selected models may not be appropriate for locations with extreme orographic influence resulting in inhomogeneous flow patterns; such conditions cannot be resolved by the OFIS model and UAQAM .

The estimated urban background concentrations are then superimposed on regional background concentrations. The contribution to urban air quality from the regional background depends on the pollutant. For NO_2, the urban concentrations are considerably higher than the concentrations outside urban areas. For particles, however, the differences are smaller, and estimating their regional background concentrations is more critical. In modelling urban ozone levels, the regional background concentrations form an important factor. In the models, a gradient from background (outside city) concentrations to city background concentrations to city hot spot concentrations was assumed. This background concentration outside the city generally has been calculated by or derived from the EMEP MSC-W model for acidifying compounds, the EMEP-MSC-W photochemical model or the long-range transport model TREND. Regional scale model results are not available for CO; in this case background concentrations were estimated from monitoring data.

The reference year was 1995; for lead and B(a)P, no emission data for 1995 were available and 1990 were taken instead. The reference case was modelled using the OFIS model (ozone) and UAQAM (other components). Simulations with the OFIS model were performed for each day between 1 April and 30 September 1995 for 57 cities. The cQ model was not applied; the measurement in the reference period were used for parameterisation of the model.

Measurement data have been collected from as many of the selected cities as possible for SO_2, NO_2, particulate matter (PM_{10}) and Pb, covering the years 1992–96. For NO_2, the measurement database contains 953 site-years of data for the annual average and 592 site-years of data for 1 hour maximum concentrations. For calculating averages, only cities with more than one site-year of data have been selected. Measurement sites classified as directly influenced by traffic (kerb site, road site) were excluded. The information on station classification is, however, not always available and not always reliable, which may result in bias in the concentrations relative to the urban background concentrations. In the case of particulate matter (PM_{10}), 204 site-years were collected for annual average concentrations and 148 site-years for reported maximum 24-h concentrations. In order to give a clearer picture of the composition of emission sources in the selected cities, a database of SO_2 measurements, covering the period 1990–94, has also been used by the authors.

The UAQAM calculates the urban NO_x concentration as a sum of the background concentration and the contribution from urban emissions. From the calculated NO_x concentration, the NO_2 concentration is estimated using the empirical BUWAL-equation.

To illustrate uncertainties in PM10 modelling, model calculations were made both for base case Version 4 as well as base case Version 5 emissions. Version 5 has the lowest emissions; the main differences between the two versions are in the assumed emission factors for tail-pipe and non-exhaust transport emissions and in the estimates for waste incinerators.

For CO, emission estimates were scaled from emission data on country/SNAP 1 level as obtained from the AOP II base case, Version 5 (SENCO, 1999). For SO_2, the urban emissions for 1995 were prepared on the basis of SENCO base case Version 5. For benzene, national emission totals per SNAP sector are taken from Version 5 of the AOP II base case. The comparison with observations is limited partly by the scarcity of data and partly by the fact that measurements are frequently made at stations in a traffic environment. For lead, no information on emissions at SNAP1 level for the individual countries is available for the reference year 1995. The reference calculations have therefore been made for 1990. The modelled concentrations include regional background concentrations obtained by the TREND model. Calculations for Benzo(a)Pyrene - B(a)P were made for 1990 as information on emissions for 1995 was not available. The uncertainties in calculated B(a)P concentrations are expected to be large.

UAQAM: URBAN BACKGROUND CONCENTRATION INDICATORS (annual mean concentration - AOP-base case Version 5)

SO_2^{1995} [μg/m^3]	reference case: year 1995
SO_2^{2010} [μg/m^3]	base case: year 2010
NO_2^{1995} [μg/m^3]	reference case: year 1995
NO_2^{2010} [μg/m^3]	base case: year 2010
CO^{1995} [mg/m^3]	reference case: year 1995
CO^{2010} [mg/m^3]	base case: year 2010
Pb^{1995} [μg/m^3]	reference case: year 1995
Pb^{2010} [μg/m^3]	base case: year 2010
$Benzene^{1995}$ [μg/m^3]	reference case: year 1995
$Benzene^{2010}$ [Tonne/year]	base case: year 2010
PM_{10}^{1995} [μg/m^3]	reference case: year 1995
PM_{10}^{2010} [μg/m^3]	base case: year 2010

CQ-Model: URBAN BACKGROUND CONCENTRATION INDICATORS (annual mean concentration - AOP-base case Version 5)

$SO_2^{1992-1995}$ [μg/m^3]	average of measured concentrations: years 1992-1995
SO_2^{2010} [μg/m^3]	estimated concentration: year 2010
$NO_2^{1992-1995}$ [μg/m^3]	reference case: year 1995
NO_2^{2010} [μg/m^3]	base case: year 2010
$PM_{10}^{1992-1995}$ [μg/m^3]	reference case: year 1995
PM_{10}^{2010} [μg/m^3]	base case: year 2010

OFIS: NUMBER OF EXCEEDANCE DAYS of the running 8h-average of 120 mg/m3 ozone (AOP-base case Version 5)

N_{avg}^{1995}	average number of exceedance days over the urban area: year 1995
N_{avg}^{2010}	average number of exceedance days over the urban area: year 2010
N_{max}^{1995}	maximum number of exceedance days over the urban area: year 1995
N_{max}^{2010}	maximum number of exceedance days over the urban area: year 2010

Table 4 Auto Oil II UAQAM, CQ-Model and OFIS indicators

3.4 Urban Audit

Introduction

The *Urban Audit* is an initiative managed by the DG Regional Policy and EUROSTAT, and its purpose is assessing the quality of life in European cities.

The European Commission launched the terms of reference for the plot phase of the urban audit in June 1997. This pilot phase, which began in May 1998, was undertaken within the aegis of Article 10 of the ERDF Regulation, which enables the support of innovative measures, by the European Commission. The Urban Audit has been directed and managed by Directorate General REGIO, Regional Policy, unit A.1 and Eurostat. Other Directorates of the European Commission have advised on aspects of the work. The urban Yearbook and other products have been prepared by a team of consultants and researchers brought together under the umbrella of ERECO for the Urban Audit pilot phase. The opinions expressed in the Urban Audit products are not necessarily those of the European Commission.

The overall purpose of the urban audit is to enable an assessment of the state of individual EU cities and to provide access to comparative data. It is foreseen that the process will facilitate the exchange of information amongst cities and help to cover the demand amongst policy makers at all levels for an assessment of quality of life in Europe's cities.
This process has engaged directly the city authorities who were invited by the European Commission to participate. Though practice concerning information collection and management varies between and within countries, use has been made of a large number of local data sources, in order to supplement the 'official statistics' available at national levels.

To achieve this, close co-operation has been necessary between the European Commission and the cities. Many individuals within the cities, in statistical agencies at the national levels, and in other agencies at the local level have contributed to the work.

The results of the pilot phase are of immediate interest to city authorities and citizens alike. However, the value of the information brought together in the pilot phase of the Urban Audit would be much increased if steps were taken to fill the gaps, to update the information, to increase the number of participating cities, to improve the richness of the information in particular domains, and to ensure easy and wide access to the detailed information. The European Commission proposed to continue to work with the cities to this end.

The results of the Urban Audit pilot phase are published in three Volumes:

- Volume I provides the first part of the Yearbook with an overview of the results and brief analyses of the apparent differences in results between different types of cities and emerging trends. Volume I also presents the main results in a series of comparative tables so that findings may be compared between cities and with the results at the Conurbation/Wider Territorial Unit and national levels.

- Volume II, which is the second part of the Yearbook, presents the summary results for each of the 58 cities. The presentation of findings allows the reader to see how a particular city compares with the other Urban Audit cities and, if appropriate, the variation between scores at the city and Conurbation/Wider Territorial Unit level.
- Volume III presents the Urban Audit Manual, which allows readers to appreciate in detail the way in which the information was collected and compiled during the pilot phase of the Urban Audit.

In addition to this publication, the pilot phase of the Urban Audit generated several other outputs, which are publicly available. Namely:

- An **Urban Audit Web Site** (http://www.inforegio.cec.int/urban/audit/). Visitors to the Web Site can investigate different aspects of the Urban Audit process and have access to the results contained in this urban Yearbook and Individual City Audits. The Web site also provides access to the bibliography of parallel work concerning urban indicators. Where applicable, hyperlinks are provided from the Urban Audit Web Site to the sites of participating cities.

- **Individual City Audits.** for each of the 58 Urban Audit Cities. These Individual City Audits elaborate on the information summarised for each city in this document and are 'virtual' annexes to the Yearbook. They include maps on population density and land use illustrating the City and WTU/Conurbations boundaries used in the Urban Audit. They are available via the Urban Audit Web Site.

The Data Base used in the benchmarking exercise refers to the first edition of the Urban Yearbook. It presents the main results of the pilot phase of the Urban Audit. The work has, for the first time, brought together information from 58 major EU cities concerning a wide range of aspects of the 'quality of life' in urban areas.

Policy Context

There is demand amongst policy makers at all levels for an assessment of quality of life in Europe's cities. To meet this demand, there is a need for comparable information. Such information helps to identify priorities, to target actions and to assess progress. Such information is currently very limited.

The Commission Communication 'Towards an Urban Agenda in the European Union (COM(97)197)' identified this need for comparable information and proposed a two-fold approach.

First, the Urban Audit to 'measure the quality of life in our towns and cities through the use of a simple set of urban indicators and a common methodology'. This would be undertaken with a view to these indicators being updated and, in the future, providing an assessment of the impact of urban policies on the development of urban areas.

Second, in parallel with this approach, EUROSTAT, in co-operation with national statistical institutes, would process the 'local' level information on cities and urban agglomerations and harmonize information systems and definitions.

Selection of cities and geographic coverage

58 cities were invited by the European Commission to participate in the urban audit during the pilot phase. The 58 cities were identified by the European Commission on a systematic and objective basis. The largest cities (by population size within their administrative boundaries) within the EU member states have been included. The main exceptions to this principle are: the exclusion because of their large scale of London and Paris; and, in order to ensure a good geographical spread across the EU and to cover a significant percentage of the population in each country, some cities from the smaller EU countries were included even though they have smaller populations than some of those cities not included from the larger countries.

The combined population of the 58 cities (at the city administrative level) is 42.6 million. Taking into account the wider territorial areas (Conurbation and Wider Territorial Unit) for which information has been collected for 27 cities, the total population within the Urban Audit cities is 70 million.

The pilot phase of the Urban Audit has demonstrated, for the first time, the feasibility of obtaining and presenting information on a consistent pan-European basis for a wide range of indicators at the city administrative level, the wider urban area, and for sub-city areas.

This has been achieved through the active co-operation of the cities invited by the European Commission to participate. Information has been assembled from a wide variety of sources. Whilst many of the chosen indicators have been informed by national data sources, information compiled at the local level has also been extremely important with respect to recreation and culture, civic involvement, and levels of education and training provision, as well as aspects of economic conditions.

For most indicators, the information was obtained for the majority of cities. Furthermore, at least one city had sufficient information to complete in its entirety the information requested in each domain.

There are many issues of definitions that limit cross-national comparability and the confidence with which generalisations can be drawn. However, taken as a whole, the Urban Audit pilot phase has demonstrated the strong potential that exists for European comparative urban information.

The primary focus of the Urban Audit has been on the "city level" as defined by the main administrative areas under the jurisdiction of an elected body and on the conurbation where the urban area has its own administrative entity.
In order to facilitate possible comparisons, where "local authority areas adjoining a city partake significantly in the life of the city" (Terms of Reference), a Wider Territorial Unit (WTU) comprising a combination of administrative areas was identified. The general approach used to define the 20 WTU was that the wider areas should fulfil either of the following two criteria:

- the administrative areas each contiguous with the city administrative level have a population density equal to or greater than 500 persons per square kilometre;
- the proposed group of administrative areas corresponds to a build-up area with less than 200 metres between two built units.

Furthermore the total populations of the city and administrative areas within the WTU were at least 50% greater than the population of the city. For 27 out of the 58 participating cities, information has also been collected at the Wider Territorial Unit or Conurbation level.

For a small number of indicators, mainly those concerning socio-economic aspects, indicator scores have been calculated for a total of 2500 sub-divisions of the cities. The main purpose of the sub-city analysis is to estimate the apparent level of disparities in conditions between parts of the Urban Audit cities. There are considerable variations amongst the Urban Audit cities in the ways in which cities are normally subdivided for administrative and/or statistical purposes. However, as far as possible a common approach has been adopted to the assembly and analysis of information at the sub-city level. Whenever possible in all cities, information has also been compiled at this sub-city level.

In the review of key findings, the cities have been classified:

- by size at city level in three categories (above 1 million, above 500,000, below 500,000 inhabitants)
- by geographic location: northern and southern,
- by geographic location: central and peripheral, and by capital and non capital cities.

1. Ålborg	20. Genova	39. Nantes
2. AMSTERDAM	21. Glasgow	40. Napoli
3. Antwerpen	22. Göteborg	41. Nice
4. ATHINAI	23. Graz	42. Palermo
5. Barcelona	24. Hamburg	43. Patrai
6. Bari	25. HELSINKI	44. ROMA
7. BERLIN	26. KOBENHAVN	46. Sevilla
8. Birmingham	27. Köln	47. STOCKHOLM
9. Bordeaux	28. Leeds	48. Strasbourg
10. Bradford	29. Leipzig	49. Stuttgart
11. BRUXELLES	30. Lille	50. Suceava
12. Cardiff	31. Liverpool	51. Thessalonika
13. Cork	32. Lyon	52. Torino
14. Dresden	33. MADRID	53. Toulouse
15. DUBLIN	34. Málaga	54. Valencia
16. Edinburgh	35. Manchester	55. WIEN
17. Essen	36. Marseille	56. Zaragoza
18. Firenze	37. Milano	
19. Frankfurt	38. München	

Table 5. Urban Audit Cities estudied in SUTRA

Quantified indicators

The indicators of the urban audit cover five fields: socio-economic aspects, participation in civic life, education and training, environment, and culture and leisure (see annex 2)

The terms of reference for the urban audit pilot phase identified the 33 indicators. One criterion emphasised in the selection of indicators was the availability of data. During the pilot phase further consideration was given to refining more precisely the indicators so that, as far as possible, information could be collected on a comparable basis for the 58 cities. These considerations involved a review of existing relevant work; discussions amongst those involved in the urban audit pilot phase work including correspondents in each Member State and representatives from participating cities; and a detailed assessment of the practicality of obtaining information to build the 33 indicators mentioned in the terms of reference.

As a result of this work the following refinements were made:

- The indicators were regrouped into 21 domains reflecting aspects of urban 'quality of life'. The grouping offered the practical advantage that because, by and large, the information required to inform the indicators within each domain is available from a small number of sources, and usually different from the sources for other domains, the wide ranging data collection work could be managed more easily.
- A full list of indicators was defined within the 21 domains. For most variables forming part of the indicator a preferred 'standard' definition was given. However, scope was also provided for minor revisions to be made to the definitions if this would enable the generation of 'useable' indicator scores.

- A system was devised so that the following information was recorded for each variable used to generate the indicator scores: the date to which it refers; any differences to the ‘standard’ definition; any differences to the spatial boundary to which the indicator applies; and the dataset used to source the information and its characteristics.
- Information to inform all the indicators was, where possible, obtained for three points in time (1981,1991, and 1996).
- Where appropriate, comparable information at the national level was collected. This process assists the interpretation of results in that Urban Audit users can better judge the extent to which differences in indicator scores between the 58 cities are a consequence of national differences.

As already mentioned, during the Urban Audit pilot phase, a methodology was developed for collecting information to compile these indicators. All available information sources at national, regional and local levels have been investigated and where appropriate used. Account has been taken of the variety of data sources and definitions used in different contexts so that useful comparisons can be made.

The wide variety of variables for which information was sought, the three points in time and three different spatial levels posed a major challenge. However, for most indicators, the information was obtained for the majority of cities. Furthermore, at least one city had sufficient information to complete in its entirety the information requested in each domain.

Only the domains of energy and travel patterns stand out as having been found particularly difficult to complete. The lack of information on household income was also considered disappointing.

There are many issues of definitions that limit cross-national comparability and the confidence with which generalisations can be drawn. Although every effort was made during the pilot phase of the Urban Audit to generate results that allow for valid comparisons between cities, there are, however, a number of factors which limit the quality of information and the comparability of indicator scores between cities.

Some of the datasets which inform the indicators and variables for which information has been compiled are based upon sample surveys, estimates and modelling approaches. The process of data collection is sometimes ad hoc and the results ‘unofficial’.

The confidence with which comparisons between the cities can be made on the scores for particular indicators is influenced by the precise definitions used for the variables. There are variations in the definitions between member states and also between cities within member states. The approach adopted during the Urban Audit pilot phase was nevertheless to collect information even though there exist such variations, and to point out to users where the validity of comparison are reduced by this variation.

The main reasons for caution in viewing the results given below are as follows:

- Population: There are differences in national retirement ages.
- Nationality: The number of EU member states has changed during the reference period and, in some countries, country of births rather than nationality is recorded.
- Labour Market and Unemployment: There are variations in the methods of counting the 'unemployed' and defining economically active population both over time and between countries.
- Income, Disparities and Poverty: Household income is subject to variations in definition (for example income may be gross or net of tax).
- Housing: There are variations in the definition of housing tenure.
- Health: The definitions of life expectancy at birth may vary.
- Crime: The methods of recording crime and classifying crime are subject to major variations.
- Employment: The methods of classifying employment vary between countries
- Economic Activity: There are different methods of calculating GDP at the urban scale.
- Civic Involvement: Regulations affecting eligibility to vote (for example voting age and voting rights of non-nationals) vary between countries.
- Municipal Income: The procedures for measuring Municipal expenditure vary and are influenced by factors such as the accounting treatment of 'investment' and the division of responsibilities between Municipal level authorities.
- Education and Training Provision: Definitions of crèches vary. For many cities, data is available for the number of "children" or "students" rather than the number of "places". The age at which compulsory education ends varies between countries as does the meaning of the concepts: 'minimum qualifications'; and, higher and further education. There have also been difficulties in tracking the performance and progress of 'reference year' students.
- Level of Educational - Qualifications: some difficulties have been experienced applying the ISCED level definition to the populations in the different cities.
- Air quality and Noise: The number of sampling points for NO_2 and their locations affect the score.
- Water: Sampling techniques vary.
- Waste Management: Systems of data collection vary as does the definition of 'recycling'.

- Land Use: Systems of measuring and defining 'green spaces to which the public has access' vary considerably.
- Travel Patterns: The systems of gathering data relevant to this domain vary. They are normally sample surveys and different categories of mode and purpose of travel are applied.
- Energy Use: Definitions of energy type vary and the data may not be related to urban boundaries.
- Culture and Recreation: There are variations in the definition of 'concerts', 'museum' and 'sports facilities' and methods of obtaining data on usage. Attendance figures are often underestimated because they do not refer to all venues.

Direct comparisons must always be treated with caution especially for data compiled from many different datasets, using different sampling methods and timing.

3.5 Citizens' Network Benchmarking Initiative

Introduction

The Citizens' Network Benchmarking Initiative is a project of the European Commission, DG Energy and Transport (DG TREN), developed in the framework of the work programme for the implementation of the Citizens' Network (*European Commission, 1996*). The initiative, launched in early 2001 after a Pilot Project in 1998, was intended to enable European cities and regions to share knowledge in the field of local and regional passenger transport and learn from each other by comparing the performance of their transport systems (transport policy, transport infrastructure and supply, travel determinants and effects), across all modes of transport (private car, public transport, walking, cycling, powered two-wheeler and taxi).

The Citizens' Network Benchmarking Initiative involves an extensive group of local and regional authorities, ranging from large metropolitan regions to rural towns and districts. The initiative is open to municipalities, regions and transport authorities from throughout the whole of Europe (EU Members states, other countries including Central and Eastern European countries) and is designed as a continuous process that shall, on a regular basis, enable new participants to become involved in its activities.

The overall objective of the project is to promote the identification and dissemination of good practice in urban transport systems and infrastructure by enabling cities and regions to exchange ideas and experiences and to compare the performance of their local and regional transport systems through the use of benchmarking methods.

The initiative aims to develop and manage a network of local and regional authorities to support the exchange of practical know-how and experience, to define a set of measurable transport performance indicators for policy-making, and to identify good practice in mobility policy through a process of direct interaction between persons having responsibility for transport issues in local government and operating companies, as well as seeking the direct involvement of all local stakeholders concerned (public bodies, associations, user groups).

The common indicators provide a general statistical overview of the mobility systems in the urban and regional areas surveyed. They are used by the participating cities and regions to measure and compare the characteristics of their own transport systems to those of other comparable cities and regions in order to identify and assess respective key success factors for use at other stages of the project, or for other specific purposes of the participating areas (internal assessments, reviews, policy papers, etc.).

The common indicators address a number of questions:

- How do people travel? What transport services do people prefer, and how well is the system meeting these requirements?
- How accessible is the transport system? How congested are the roads? What information is available to motorist and transport users?
- What are the costs of transport? What is the impact of transport on the environment? How safe is it to travel?

Methodology and Data collection

The initiative follows a two-step approach:

- The self-assessment of general performance reflected in the common indicators, for which the project provides a contribution towards harmonizing the way transport figures are gathered and used for local decision making, and contributes to developing an integrated approach to local transport benchmarking;
- The benchmarking of performance in specific fields, whereby working groups, each led by one of the participating local authorities, selected a specific area of interest which they assessed on the basis of thematic indicators and examine through site visits to cases of good practice in different cities.

This Citizens' Network Benchmarking Initiative is based on the definition of a set of common indicators, and a common methodology for their quantification by means of the collection of statistical data from the 40 European cities and regions involved in the projecy. The aim of the project is to collect and add value to readily available data rather than initiating laborious on-site surveys and to present this information in a straightforward and user-friendly manner, thus avoiding to elaborate sophisticated aggregate indicators. The analysis is not performed by external third parties, it is undertaken as part of a self-assessment exercise by the participants themselves.

The results of the main common indicators were then analyzed and reported as graphs and charts, also providing information on the key points of each city or region. The project management office was responsible for data processing and validation, whereby the data was verified for coherence and reliability, entered into common database and was translated into graphs. In order to present the indicators in a more comprehensive and synthetic manner raw common indicator results were combined (e.g. conversion of all distance and monetary units to kilometres and euro) and processed into relative indicators. Data collection was undertaken by the participating authorities on the basis of instructions and documentation provided by the project management office and information has been assembled from a wide variety of sources. Methodology sheets containing technical guidelines for data compilation and data collection reporting formats were sent to the local and regional authorities taking part in the initiative, requesting participants to fill in a questionnaire (data input sheet) by providing data for the years 1990 and 2000 (or the closest years for which data are available).

The methodology sheets include explanations and descriptions of the different indicators and present precise information and definitions of the type of data to be collected for each of the indicators (terms of references, units of measurement). They also provide contextual and technical information on the way in which the information provided are to be interpreted and compared as part of the overall benchmarking exercise.

The data input sheets allow users to specify definitions, methods, units or periods used that differ from those proposed in the methodology sheets. For this exercise, data collection started in April 2001 and lasted formally until the end of the year.

Each participating area designated a person to be responsible for organising and co-ordinating the data collection at local level in relationship with the local reference groups established in many participating authorities, and acting as contact point with the Project Management Office. The aim of the methodology sheets was to provide sufficient information on how to proceed in gathering the data to the persons in charge of compiling and collecting the data for the city or region (nominated contact persons, local authority officers, representatives from organisations belonging to the local reference groups, etc.).

The Project Management Office was responsible for data processing and validation, where by the data was verified for coherence and reliability, entered into common database and was translated into graphs.

Selection of cities and geographic coverage

In terms of coverage 40 cities and regions from 13 countries took part in this exercise and the coverage of the common indicators, simply reflects the cities and regions that have voluntarily undertaken to collect and provide data for the exercise. Where relevant, data from the cities that took part in the pilot phase of the project in 1998-99 (Bremen, Dresden, Graz, Lisbon, Nantes, Prague and Stuttgart) have also been included. Data is generally provided for the geographic areas corresponding to the boundaries of the authorities mentioned below, except as otherwise mentioned in the footnotes for each indicator.

Quantified indicators

In the framework of the project a series of 39 common indicators have been developed. The common indicators are grouped according to different themes covering all the relevant modes of transport (private car, public transport, walking, cycling, powered two-wheeler and taxi) and certain elements relating to the social and environmental consequences of transport at the urban and regional level. The indicators are mainly descriptive indicators which provide a comprehensive picture of the level of transport infrastructure and services available in a city or region and the main travel behaviour patterns. A certain number of indicators can be considered as key performance indicators which provide additional information as to the actual or perceived performance of the transport system from the point of view of efficiency (environmental sustainability and economic profitability).

Following the pilot project a second indicator-based report was developed under the Citizens' Network project. While building on the same conceptual framework as the pilot project, the indicators used in this follow up differ from the set of indicators used in the pilot project in a number of respects:

- New and revised indicators: some indicators have been added (e.g. children's journeys to school, average road network speed, speed limited zones, traffic accident fatalities) in order to reflect a wider range of topics of concern to local travel patterns and conditions, while for others the definitions used have been modified in order to take account of commonly accepted measurements or standards, or to provide a more precise characterisation of data acquisition or sampling methods.
- Abandoned indicators: due to difficulties encountered with data availability and comparability in the pilot project a series of indicators were not included anymore (e.g. number of off-vehicle sales points of public transport tickets, annual expenditure on information services for public transport users, number of days per year on which thresholds of air pollution are breached). Other indicators not particularly relevant or meaningful within the general comparison of performance have not been included (e.g. provision of public transport information on the internet), though some data on these aspects may be found in the thematic indicators developed in the benchmarking working groups.
- Not calculated or displayed indicators: other indicators for which data is sufficiently available and which can easily be derived from the results provided in this report have nevertheless not been included so as not to overburden the amount of information presented (e.g. evolution in the share of passengers trip taken by alternatives to individual motorised transport, level of car ownership compared with national average). The

relationship between car ownership and car use has not been included, as these figures do not enable any conclusive results to be drawn.

The general data provide references for displaying data results in relation to population size, geographical surface or level of economic development. This serves to improve comparability among indicators and provides a basis for examining data series over different periods of time or for comparing data from different local and regional contexts.

Finalized to the aims of SUTRA, from the list of the available indicators (one has to notice that for several indicators the data collected was relatively poor, in terms of the covered urban conglomerate), the indicators reported in boldface have been considered of particular interest:

BACKGROUND INFORMATION

Population

Surface area

Employment and commuting

Average income / GDP

HOW PEOPLE TRAVEL

Number of trips

Average trip distances

Passenger-kilometres

Children's school journeys

Trips per day and user group

MOTORIZED ROAD TRANSPORT

Length of the road network

Investment into road infrastructure

Investment into transport telematics (ITS)

Private car and powered two-wheeler ownership

Cost of car use

Road traffic management technologies

Average road network speed

Provision of parking and park-and-ride facilities

PUBLIC TRANSPORT

Length of the public transport network

Number of stops and stations

Number of vehicles

Seat-km and passenger-km

Priority devices for public transport

Average speed

Accessibility for users with special needs
Public transport real time information
Investment into public transport infrastructure
Operating costs and revenues
Fare structure and ticketing
Number of taxis

WALKING
Pedestrianised area
Area of speed limited zones
Investment into pedestrian infrastructure

CYCLING
Length of cycle paths
Number of bicycle parking spaces
Investment into bicycle infrastructure

SOCIO-ENVIRONMENTAL IMPACTS
Air pollution
Noise pollution
Traffic accident injuries
Traffic accident fatalities

Table 6. Citizen's Network Indicators sutdied in SUTRA

3.6 Other Sources

EMTA Barometer Of Public Transport In The European Metropolitan Areas

The association of European Metropolitan Transport Authorities (EMTA) is an association of public institutions in charge of the public transport systems in the main European metropolitan areas. A total of 26 institutions, from 26 metropolitan areas and 19 countries, are currently members of EMTA.

The EMTA Barometer has been designed as a mean to provide information on the public transport systems in those cities, thus permitting comparisons and setting a basis for benchmarking exercises for the EMTA members, and the public at large.

Data included in this first version of the EMTA Barometer refer to year 2000. It is expected that data will be updated and further harmonised in future versions.

The information included in the EMTA Barometer refer to 3 main areas:

- Basic facts of the metropolitan area as population, surface, density, modal split, ...
- Public transport system data in three areas: supply, demand and quality.
- Financial data related to fares, revenues and expenditures, coverage and investments.

The report contains the following fifteen cities: Athens, Barcelona, Bilbao, Brussels, Helsinki, London, Madrid, Manchester, Paris, Prague, Seville, Stockholm, Vienna, Vilnius and Zurich. Other EMTA cities are expected to be joining this Barometer in the future.

The figures presented in the report are only a fraction of those provided by cities. In particular, this information refers to the whole metropolitan area, whereas cities provided information separately for the city centre and the metropolitan ring.

The “EMTA barometer” report was developed under the direction of Mr. Carlos Cristóbal-Pinto, Head of Studies and Planning Department of the Consorcio Regional de Transportes de Madrid (Madrid Public Transport Authority), with the collaboration of BB&J Consult and the Transport Department of Madrid Polytechnic University (UPM).

Ecosistema Urbano 2003 di LEGAMBIENTE

Some data about Italian urban conglomerations where extracted from the 2001-2003 “Urban Ecosystem report: an effective experience of environmental reporting and ranking in 103 Italian cities” (an English report describing the approach and summarizing the basic results is available, at the time of writing, on the web, at www.legambiente.com/documenti/1997-1999/ecosistema_urbano_1999/ecosistema_urbano_1999_ENG.pdf). The study was promoted by an Italian NGO (Legambiente), with the support of a research institute (Ambiente Italia), and in cooperation with the majority of the cities involved.

The “Urban Ecosystem” is a survey on environmental sustainability in 103 Italian municipalities being provincial seats, developed every year since 1994. The survey results are largely diffused on Italian newspapers, magazines and TV, both in national and local reports. Urban Ecosystem data are currently used as environmental indicators in urban quality of life surveys (e.g. Il Sole24Ore annual survey).
Taking into account the data availability, the selected indicators aim to evaluate the urban sustainability rather than the environmental “urban quality”, which is often determined by unquantifiable factors. Urban Ecosystem is addressed to evaluate local environmental policies, to highlight the environmental pressures and the most critical aspects. The Urban Ecosystem is considered by the authors not the Environmental Quality Award but the Thermometer of urban sustainability.

Every year Urban Ecosystem collects data on 42 environmental parameters. On this basis 18 environmental sustainability indicators were selected, having a balanced P-SR approach.
For each indicators an appropriate sustainability target was defined and a specific performance scale. The result is a set of performance measurements able to be used together and combined. For some indicators (e.g.: public transport) small and big cities are evaluated differently, taking into account the “size factor”.
In the last survey diversified weights for indicators were also used, according to a panel composed by local authorities (20 municipalities) and NGO’s experts and data were published and let accessible on Internet.

The main urban indicators quantified in the “Urban Ecosystem” and specifically related to transport are: modal split of (systematic and non systematic) trips, number of trips on public transport (pro capita and year), extension of the public transport network (with particular attention to lanes reserved to the circulation of public vehicles alone), average speeds and number of public vehicles, number of public circulating cars [cars/100 inhabitants in the municipality], pedestrian areas [m^2/inhabitant], extension of bike paths [m/inhabitant], as well as indicators related to noise and the urban concentrations of the main air pollutants.

Data were furthermore extracted from several publications available in literature (see References in Section 9).

In particularly, publications by CITEPA (*Centre Interprofessionnel Technique d’Etudes de la Pollution Atmosphérique*) and CERTU (*Centre d’Etudes sur les réseuaux, les transports, l’urbanisme et les constructions publiques*), as well as contributions to the Proceedings of the ECMT European Conference of Ministers of Transport “*Sustainable Transport in Central and Eastern European Cities”* allowed the compilations of several French and Eastern European transport indicators, respectively.

The possibility of extracting data from several independent compilations (even if focussed on a small number of urban conglomerates) has been extremely important in order to obtain an (empirical) “a priori” quantification of “data quality” – see the discussion in relationship to Figures 1-5, in Paragraph 5.1.

4 The SUTRA Extended City Data Base

One of the main steps towards the cross-comparison and benchmarking exercise, was the compilation of a baseline data base obtained by merging the relevant collected data.

Being the indicators quantified under different assumptions, one has to take care about the compatibilities in the definitions and in the assumptions and algorithms used for the calculation, as well as for the good quality of the data, as their reliability and accuracy must be verified.

A number of problems were encountered which, to a certain extent, impose some limitations on the overall validity of the exercise.

Availability

The *availability* of data is affected by differences in statistical systems at local and national level between authorities from different countries, which not only define the methods and reference periods used for collecting data but also determine the scope of the data that is collected (e.g. in certain areas walking is not considered as a separate mode, and so data is not collected for pedestrian trips).
The fact of relying on the cities and regions themselves to provide the information had an influence on data quality as the availability of data is dependent on the willingness of participating authorities to provide such information, which in turn varies according to the organisation and resources of each participant and to their level of involvement in the project (confidentiality or sensitivity of information, knowledge that the information exists, lack of communication between different departments or organisations, etc.). For certain data categories (notably road traffic, noise and air pollution emissions) the fact that the contact persons and local reference group members usually come from the transport department or transport operators meant that data outside the direct domain of public transport were not always easily obtainable.
Severe problems also occurred while trying to collect data from earlier references periods (1990): such data are very often not available due to changes in administrative structure or boundaries, new indicators definitions, or due to loss of information through changes in personnel. Therefore usually only the data for the year 2000 (or thereabout) are published, though for some indicators sufficient data for 1990 were available to enable time series to be constructed.

Reliability

It was equally very difficult to obtain investment figures. Where data is available it is often very limited or presents substantial variations (e.g. figures on investment into public transport infrastructure range from 18 euro per bus/km to 41.000 euro per bus/km). Such disparities make it highly difficult to

verify the reliability of values given and to identify figures that are outside the scope of plausibility.
Investments in a specific measure are often part of a larger budget (e.g. pedestrian areas as part of the general road infrastructure budget) or the funds stem from different public budgets (transport, economic development, housing and construction maintenance, tourism, human resources, etc.). Alternatively, data might comprise a range of systems and measures which in the end means that data is not comparable. The situation is generally complex and difficulties in tracking financial figures are heightened by the share of responsibilities between the private and the public sectors – the way in which subsidies are granted is very divergent as is the way in which these have to be accounted for.

Comparability

Transport policy is closely linked with other policies such as housing and land use planning, some data might therefore be defined in a way that is inappropriate for the purpose of transport policy. Despite the explanations given in the methodology sheets there is usually room for interpretation, which leads to different definitions being used (e.g. when is a bus stop accessible for people with reduced mobility?).

By carefully merging the data collected from the surveys and databases mentioned in Paragraph 3 "Cross-comparison and Benchmarking: Identification of indicators and data needed" – some critical details to be faced in the merging process as well as the used strategy are discussed in Paragraph 5.1 “Benchmarking strategy and results”, it has been possible to obtain a database referring to 250 European urban conglomerate and a set of more than 80 indicators.

Due to the difficulties in finding in literature sources that would allow a quantification of the set of indicators and the selected cities, a significant number of fields of the database couldn’t be quantified. We have preferred to obtain a “large sparse matrix” (i.e., with many columns, i.e., cities – and many rows, i.e., indicators) instead of concentrating on the subset that could be adequately quantified in a reasonable percentage of cases. This should guarantee the generality of the approach and the possibility of easily updating the results, whenever they will become available.

To give an idea of the “sparseness” of the collected database, in the following two tables are reported the used set of indicators (and the number of cities for which each indicator could be quantified) as well as the urban conglomerates for which data have been gathered (and, for each city, the indications of the number of collected indicators).

Indicator associate at Urban Conglomerate level	Number of Urban Conglomerate for which the Indicator has been collected
Country (the Urban Conglomerate belongs to)	250
Geographic unit (Baltic, Central, Eastern or Mediterranean)	250
Latitude	230
Longitude	230
Total Population	250
Total Urban Area [km^2]	247
Population Density [inhabitants / km^2]	247
Average annual population change in interval 1981/1996 [%]	81
Proportion of Population in Age Groups 0-15 years [%]	78
Proportion of Population in Age Groups 16-24 years [%]	78
Proportion of Population in Age Groups > 64 years [%}	80
Economically Active Population [%]	80
Employment in Services [%]	80
Gross Domestic Product GDP/Capita [euros 1998 prices]	101
Urban Area Road/Rail Network [%]	27
Cars Registered in City Boundary per 1000 inhabitants [Cars/1000 inhabitants]	101
Powered two-wheelers Registered in City Boundary per 1000 inhabitants [Powered two-wheelers/ 1.000 inhabitants]	57
Proportion of households without a car [%]	58
Total number of jobs in the metropolitan area [employed working in Urban Conglomerate]	58
Share In-commuters [%]	26
Share Out-commuters [%]	22
Percentage of non motorised modes over all trips [%]	68
Modal split of motorised trips: Private car contribution [%]	71
Modal split of motorised trips: Public transport contribution [%]	71
Modal split of motorised trips: Non Motorized + Public transport [%]	68
Proportion of journeys to work by public transport (rail / metro / bus /tram) [%]	44
Proportion of journeys for non-work purposes [%]	27
Proportion of trips for journey to work [%]	28
Average number of occupants of motor cars	34
Average traffic speed: rush hour speed [km/h]	25
Average traffic speed: off-peak speed [km/h]	22
Operating speed: Bus speed [km/h]	40
Operating speed: Tram/light-rail speed [km/h]	23
Operating speed: Metro speed [km/h]	14
Operating speed Heavy-rail speed [km/h]	15
Number of trips/capita and year on Private car	47
Number of trips/capita and year on Public transport	69
Average trip length for private car [km]	21
Average trip length for Public transport [km]	23
Overall (private + public transport) average trip length [km]	34
Passenger-km / (capita and year) for private car [km/inh year]	16
Passenger-km / (capita and year) [Public transport] [km/inh year]	20
Total annual distance travelled	27

per person (by all modes [including walking, cycling, etc) [km]	
Bus-km [millions vehicle km]	**33**
Passenger-km by bus [millions km/year]	**23**
Tram/Light-rail-km [millions vehicle km]	**16**
Passenger-km by tram/light-rail [millions km/year]	**7**
Metro/heavy-rail-km [millions vehicle km]	**16**
Passenger-km by metro/heavy-rail [millions km/year]	**15**
Tram/light-rail + metro/heavy-rail[millions vehicle km]	**8**
Passenger-km by tram/light-rail + metro/heavy-rail [millions km/year]	**21**
Passenger-km all vehicle-km [millions km/year]	**28**
Number of Taxis/ 1.000 inhabitants [Taxis/1000 inhabitants]	**40**
Car taxes [EUR/year]	**27**
Parking costs/hour [EUR]	**31**
Public Transport One-trip-Ticket (single ticket in city centre) [EUR]	**38**
Public Transport Monthly commuter ticket [EUR]	**35**
Road accidents resulting in death or serious injury per year (per 1000 population)	**57**
Traffic accident injuries [total seriously injured] / 10.000 inhabitants	**26**
Total fatalities / 10.000 inh.	**53**
Proportion of residents exposed to outdoor noise levels above 65 dB (24hr averaging time) (%)	**17**
CO_2 Emissions (Tonnes per person)	**46**
Winter smog: Days per year SO_2 exceeds125 µg/m^3 (24hr averaging time)	**51**
SO_2 Emissions per inhabitant [kg/year] 1995	**190**
Reduction factor for SO_2 Emissions 1995 vs 2010 [%]	**190**
"observed" SO_2 Concentrations (µg/m3) 1990-1994	**96**
NOx Emissions per inhabitant [kg/year] 1995	**190**
Reduction factor for NO_X Emissions 1995 vs 2010 [%]	**190**
"observed" NO_2 Concentrations [µg/m^3] 1992-1996	**109**
CO Emissions per inhabitant [kg/year] 1995	**190**
Reduction factor for Emissions 1995 vs 2010 [%]	**190**
estimated concentrations UAQAM <CO> (mg/m3) annual mean 1995	**190**
Pb Emissions per inhabitant [g/year] 1995	**190**
Reduction factor for Pb Emissions 1995 vs 2010 [%]	**190**
estimated concentrations UAQAM Pb 1990	**190**
Benzene Emissions per inhabitant 1995 [g/year]	**190**
Reduction factor for Benzene Emissions 1995 vs 2010 [%]	**190**
estimated concentrations UAQAM benzene 1995	**190**
PM10-Emissions per inhabitant 1995 [kg/year]	**190**
Reduction factor (%) for PM10 Emissions 1995 vs 2010 [%]	**190**
PM10 Concentrations (µg/m3) 1992-1996	**42**
Summer smog: Days per year Ozone O3 exceeds120 µg/m3 (8hr averaging time)	**42**
Summer smog: Days per year Ozone O3 exceeds120 µg/m3 (8hr averaging time) OFIS simulations 1995 (urban average)	**55**
Summer smog: Maximum number of days per year Ozone O3 exceeds120 ug/m3 (8hr averaging time) OFIS simulations 1995	**55**

Table 7. Extended City List Indicators available for each city

Urban Conglomerate	Nation	Number of collected indicators
Aix-en-provence	**France**	**29**
Ålborg	**Denmark**	**30**
Alicante	**Spain**	**23**
Amiens	**France**	**31**
Amsterdam	**Netherlands**	**55**
Antwerpen (Anvers)	**Belgium**	**49**
Apeldoorn	**Netherlands**	**25**
Arhus	**Denmark**	**23**
Arras	**France**	**25**
Aschaffenburg	**Germany**	**23**
Athinai	**Greece**	**21**
Athinai WTU	**Greece**	**67**
Augsburg	**Germany**	**23**
Barcelona	**Spain**	**23**
Barcelona WTU	**Spain**	**73**
Bari	**Italy**	**34**
Beja	**Portugal**	**32**
Belfast	**United Kingdom**	**26**
Belfast WTU	**United Kingdom**	**29**
Berlin	**Germany**	**64**
Bern	**Switzerland**	**19**
Besancon	**France**	**26**
Bethune	**France**	**8**
Bialystok	**Poland**	**23**
Bielefeld	**Germany**	**23**
Bilbao	**Spain**	**39**
Birmingham	**United Kingdom**	**20**
Birmingham WTU	**United Kingdom**	**17**
Bologna	**Italy**	**37**
Bonn	**Germany**	**23**
Bordeaux	**France**	**23**
Bordeaux WTU	**France**	**42**
Bradford	**United Kingdom**	**18**
Braga	**Portugal**	**12**
Brandenburg	**Germany**	**25**
Braunschweig	**Germany**	**25**
Bremen	**Germany**	**27**
Bristol	**United Kingdom**	**57**
Brno	**Czech Republic**	**37**
Bruxelles (Brussel)	**Belgium**	**80**
Bucharest	**Romania**	**40**
Budapest	**Hungary**	**41**
Caen	**France**	**27**
Calais	**France**	**27**
Cardiff	**United Kingdom**	**37**
Catania	**Italy**	**24**
Ceske Budejovice	**Czech Republic**	**35**
Charleroi	**Belgium**	**25**
Chemnitz	**Germany**	**23**
Clermont-ferrand	**France**	**49**
Colmar	**France**	**25**
Cordoba	**Spain**	**23**

Cork	**Ireland**	**19**
Cottbus	**Germany**	**25**
Coventry	**United Kingdom**	**23**
Creil	**France**	**25**
Darmstadt	**Germany**	**23**
Doncaster	**United Kingdom**	**23**
Dordrecht	**Netherlands**	**25**
Dortmund	**Germany**	**27**
Dresden	**Germany**	**41**
Dublin	**Ireland**	**17**
Dublin WTU	**Ireland**	**36**
Dunkerque	**France**	**32**
Düsseldorf	**Germany**	**39**
Edinburgh	**United Kingdom**	**49**
Eindhoven	**Netherlands**	**25**
Emden	**Germany**	**23**
Erlangen	**Germany**	**23**
Esbjerg	**Denmark**	**24**
Espoo	**Finland**	**25**
Essen	**Germany**	**40**
Firenze	**Italy**	**36**
Frankfurt am Main	**Germany**	**49**
Frankfurt am Main WTU	**Germany**	**9**
Freiburg	**Germany**	**23**
Geneva	**Switzerland**	**20**
Genova	**Italy**	**62**
Gent	**Belgium**	**25**
Gijón	**Spain**	**23**
Glasgow	**United Kingdom**	**40**
Glasgow WTU	**United Kingdom**	**27**
Göteborg	**Sweden**	**45**
Granada	**Spain**	**23**
Graz	**Austria**	**48**
Grenoble	**France**	**33**
Haarlem	**Netherlands**	**24**
Halle	**Germany**	**25**
Hamburg	**Germany**	**50**
Hanau	**Germany**	**23**
Hannover	**Germany**	**28**
Heerlen/Kerkrade	**Netherlands**	**23**
Heidelberg	**Germany**	**23**
Heilbronn	**Germany**	**23**
Helsinki	**Finland**	**18**
Helsinki WTU	**Finland**	**80**
Ingoldstadt	**Germany**	**23**
Innsbruck	**Austria**	**25**
Jönköping	**Sweden**	**25**
Juväskylä	**Finland**	**26**
Kaiserslautern	**Germany**	**25**
Karlovy Vary	**Czech Republic**	**18**
Karlsruhe	**Germany**	**25**
Karlstad	**Sweden**	**25**
Kassel	**Germany**	**25**
Kiel	**Germany**	**23**
Kingston-upon-hull	**United Kingdom**	**26**

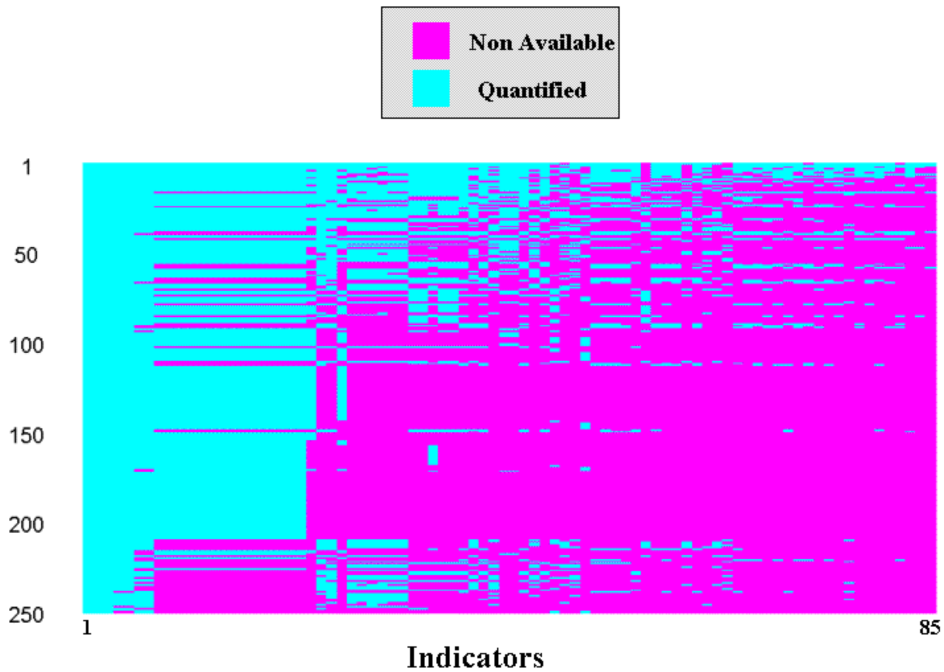
Klagenfurt	**Austria**	**25**
Kobenhavn	**Denmark**	**19**
Kobenhavn WTU	**Denmark**	**46**
Koblenz	**Germany**	**25**
Köln	**Germany**	**39**
Kostelec	**Czech Republic**	**22**
Krakow	**Poland**	**25**
La-rochelle	**France**	**26**
Leeds	**United Kingdom**	**20**
Le-havre	**France**	**32**
Leicester	**United Kingdom**	**26**
Leipzig	**Germany**	**34**
Lens-bethune	**France**	**24**
Liberec and Jablonec	**Czech Republic**	**37**
Liege	**Belgium**	**25**
Lille	**France**	**23**
Lille WTU	**France**	**45**
Linkoping	**Sweden**	**25**
Linz	**Austria**	**25**
Lisbon	**Portugal**	**16**
Lisbon WTU	**Portugal**	**38**
Liverpool	**United Kingdom**	**21**
Liverpool WTU	**United Kingdom**	**39**
Livorno	**Italy**	**24**
London	**United Kingdom**	**43**
Lübeck	**Germany**	**25**
Lucca	**Italy**	**21**
Lund	**Sweden**	**23**
Luxemboug	**Luxembourg**	**39**
Lyon	**France**	**22**
Lyon WTU	**France**	**51**
Madrid	**Spain**	**42**
Madrid WTU	**Spain**	**48**
Magdenburg	**Germany**	**25**
Mainz	**Germany**	**24**
Málaga	**Spain**	**35**
Manchester	**United Kingdom**	**21**
Manchester WTU	**United Kingdom**	**54**
Mannheim-ludwigshafen	**Germany**	**27**
Marseille	**France**	**33**
Marseille WTU	**France**	**45**
Merseyside	**United Kingdom**	**35**
Messina	**Italy**	**24**
Milano	**Italy**	**37**
Milano WTU	**Italy**	**51**
Modena	**Italy**	**24**
Monchengladbach	**Germany**	**23**
Montbeliard	**France**	**27**
Montpellier	**France**	**25**
Most and Litvinov	**Czech Republic**	**26**
Mulhouse	**France**	**32**
München	**Germany**	**70**
Munster	**Germany**	**23**
Murcia	**Spain**	**23**
Namur	**Belgium**	**24**

Nancy	**France**	**31**
Nantes	**France**	**23**
Nantes WTU	**France**	**52**
Napoli	**Italy**	**30**
Napoli WTU	**Italy**	**13**
Newcastle	**United Kingdom**	**18**
Nice	**France**	**35**
Nijmegen	**Netherlands**	**23**
Norrkoping	**Sweden**	**25**
Nottingham	**United Kingdom**	**48**
Nürnberg	**Germany**	**25**
Oberhavel	**Germany**	**29**
Oberspreewald-Lausitz	**Germany**	**29**
Odense	**Denmark**	**25**
Oporto	**Portugal**	**14**
Oporto WTU	**Portugal**	**32**
örebro	**Sweden**	**25**
Oslo	**Norway**	**20**
Oulu	**Finland**	**37**
Palermo	**Italy**	**34**
Palma-de-Mallorca	**Spain**	**23**
Paris	**France**	**65**
Patrai	**Greece**	**16**
Piacenza	**Italy**	**24**
Plymouth	**United Kingdom**	**23**
Prague	**Czech Republic**	**25**
Ravenna	**Italy**	**24**
Reggio-emilia	**Italy**	**24**
Reims	**France**	**31**
Rennes	**France**	**31**
Roma	**Italy**	**68**
Rostock	**Germany**	**24**
Rotterdam	**Netherlands**	**21**
Rotterdam WTU	**Netherlands**	**39**
Rouen	**France**	**33**
Saarbrücken	**Germany**	**25**
Saint-etienne	**France**	**28**
Salzburg	**Austria**	**25**
San Sebastian	**Spain**	**26**
Sassari	**Italy**	**24**
Schwerin	**Germany**	**24**
Setubal	**Portugal**	**24**
Sevilla	**Spain**	**37**
Sevilla WTU	**Spain**	**35**
S'gravenhage	**Netherlands**	**25**
Sheffield-Rotherham	**United Kingdom**	**27**
Siracusa	**Italy**	**24**
Southampton	**United Kingdom**	**26**
Stevenage	**United Kingdom**	**24**
Stockholm	**Sweden**	**45**
Stockholm WTU	**Sweden**	**34**
Stoke-on-Trent	**United Kingdom**	**23**
Strasbourg	**France**	**23**
Strasbourg WTU	**France**	**47**
Strathclyde	**United Kingdom**	**41**

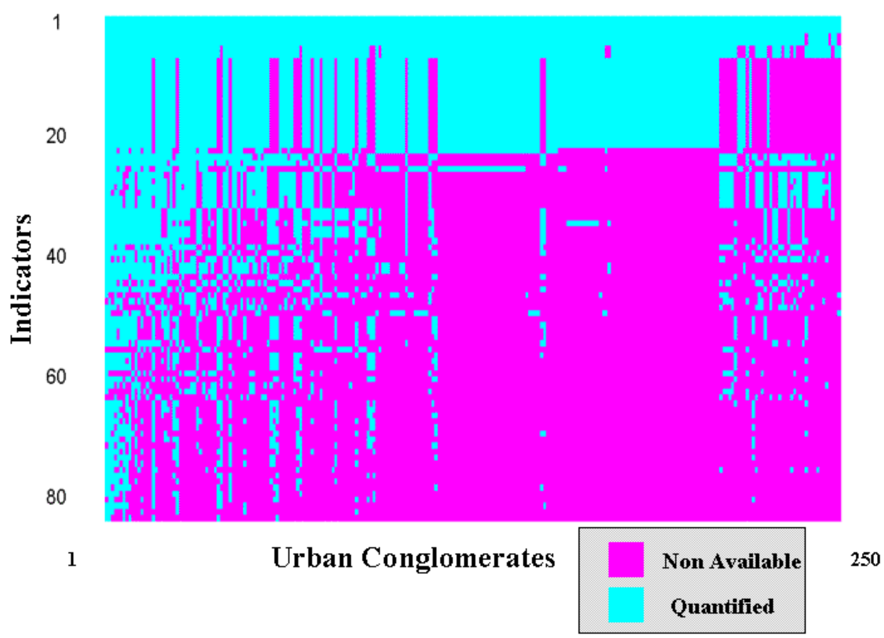
Stuttgart	**Germany**	**51**
Stuttgart WTU	**Germany**	**8**
Suceava	**Romania**	**12**
Sunderland	**United Kingdom**	**22**
Teesside	**United Kingdom**	**21**
Terni	**Italy**	**45**
Thessalonika	**Greece**	**39**
Torino	**Italy**	**42**
Toulon	**France**	**29**
Toulouse	**France**	**42**
Toulouse WTU	**France**	**26**
Tours	**France**	**24**
Trento	**Italy**	**24**
Trier	**Germany**	**23**
Tyneside	**United Kingdom**	**23**
Ulm	**Germany**	**23**
Uppsala	**Sweden**	**23**
Utrecht	**Netherlands**	**27**
Valencia	**Spain**	**36**
Valencia WTU	**Spain**	**18**
Valenciennes	**France**	**29**
Valladolid	**Spain**	**23**
Venezia	**Italy**	**24**
Verona	**Italy**	**24**
Vigo	**Spain**	**23**
Wetzlar	**Germany**	**23**
Wien	**Austria**	**57**
Wiesbaden	**Germany**	**25**
Wilhelmshaven	**Germany**	**23**
Wuppertal	**Germany**	**23**
Zaanstad	**Netherlands**	**23**
Zaragoza	**Spain**	**39**
Zürich	**Switzerland**	**30**

Table 8. Extended City List Indicators available for each city

In the next page the “sparseness” of the Urban Conglomerate / Indicator matrix is represented in a graphical form. Each cell of the grid refers to a specific indicators and a specific urban conglomerate and the colour with which it is painted reflects the fact if that indicator could be quantified or not for that specific city. As can be seen from the pictures, from the overall “sparse” matrix tend to emerge some densely populated patterns (usually corresponding to a set of data extracted from a single source).
These data will be at the base of the benchmarking analysis presented in the next Chapter.



Graphical Visualisation of the Urban Conglomerates for which Indicators could be quantified (for each indicator, i.e., column in the figure, the cities for which it could be quantified are represented by a cyan cells while the cities for which no data were available by magenta cells)



Same as the previous Figure, but now the columns refer to the Urban Conglomerates while the Indicators are represented as columns

5 Benchmarking results and web interface implementation

Benchmarking is only as good as the quality and availability of the data it is based on and solid data collection and assessment techniques are therefore the basis for a meaningful benchmarking exercise.

For example the 1992 and 1999 surveys of cities organized by ECMT-OECD in the frame of the project on *Implementing Sustainable Urban Travel Policies (ECMT-OECD, 2001)*, have demonstrated that data, particularly as concerns urban travel and land use and their interactions, remain sparse, inconsistent and often of overall poor quality, i.e., they are insufficient in both quantity and quality and are often not available and in many cases not easily accessible in useful form to National Governments. Furthermore, data are not collected in a consistent way among cities and collection methods are often subject to modification within a given city. As a result, potentially helpful benchmarking exercises are difficult to carry out.

Inconsistencies and poor data quality are a key impediment to understanding trends in urban travel patterns and the forces behind the trends. Several factors are no doubt involved, among them: data collection methods are often inconsistent within and among cities, measurements and definitions are divergent from one city to the next and often do not fit those requested in statistical inquiries and, in some countries, private public transport operators are not communicating key public transport traffic trends citing privacy rights. The result is that opportunities for monitoring the impacts of policies based on transport and land use statistics are seriously compromised and comparative exercises such as benchmarking virtually impossible. Consequently, one of the ECMT-OECD recommendations for national government on improving implementation of sustainable urban travel policies focussed on the improvement of data collection *(ECMT-OECD, 2001)* based of the fact that sound and reliable data are the empirical basis for good policy-making and serve as the inputs to the analytical process. More importantly, they provide insight into urban travel trends and the forces behind them – necessary to evaluate what combinations of policies are best for the problems observed. ECMT-OECD suggested that national governments could take initiatives or support on-going activities to improve consistency of data collection and that it would be valuable to develop a consistent methodology at international level that can be used in all such inquiries.

Similar difficulties were faced in attempts of benchmarking even at national level, see, e.g., *TERM 2001 - Indicators tracking transport and environment integration in the European Union (EEA, 2001).* Although the assessment in TERM focuses mainly on the EU level, a kind of “benchmarking exercise” was undertaken by comparing indicators trends at national level.

Several common features at the Member State level were noticed. For example, personal mobility, expressed as the average number of passenger-km per capita, increased in all Member States (except Finland). Differences between countries could be explained by differences in personal income, size of the country and location of holiday destinations. The modal split moved towards the less environment-friendly modes of transport, i.e. passenger cars and powered two-wheelers in most Member States. There are two notable exceptions: the Netherlands (where passenger transport by rail increased markedly) and Austria (where bus/coach transport increased considerably). Freight transport demand per unit of GDP (freight transport intensity) also increased in most Member States, with significant differences between countries. However, in Austria, Denmark, Finland and Portugal only, an increasing share of rail, inland waterways and oil pipelines can be observed. CO_2 emissions from transport are increasing in all countries. Most countries have made considerable progress towards reducing NO_x emissions. Exceptions are Spain, Greece, Ireland and Portugal. There are substantial differences in approaches to adapting transport systems to better address sustainability concerns. For example, Nordic countries make much greater use of taxes, other pricing mechanisms and land-use planning than countries in southern Europe. Some countries, such as Austria, Denmark, Finland, the Netherlands and Sweden, have developed environmental action plans and set targets for the transport sector. Some have also established conditions for carrying out strategic environmental assessments of certain transport policies, plans and programmes. This enhances the integration of environmental concerns and ensures the involvement of environmental authorities and the public in decision making. Although important details on national differences could be found, the authors concluded that more methodological work is required to develop TERM fully into a tool for country benchmarking, that could help countries to learn from each other's experience.

In this respect a Workshop on 'Shared policy learning in transport and environment' was organised jointly by EEA and the Dutch Ministry of Transport at The Hague in March 2001. The participants were transport/environment experts of the EU countries, the Commission and international organisations. Most experts agreed that national comparisons can be useful, both from a European perspective (to assess EU developments on transport and environment, a good insight into country differences is necessary) and from the national point of view (some countries like to know what position they have in the EU transport/environment 'race').

However, serious concerns were expressed regarding the poor quality of data for various indicators, which can give a distorted picture of national differences. There was also difficulty in getting, at EU level, the proper insight into specific national policies and the various instruments they use (i.e. the explanatory factors behind the country differences). Where possible, the indicators and countries are to be evaluated against concrete EU targets and objectives. The current lack of sector-specific targets is a major problem in this respect. The DG ENV-DG TREN expert group on transport and environment has also strongly recommended the setting of intermediate and long-term sectoral targets, and the linking of indicator development to these. It was generally agreed that the countries should be involved more directly in the TERM process, at the data level (through the national statistical offices), the assessment level (EEA is gradually establishing a network of national reference centres for transport and environment) and the political level (the

Commission has created a working group on TERM under the DG ENV-DG TREN expert group on transport and environment).

Due to these basic difficulties, met in any benchmarking exercise previously attempted - not only at urban level but even at a national level (where the availability of quality certified data should be guaranteed by national statistical offices), some care should be taken before analysing the collected data.

The first question to be approached is therefore: “Are the available collected data characterized by an intrinsic quality sufficient to allow the possibility to extract statistically robust and significant results?”. Having no access to the data collection procedure that could in principle allow an “a priori” quantification of data quality, this main question has been approached by a “post-analysis” of the available data. Arising the data at the base of the benchmarking exercise from different and independent data bases and/or ad-hoc surveys, the same indicators can have been quantified for the same cities by more than one authors. Assuming such quantities as “independent observations” of the same quantity a (qualitative, in the contest of our benchmarking exercise) statistical test has been done to verify that the “variability” arising form the quantification of the same indicator for the same city by different (and independent) authors, is significantly smaller than the “variability” emerging from the values derived for the same indicator for the different urban conglomerate for which it has been quantified.
Only in case the “variability” in the quantification of the same indicator for the same urban conglomerate is consistently smaller than the “city to city variation” of the same indicator one can be confident enough to be on the track of a real statistically significant information without necessarily getting stuck in a meaningless analysis of a signal completely overwhelmed by “noise” (i.e., the inaccuracy intrinsic to the quantification of the indicators).

We have therefore started our analysis by an attempt to verify that the quality of the collected data is sufficiently high to allow a statistical analysis.
The results of this attempt as well as the main results of our “benchmarking exercise” are reported in the next Section.

5.1 Benchmarking strategy and results

The analysis of the collected data was mainly finalized to highlight the existing relationship between characteristics of social and urban development and mobility related indicators. The cities studied (obtained by merging several existing databases, as described in details in the previous Chapters) are spread across Europe, extending from the Iberian Peninsula to Eastern Europe and from Northern to Mediterranean countries. Contrary to other studies, as for example the analysis of the Millennium Cities Database, our work has been strictly limited to European urban data. This makes our analysis more specific to European policy but at the same time it makes more critical to extract statistically significant relationships as the homogeneity between European cities is much higher than the heterogeneity intrinsic to a world wide benchmark (including, i.e., affluent North American and Asian countries – characterized by very different urban transport development, as well as developing countries).

Within the analysed data one of the major heterogeneity is related to the European cities of the former communist block. The centralized planning in force until 1989 enabled urban planning and transport to be tightly coordinated – at the same time access to cars was made difficult. The Eastern European cities tend to be quite dense and criss-crossed by high performance public transport networks articulated around metro and tramway systems. In the years that have followed the collapse of Berlin Wall, the car population has considerably increased but this “automobile boom” seems to be concerned more with ownership than with the real use of private transportation vehicles (still relatively moderate, compared to European Union, mainly due to its cost).

In order to emphasize geographic heterogeneities, the urban conurbations for which indicators have been collected were aggregated in four main “geographic units”:

- Baltic – including Finland, Norway and Sweden;
- Central – including Austria, Belgium, Denmark, France (continental part), Germany, Ireland, Luxembourg, Netherlands, Switzerland and United Kingdom;
- Mediterranean – including France (Mediterranean part), Greece, Italy, Portugal and Spain;
- Eastern – including Czech Republic, Hungary, Poland and Romania.

Apart from France that was split into a Mediterranean and a Central component, all other countries were associated to a single “geographic unit” (e.g., both the Mediterranean as well as the Central and Atlantic Spain are considered to belong to the Mediterranean geographic unit).

Apart from a city to city benchmarking is therefore possible to benchmark the variations between the four different “geographic unit”.

As any statistical analysis our benchmarking exercise presents some basic limits, mainly related to the quality and quantity of the available data. Before considering the main results of the benchmark it is therefore appropriate to focus on the main difficulties and limits intrinsic to the present analysis. In the frame of the benchmarking exercise, data related to an exhaustive list of sustainable transport related indicators has been collected. In this process, several databases and other sources of quantitative information have been merged together. A main issue is therefore related to the quality and compatibility of the used data.

With respect to compatibility of the collected data, a problem is given by the year of reference for the available statistic and survey sources. Data extracted from different databases (or even from the same database) could refer to different year of reference. In some cases (e.g., Millennium Database) extrapolations were carried out by the authors to ensure that all data refer to the same reference year (1995 for the Millennium case). These adjustments chiefly involved data concerning demographics/economics and the mobility of inhabitants compiled during censuses and periodic household surveys.

In some other cases, data are available for more than one reference year (e.g., City Benchmark aims at quantifying transport indicator for both 1990 and 2000, making some analysis about the incremental variation in this time frame). Merging different sources implied the definition of a strategy about how to treat the time-dependence. This strategy mainly focussed on the choice of the most recent data (in case where more reference years were present). Furthermore, it is believed that the time scale typical for systematic changes in the indicator values should be rather long, compared to the time interval over which the indicators were quantified in the used surveys.

Indicators develop over time, on a characteristic time scales similar to those related to the evolution of cities themselves and the realisation of major transport infrastructures. It seems therefore a reasonable assumption to estimate that the length of validity of the data collected is typically over ten years for the cities in the European Union.

There could be, however, exception both in EU as well as Eastern European countries. Some European cities could make conscious choices to consistently invest in public transport. In Vienna, e.g., the market share of public transport has risen 10% in 4 years due to a combination of measures leading to a fully integrated mass transit system: common tickets for all modes in one area, interchange stations to encourage and facilitate the change from one mode to another, the expansion of metro and suburban rail, modern light rail systems in city streets, new tramline to a new housing area, and personalised marketing in new residential areas.

The time scale could also be shorter in Eastern Europe, due to the rapid evolution following the collapse of Berlin Wall and the consequent social changes. For these countries substantial changes have happened on a time interval smaller than ten years and some special care has to be taken to guarantee the compatibility of the updated collected data.

As a contribution to the thematic related to data quality (and consequently reflecting the possibility to extract valuable information from the statistical analysis) we will briefly report some of our experiences. Having collected the data through literature and not having access to the raw data at the basis of the indicators, the quality and consistency of the data extracted form the different sources can mainly only be post-analysed in statistical terms. For conciseness we will present some reflections related to three kinds of indicators, selected on the basis of the “easiness and standardization” in their definition and data collection procedure. We will analyse:

- **Total Urban Area** [km^2] – an essential indicator (as any consideration related to the population density dependence is directly related to its value). This indicator seems a rather simple quantity that could be quantified in a straightforward way. We will see that the definition can be “rather fuzzy” (being the limits and definition of “urban area” not precisely defined concepts) and consequently could be quantified in significantly different ways by different bodies;

- **Private Cars per Capita Registered in City Boundary** [Vehicles/1000 inhabitants] – a transport related indicator whose quantification should be rather straightforward, requiring the number of registered vehicles (usually available through a local registration office) and the population number (the two quantities are rather correlated one with the other, so that a different definition of the urban area is not expected to affect considerably the results). However, even for the motorisation rates there could be a lack of harmonisation among different cities, as registration records are not equally updated in the different countries, and there could be many other factors to consider: e.g. company cars are usually registered in capital cities, in some countries, even if they finally operate in other cities; the concept of “car” may include or not some categories (family vans, off-road vehicles...);

- **Modal shift of motorized trips: percentage contribution of private (or public) transport** [%] – an important indicator in relation to any consideration about the modal split between public and private transport. The indicator is not a straightforward quantity requiring a knowledge of the transport behaviour and modality in order to allow any quantification. The consistency in the quantification of a such “complex” indicator between different data sources can be seen as a good consistency check between the different sources that have been merged in the database at the basis of the present benchmarking exercise.

Total Urban Area [km^2] – One of the complications faced in the compilation of the data base at the base of the “WP14 benchmarking exercise” involved the definition of the boundaries of conurbations and consequently of the population density. As our data collection consisted in the integration of several data, compiled by different bodies using, in principle, different definitions for city boundary, a compatibility within the merged data couldn’t be automatically guaranteed.
In some cases, the definition of the conurbation boundaries was based on administrative limits. The “Urban Audit” faced this ambiguity, by introducing for a subset (of 27 out of 58 the examined cities) two complementary definitions: the boundary at city level defined as *the main administrative areas under the jurisdiction of an elected body and on the conurbation where the urban area has its own administrative entity* was integrated by information collected at the Wider Territorial Unit or Conurbation level *comprising a combination of administrative areas.* The general approach used to define the WTU was that the wider areas should fulfil either of the following two criteria: that the administrative areas each contiguous with the city administrative level have a population density equal to or greater than 500 persons per square kilometre; that the proposed group of administrative areas corresponds to a build-up area with less than 200 metres between two built units. Furthermore the total

populations of the city and administrative areas within the WTU were at least 50% greater than the population of the city..

Some other cases, as “Generalised Empirical Approach (GEA) for air quality evaluation in the second Auto Oil Programme (AOP-II)” evaluated the size of the urban area using as basic input the CORINE land cover data set and the Major Land Cover Types of Europe (MLCT data set). The second data set was used, as CORINE was not yet available for some countries (UK, Sweden and Finland). In the evaluation of urban area, only the land cover classes 1.1.1 (continuous urban fabric), 1.1.2 (discontinuous urban fabric), 1.2.1 (industrial or commercial units), 1.4.1 (green urban area) and 1.4.2 (sport and leisure facilities) were considered. When these urban zones were less than 200 meters apart, they were believed to be of the same urban agglomeration. In addition to the combination of cities described above, the procedure to estimate the urban area resulted in a further grouping of several cities. Clearly the distance between cities was so small that the urban agglomerations were "floating" together. The following cities were combined: Tyneside and Sunderland (United Kingdom), Rotterdam and Vlaardingen (the Netherlands), Mannheim and Ludwigshafen (Germany), Milano and Sesto San Giovanni (Italy), Essen, Duisburg, Bochum and Gelsenkirchen (Germany), Lens and Bethune (France). The procedure failed to produce a meaningful result for Helsinki. Helsinki is strongly fragmented and the automatic procedure was not able to make the correct linkage. Two outliers were than “artificially” post-corrected: at the high end the Spanish city Murcia was estimated to have a population density of about 40.000 inhabitants per km^2; the area of Murcia was adjusted by a factor 2 in order to bring its population density more in line with the averaged density in Spanish cities. At the low end, a density of less than 500 inh/km^2 was found for Braunschweig, Germany with an estimated area of 470 km^2. Using the CORINE data set an area of 34 km^2 was calculated. Applying a similar procedure to estimate urban area but now starting with a population density map, results in an area of 42 km^2 for Braunschweig. Evidently, the estimated area of 470 km^2 for Braunschweig is too large. In the further calculations the Braunschweig area was reduced by a factor of 10 to bring it in agreement with the other German cities. In comparison to other population density estimates (e.g. made on the basis of urban questionnaires for the Dobris assessment) the GEA AOP-II current densities seems to be relatively high although a large scatter is found. As population numbers are in a reasonable agreement, the current area estimations might have a tendency to be too low. In the opinion of the authors, the uncertainties were however, considered so large not to justify the introduction of a correction factor. The authors conclude their efforts by noting that further work on obtaining more accurate urban characteristics, such as built-up area, would be required.

While the total surface can give a general idea of the total area that has to be covered by the transport system, the built surface only includes urbanised areas. Both figures may help to understand other indicators. For some cities, both figures are similar (thus indicating that most of its territory has been urbanised and/or that not the whole of the functional metropolitan area is included in the figures provided), while for others the built surface is only a small percentage of the total surface, suggesting that the administrative boundaries include large non-urban areas, with only weak functional links with the metropolitan system.

As an example of a consistency check between the different data sources, Figure 1 shows the values of the population density (i.e., population / total urban area) for several urban conurbations. The cities were chosen giving priority to those for which data were available from several different sources. The figure reflects the difficulties in using the "population density" obtained by merging several databases as a variable in the benchmarking exercise. Data related to the same urban conurbation tend to show a large scattering. The "uncertainty" (related, e.g., to the standard deviation) inherent to the data referred to a single urban unit can as a matter of fact be of the same order or even bigger than the variation between the different urban units (intra-city variation). In particular, three "behaviours" can be identified:

- cities for which the data extracted from different data bases show a good agreement (e.g., München);
- cities that tend to show a "bi-polar" nature (e.g., Kobenhavn) - that can be in principle interpreted as a cluster related to population density at city level and to the Wider Territorial Unit, respectively;
- cities with "unexplainable" scattering (e.g., Barcelona) that should be related or to different definition and/or to poor data quality in some of the data sources.

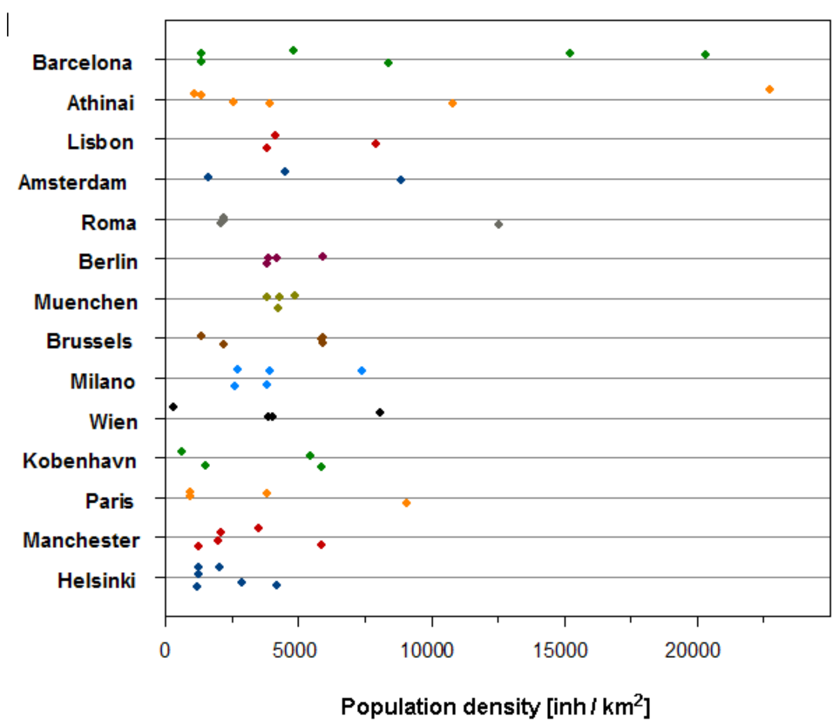


Figure 1 - Value of the population density, for few representative cities, as extracted from different data sources. As can be seen from the figure, the scattering of the values related to the same city (but evaluated by different bodies) can be of the same order than the "intra-city" scattering.

This large discrepancy required the definition of a procedure for merging the different available data in the "SUTRA WP14" database. The used criteria were:

- to give privilege to one of the database (we have, when possible, given priority to the GEA AOP-II database that evaluated in a consistent way the urban area for a considerable number of European cities);
- in cases where a "bi-polar" nature in the data could be detected, two record were inserted in the database, both referring to the same city, but one to the city level and the second to the Wider Territorial Unit;
- indicators related to area and/or population were normalized using the values intrinsic to the original database, i.e., before being imported in the "SUTRA WP14" database.

Following the aforementioned procedure was possible to obtain a data set that could reflect the population density dependence of transportation. Nevertheless, recalling the substantial uncertainty (as clearly shown in Figure 1, any results as well as the lack of any statistically significant dependence should be taken with some care). It is at the same time rather clear that conclusion in this direction would require a clear and standardized definition of the city boundary and that efforts should be undertaken in this direction.

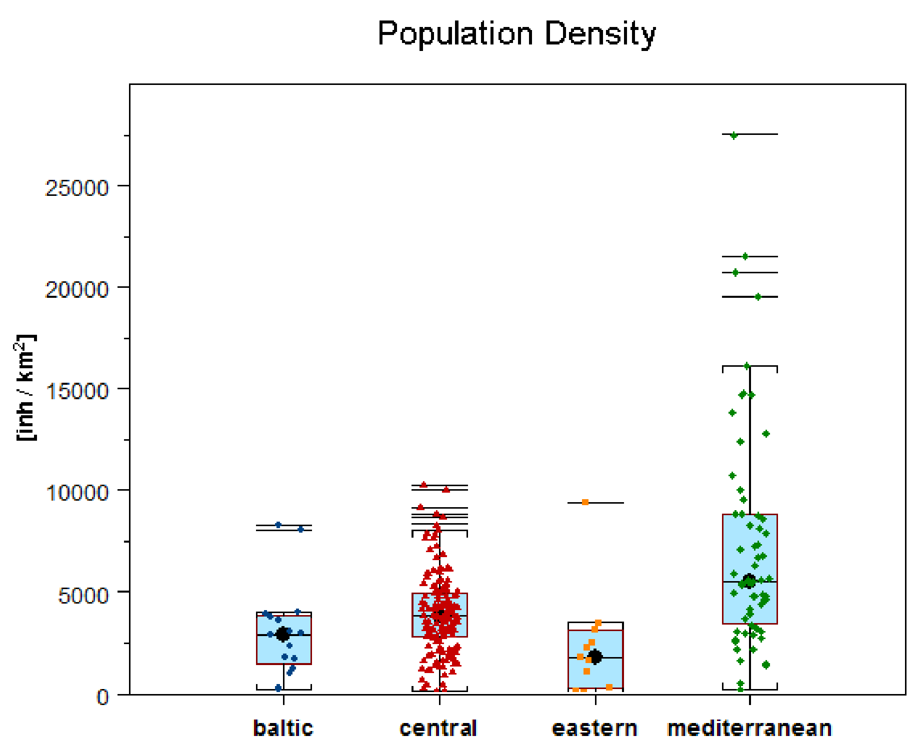


Figure 2 Population density dependence for different geographical units

The (eventual) dependence of population density with respect to geographical location is shown in Figure 2. Some geographic dependence seems to emerge from the picture, eastern European as well as Baltic conurbations appear, on average, to be less densely populated when compared to central and southern Europe. Mediterranean countries in particular tend to show a wide variation with few “outliers” characterized by extremely high densities. More than a “real” effect the wide scattering as well as the extreme values could reflect the uncertainty in the definition of city boundary (especially for small historical centres) and in the choice of the evaluation algorithm for the urban area (and its reflection in the value for population density).

Private Cars per Capita Registered in City Boundary [Vehicles/1000 inhabitants] – as expected the values extracted from different databases present a much higher consistency than the previous case. From Figure 3a it is clear than the “intra-city” variation is higher than the uncertainty intrinsic to the determination of the value of the indicator (reflected by the scattering of the values obtained form different independent databases). From the figure, a clear *outlier* appears only for the city of Milan, probably due to lack of quality in one of the data sources.

Figure 3b shows the geographical dependence reflecting the fact that Eastern European countries have reached an ownership rate comparable to other geographic units.

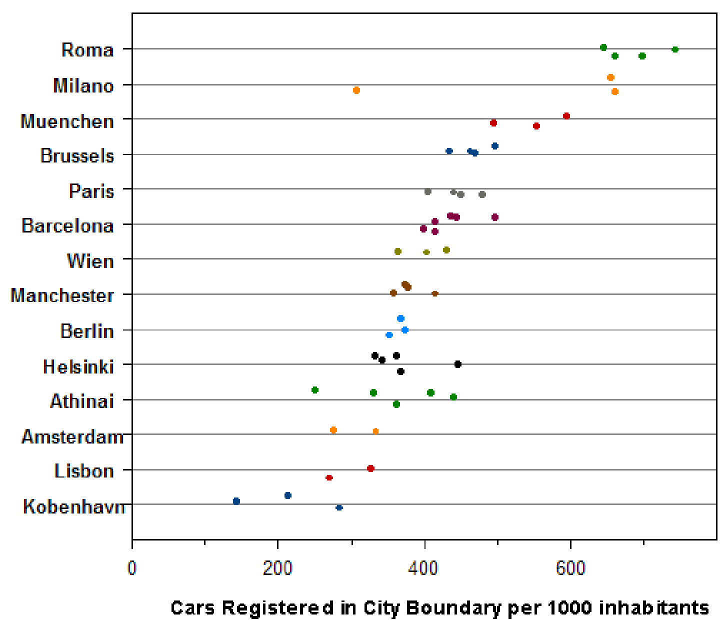
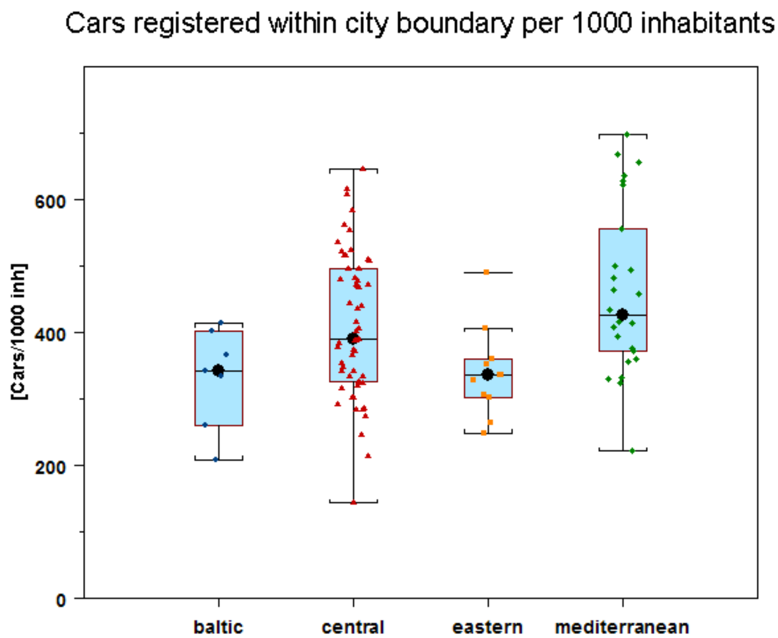


Figure 3a, 3b - Same as Figure 1|2, but in relation to the number of private vehicles per 1000 inhabitants.



Modal split of motorized trips: percentage contribution of private (or public) transport [%] – although the indicator is relatively "sophisticate", Figure 4 shows that the data contained in different data sources show a considerable consistency. The intra-city variation, even for the selected set of city – mainly representative of central Europe, appears to be wider than the uncertainty in its determination (i.e., the scattering relevant to independent evaluations of its value). This result tends to support the possibility to obtain statistically significant results by (cautiously) merging results available in literature. The significance of the information becomes even clearer in Figure 5, where the data are aggregated on the geographic unit and the "intra-city" variation enlarged mainly by the inclusion of Eastern European countries that show a clearly higher contribution of public transport on the motorized mobility.

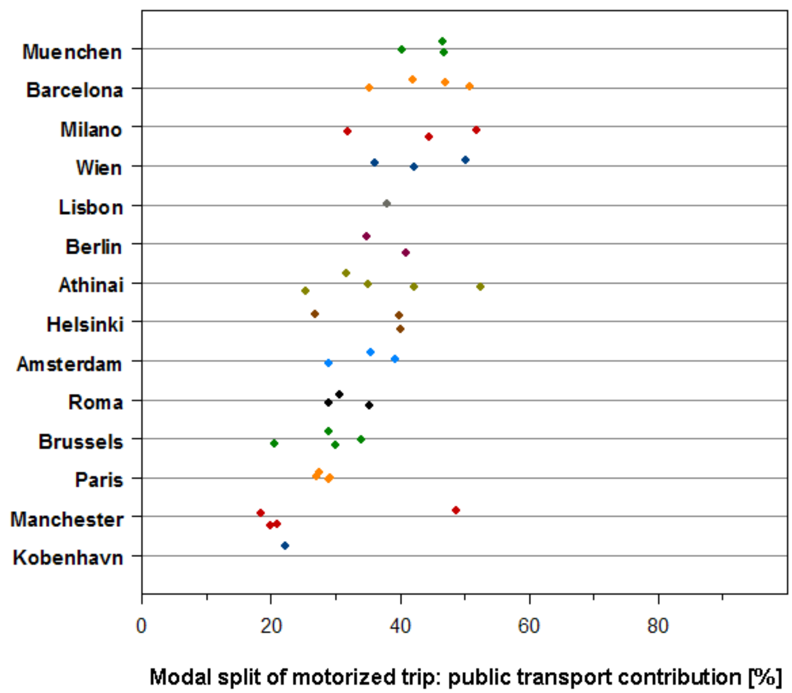


Figure 4 Same as Figure 1, but in relation to the modal split.

Through our experience in the "merging process" of data extracted by different survey, we believe that substantial information can be extracted form the available data (in particular in statistical terms and working with aggregated data). The benchmarking exercise could therefore be useful to extract background values and confidence intervals with which data related to a specific case study could be compared with, in order to obtain a ranking of the case study compared to the general averaged values.

Application of this type will be presented in the next Section .

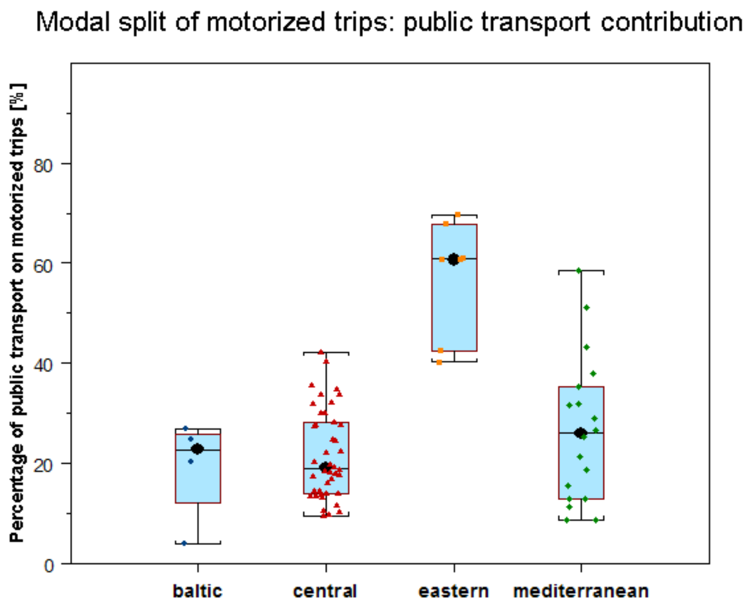


Figure 5 Same as Figure 2, but in relation to the modal split.

One of the main aim of the benchmarking exercise was the analysis of the broad patterns of transportation dependences found in the collected data. A first approach to this problem was the analysis of the relationship between different sustainable transport indicators. This is mainly done through a series of graphical analysis focussing on a limited selection of the main data. It is extremely useful and straightforward to see how some of the selected key variables are related to each other and to do this some simple bivariate local regressions are presented. As any statistical regression analysis it is worth to underline that no assumption of causality between variables can be intended or made when presenting or discussing these results. The purpose of this overview analysis is to show that certain basic relationships either exist or do not exist between key indicators across the extended WP14 benchmarking database. More detailed multivariate analysis could in principle explore these relationships in greater depth using the full set of variables available. Such an analysis is however beyond the scope of the reported benchmarking exercise.

A first analysis was dedicated to the analysis of the (eventual) presence of a geographical dependence. Apart from aggregating the urban area into geographic unit (see, e.g., Figure 2) it is possible to obtain such a dependence through a continuous plot by making use of the coordinates of the different urban areas. In the following figure it is shown the North-South dependence for few indicators (the East-West variation is partially reflected in the colour code, referring to the different geographic units).

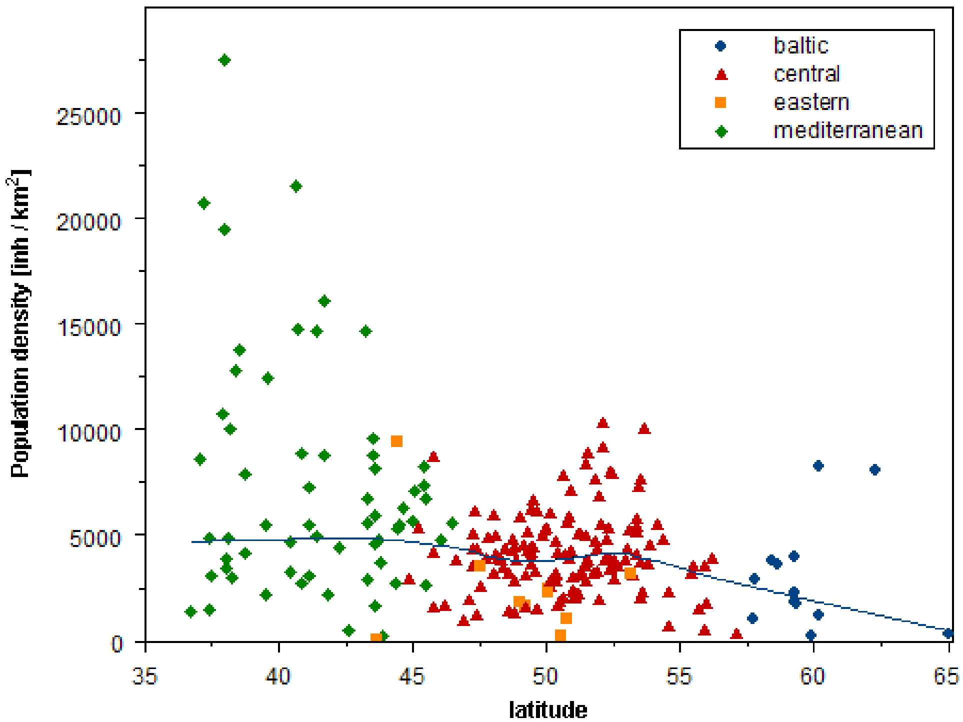


Figure 6 North/South dependence of population density

Figure 6 shows the behaviour already presented in Figure 1 and Figure 2 (and one has to remember the uncertainty related to the definition of the city boundaries, and consequently of the population density itself). The urban population density seems to decrees moving towards higher latitudes. Eastern European countries also look to be less densely inhabited than Central European ones. One also have to notice the extreme scattering in Southern Mediterranean urban conglomerate that (apart from consideration related to the quality of the gathered data) should reflect a stronger tendency to maintain the historically inherited compact central density, limiting the developing of low populated outreaching suburbs (e.g., for geographical and economic reasons).

The economic situation can be reflected by the Gross Domestic Product (GDP – one has to notice that the indicator is defined at the urban scale and is not merely a re-scaling of the national economic data) shown in Figure 7.

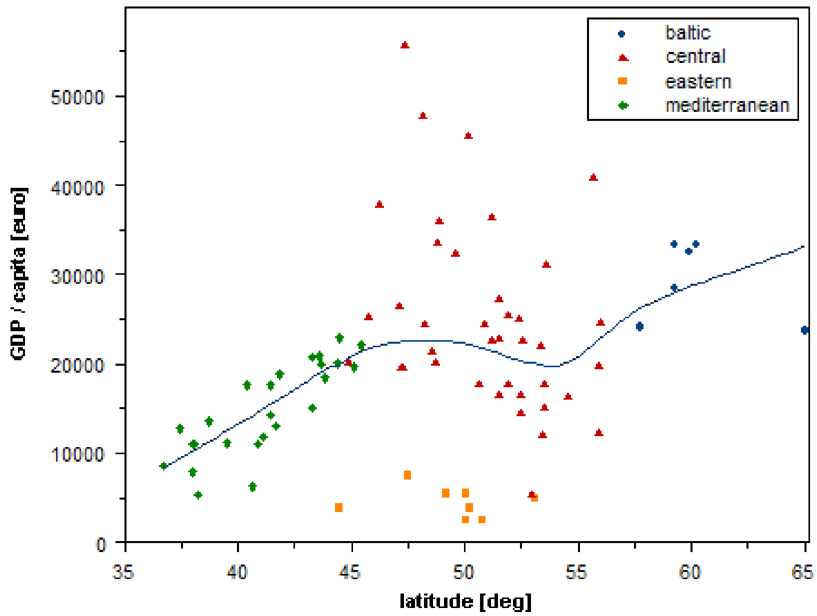


Figure 7 North/South dependence of Gross Domestic Product

As a general tendency one can notice an increase of the GDP with increasing latitude (the highest values are however reached in Central Europe, although this region is characterized by a relatively high scattering in comparison to the other geographical units and tends to appear more homogeneous). Also from Figure 7 clearly emerges the cluster related to Eastern Countries, still characterized by a GDP considerably lower than the EU average value.

While, as expected, the price of public transportation tends to "reflect" the GDP variation (see Figure 8) the car ownership seems to follow a more complex functional dependence: the wealth of the city alone does not appear to be sufficient in explaining the degree of automobile ownership dependence in different cities. Many analyses tend to suggest that it is simply inevitable for automobile dependence to grow in cities as people become more wealthy and as cars become more affordable. Of course, growing wealth is a powerful force in shaping the possibilities and choices offered to cities in the development of their transportation systems and is always a force to be reckoned with, as any city would readily recognise. Such an analysis, however, shows that within Western European urban conglomerate with comparable wealth levels, car ownership per capita doesn't bears a simple linear relationship with wealth: over a certain level of income, the number of cars can not be taken any longer as a symbol of prosperity. Quite clearly some wealthy cities (the present analysis tends to highlight this phenomenon in Baltic as well as Central Europe) have car ownership much more under control. Public policy in such cities appears to be able to shape the urban system into a much less auto-dependent.

Furthermore, Eastern European countries looks like having almost reached the Western European standards, as far as private vehicle ownership is regarded (although on a strictly economic point of view the discrepancy is still remarkable, as emerged from Figure 7).

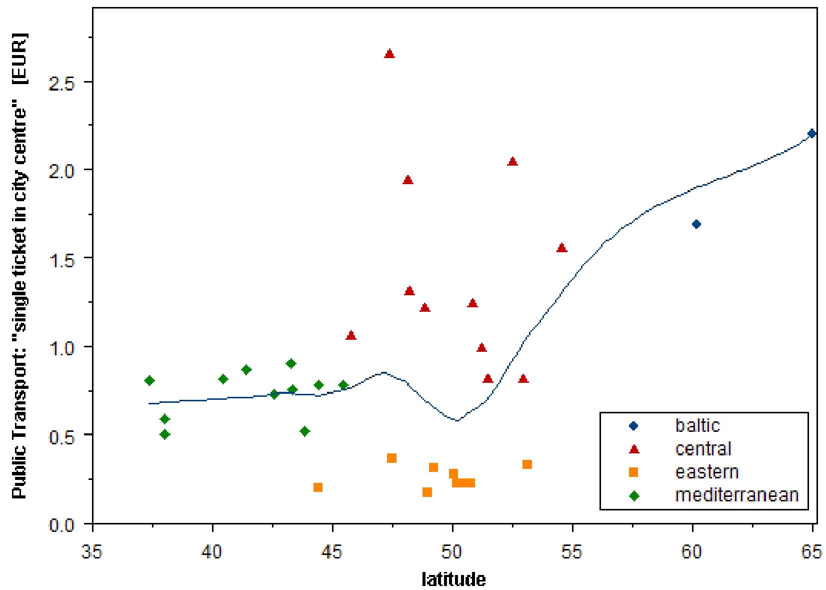


Figure 8 North/South dependence of the cost of a one trip ticket to city centre on public transportation

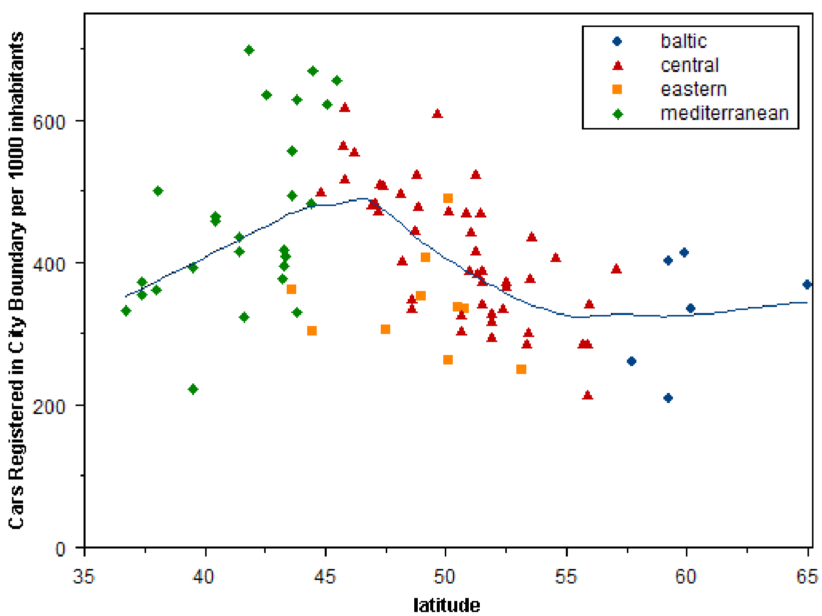


Figure 9 North/South dependence of car registered in City Boundary (vehicles/1000 inhabitants)

An essential and concise "photography" of the urban transport system can be obtained by an analysis of the modal split between non-motorized and motorized trips as well as the sharing of the latest into trips by public and private vehicle. From a poorly geographical point of view no clear dependence can be detected in the latitude dependence of the percentage of non motorized trips (mainly walking and cycling) over the total number of trips (see Figure 10). Few "outliers" can be observed in Figure 10, characterized by "much higher than average" values (Amsterdam and San Sebastian reach a value around 50% of non-motorized trips) and by "much lower than average" values (Athens Wide Territorial Unit as well as Liberec/Jablonec in the Czech Republic slightly higher than 10%). Having no access to the original data collection procedure as well as to the compatibility of the definitions of the indicators collected in the different surveys at the basis of the SUTRA WP14 Database, we have no direct possibility to verify the "confidence limits" of the collected data and consequently to decide if the observed deviations are "artefacts" or real consequences the variety of the transport behaviour in the different urban conglomeration for which data are available indeed. Although, this results to be a general limit of the present benchmarking exercise, the general "smoothness" and consistency between the available data support a data quality sufficient to allow general conclusions and the ranking between different cities and/or geographical units.

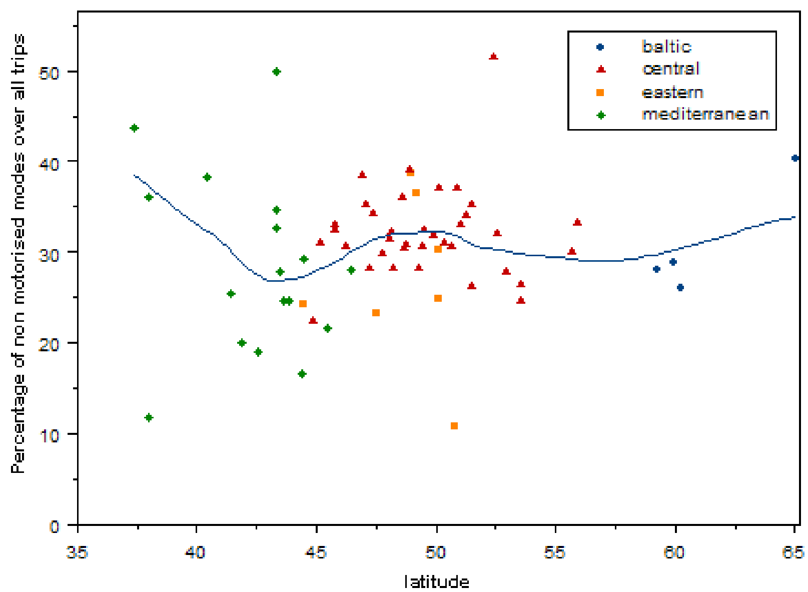


Figure 10 North/South dependence of the percentage of non motorized trips (over all trips)

The analysis of motorized trips can be disaggregated into the private and public transport contributions. This is one of the most interesting indicators. Although relatively straightforward in the definition, it can condensate in a single value the complex behaviour of the modal split at the basis of the motorized urban transportation system.

The private and public modal split are reported in Figure 11 and Figure 12, respectively. One has to notice that the two figures are redundant as one is simply the complement of the other (i.e., the contribution of motorized public transport modal split when added to the contribution of the private vehicles sums up, by definition, to 100% of the motorized trips).

Figure 11 (and consequently Figure 12) shows a general tendency where the use of private cars tends generally to increase at increasing latitudes. However, the most striking result is the "cluster" relatively to Eastern European countries that shows how, although a relatively similar ownership rate of private vehicles - remember Figure 9, the (efficient) public transportation network continue to play a major role in the transportation habits of those countries.

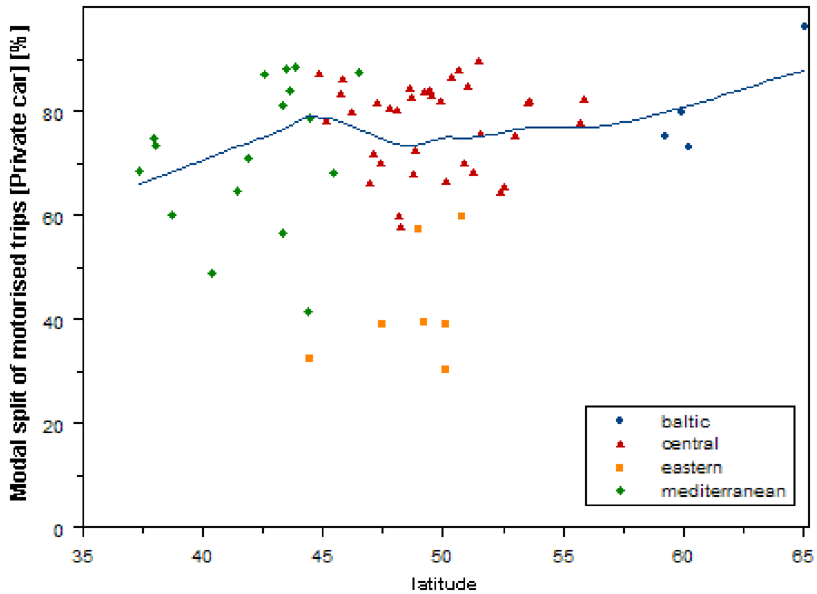


Figure 11 North/South dependence of the percentage of private car trips (over all motorized trips)

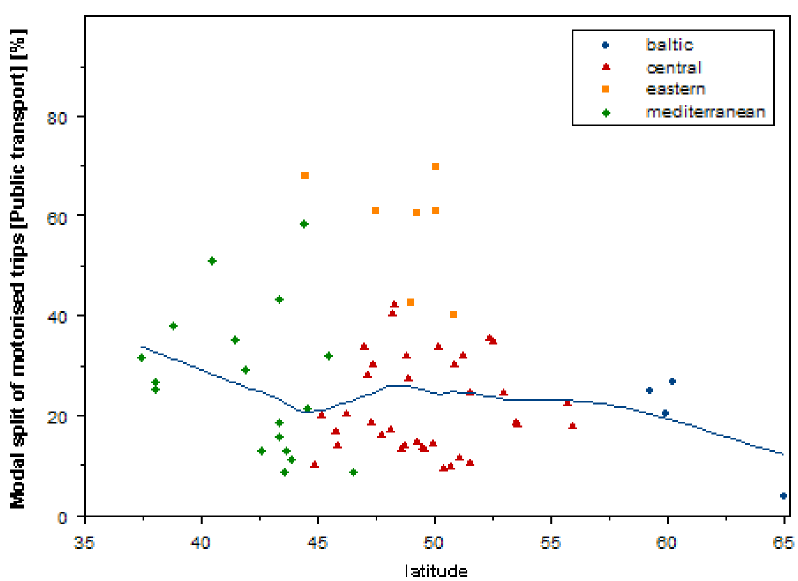


Figure 12 North/South dependence of the percentage of public transport trips (over all motorized trips)

Another (and complementary) way to look at the modal split is the analysis of the number of trips made pro capita and in one year on both public and private vehicles. The results, plotted in Figure 13 and Figure 14, mainly confirm and add value to the previous conclusions.

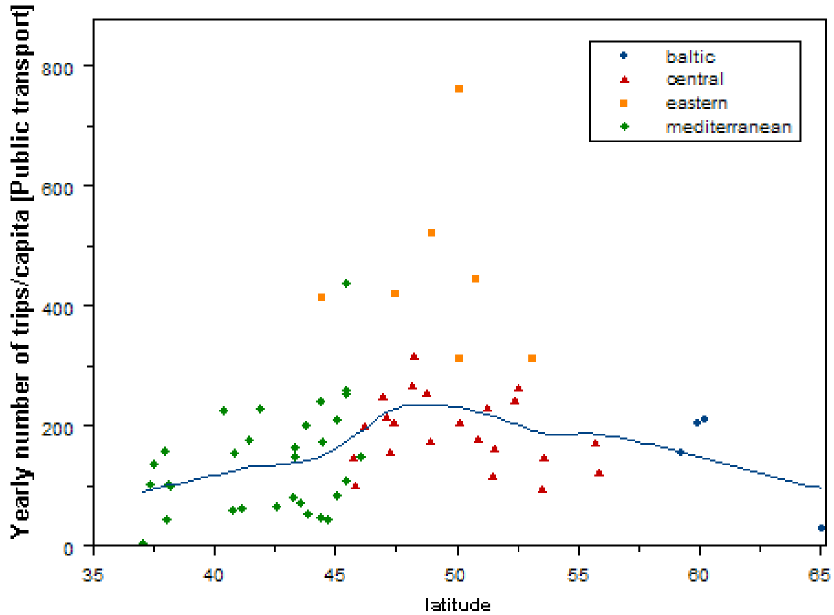


Figure 13 Total number of public transport trips (pro year and pro capita)

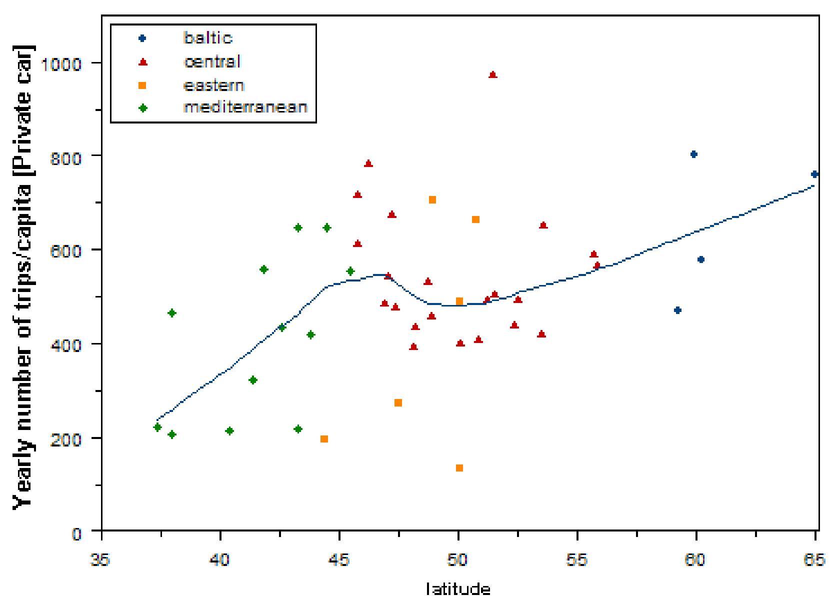


Figure 14 Total number of private car trips (pro year and pro capita)

Some interesting relationships emerge when plotting different indicators against each other (one has to notice again than the presence of a correlation doesn't necessary imply any causal relationship – especially in a multivariate contest as the one analysed in the present Work Package).

Figure 15 shows the relationship between the urban Gross Domestic Product and the percentage of households without a car. A simple inverse proportional could be interpreted as car ownership can be limited by the financial resources. A tendency of this kind appears at the lower end of the GDP pro capita scale (urban areas characterized by lower values of GDP tends to show a higher percentage of families that cannot afford themselves a private car). However, the analysis of the collected data, as already anticipated in the discussion relative to Figure 7 and Figure 9 shows a saturation at middle GDP values and the tendency for the proportion of households without a car to increase again in "extremely wealthy" urban conglomerate (the extreme point at the top right of the plot, with the highest GDP and a percentage of households without a car around 75%, is given by Copenhagen). This confirm the fact that, over a certain level of income, the car ownership can not be taken any longer as a symbol of prosperity.

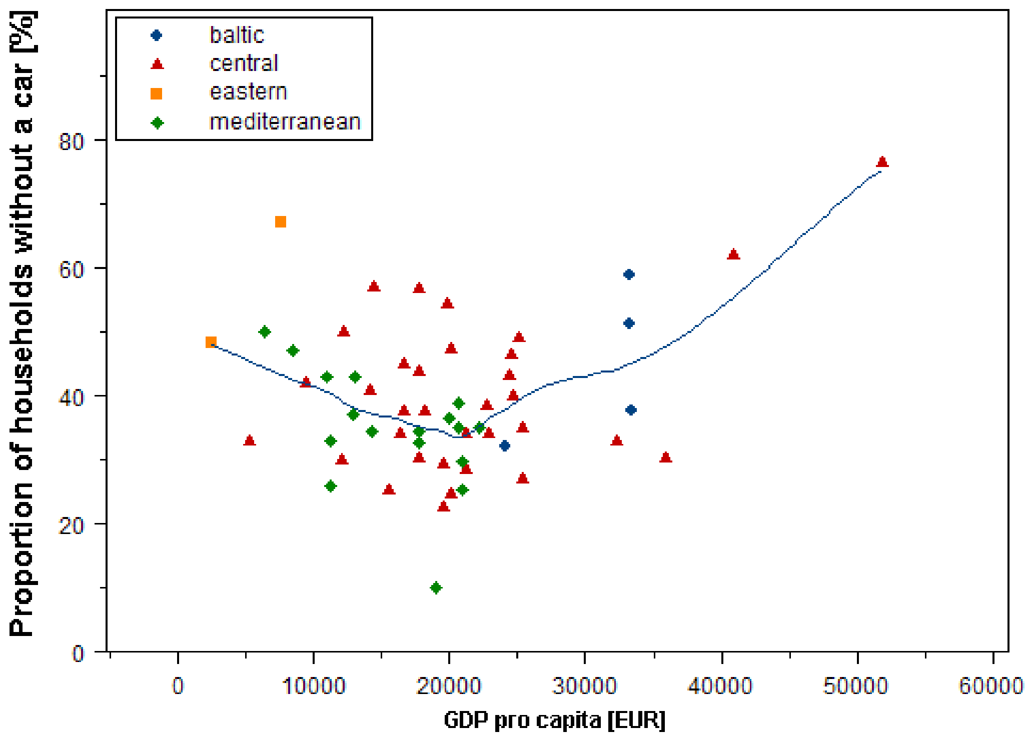


Figure 15 Relationship between urban Gross Domestic Product and the percentage of households without a car

A similar message is given by Figure 16, where the indicator has been changed from car ownership to the annual number of trips by private car pro capita. Again a possible interpretation of the observed relationship is of the presence of a financial limit to the use of private vehicles at low GDP values and a tendency to reduce private mobility in wealthy urban conglomerate.

A similar figure, but related to the public transport, (see Figure 17) shows the important role of this mode in Eastern European country, as already emerged in the previous discussion. Contrary to private transport, no decrease of public transport mobility emerges for the wealthiest Western European urban centres.

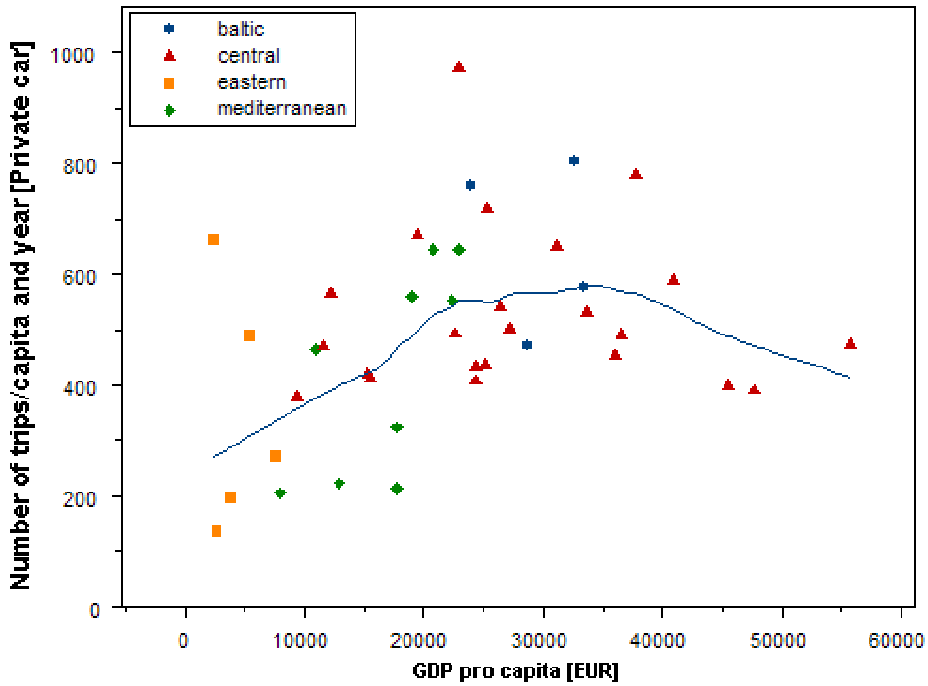


Figure 16 Relationship between urban Gross Domestic Product and the annual number of trips pro capita on private car

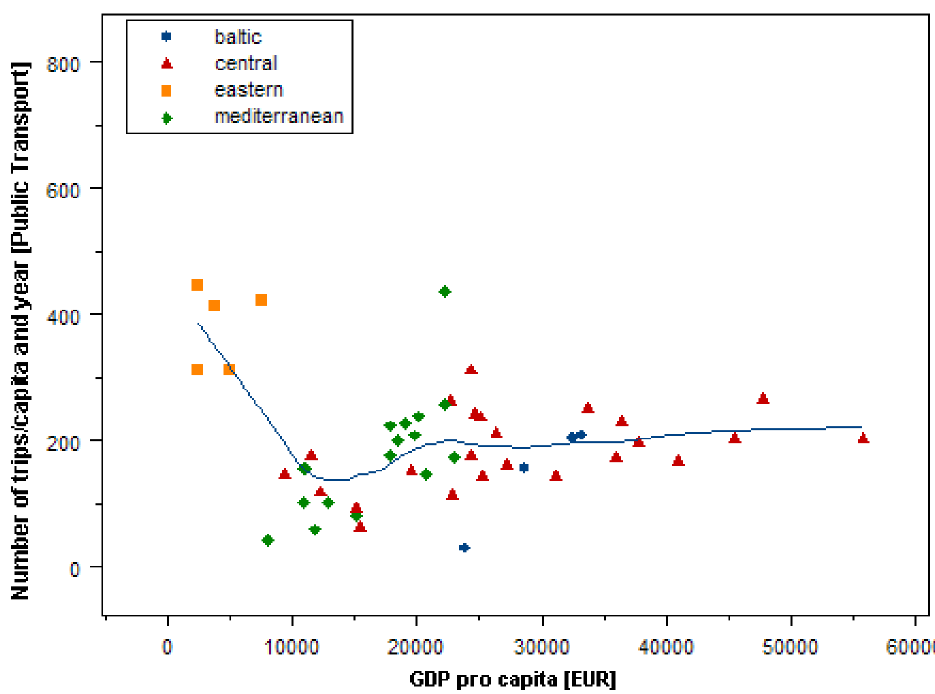


Figure 17 Same as Figure 16 but for Public Transport

One of the set of SUTRA sustainable transport future scenarios was defined in order to analyse the problematic regarding the urban planning and its interconnection with the transport system. The urban structure has evolved in time, rather recently new possibilities have arisen as a consequence of the potential availability of modern and efficient transportation means.
While for centuries, cities hold their housing, economic and cultural activities within a confined space and the dominant transport mode was walking, with the industrial revolution, cities in the most developed countries started extending along railway lines providing home-work journeys. Density remained high and walking continued to be the dominant mode for other journeys. The 20th century automobile boom has, at least potentially, allowed the development of new scenarios of urban growth, allowing for the first time the abatement of the main proximity constraints. Cities were allowed to expand on the detriment of green spaces and farmland, potentially resulting in a sprawling of the urban conglomerate. Urban sprawling allows the possibility of “living in the country while working in town” but at the cost of an increase in the automobile dependency as well as in the duration and cost of commuting. In some countries, public transport, which is inefficient when it comes to serving sprawling zones, has seen patronage fall and its role confined to that of a social service for people without a car.

The data collected in the frame of the present work package, allow an analysis of the eventual relationship between the type of urban development (e.g., urban sprawling as reflected by the urban population density) and the main characteristics of the transportation system.
An analysis of the relationship between population density and the recent developments in the urban population itself shows that already densely populated conglomerate tends generally to show a decrease in the resident population while the opposite tendency is observed in “sparsely” populated urban conglomerate (at least statistically speaking – for the cities for which data could be collected if the frame of the present Work Package, see Figure 18).

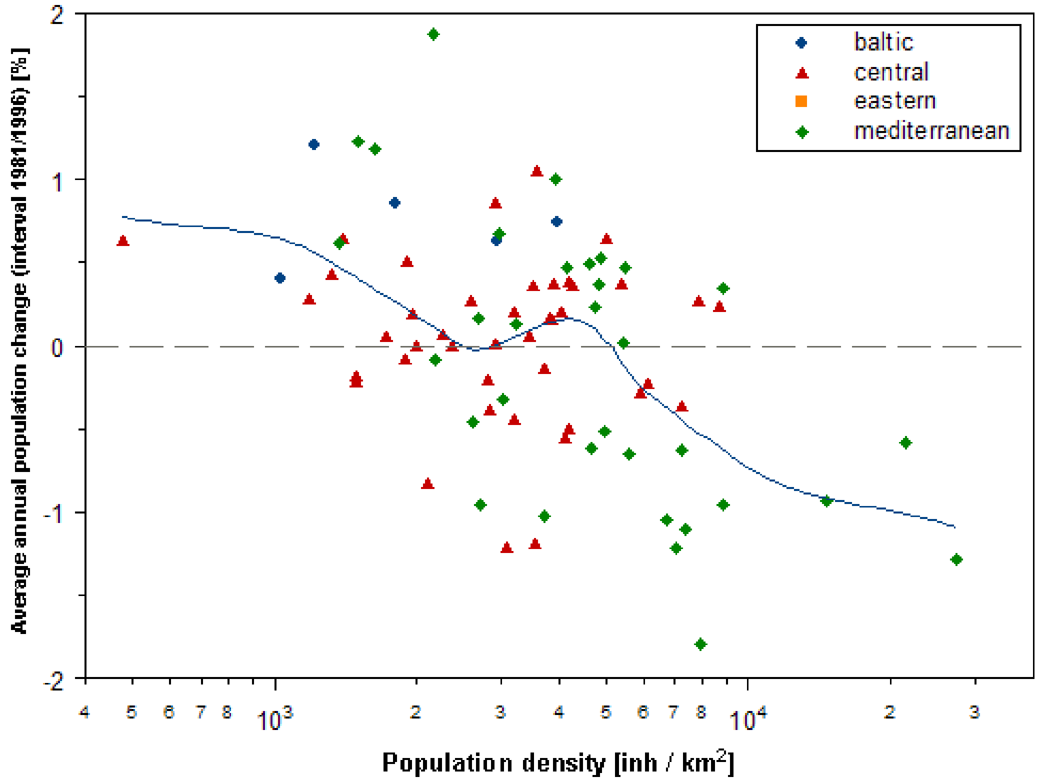


Figure 18 Relationship between population density and the demographic tendency (average annual population change). Please notice the use of a logarithmic scale for the x-axis.

With respect to travel patterns no significant relationship emerges between population density and car ownership,
The relationship with the modal share is also not extremely significant, a large scattering of the data cab be seen at "bulk" population densities in Figure 19 (as already seen, the data referring to Eastern European data – yellow squares – tends to stand out for the higher share of public transportation). The modal share tends to move away from the "average behaviour" at the lowest values of the population density. This behaviour tends to confirm the expectations that urban conglomerate characterized by low population densities (that could be put in relationship with "urban sprawling") tends to be more dependent on the private transportation mode than compact cities (and, in particular, than Eastern European countries where, as previously presented, the use of private car can be limited by both economic reasons as well as the competition with an extremely developed public transportation network).

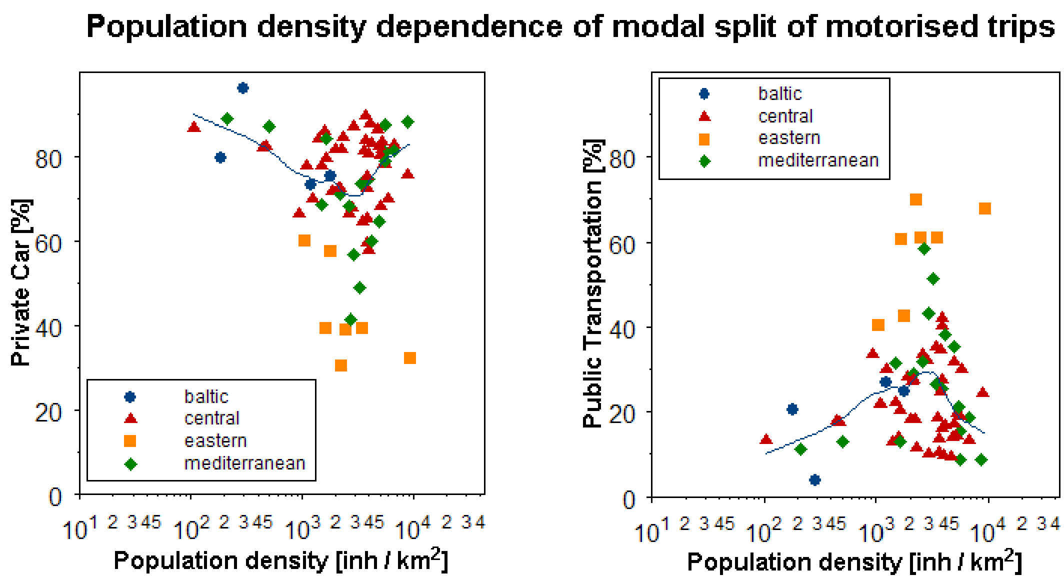


Figure 19 Relationship between population density and modal share (the two figures are two representations of the same data – one being the mirror of the other – both are reported for .

To conclude the analysis, Figure 20 shows that the increase in traffic speed with the decreasing of urban population density tends to be steeper for the private transportation mode (even for rush hours) than for the public transportation (represented by buses, in the figure). This, apart from the freedom and the difficulty of public transport to be economically competitive with private modalities in sprawling urban structures, can be interpreted as a further point supporting the tendency to use of private cars in sparsely populated urban conglomerations.

In this paragraph we have shown some of the major results of our benchmarking exercise. The content of this Section also demonstrate that the data, even if obtained by the merging of several different data sources, appear to possess a quality suitable to a statistical investigation.
On the other side, the significance and success of the benchmarking analysis depends on both the quality as well as the quantity of the available data.

With both the aim of:
- potentially increasing the quantity and quality of the available data by making them available to potential end-user, in the hope of triggering a positive feed-back,
- make the collected data available to eventually interested external users allowing a friendly Internet interface implementing some basic utilities as ranking and graphical interface,

in the frame of the benchmarking exercise we have developed a web interface to the “SUTRA WP14 database”.

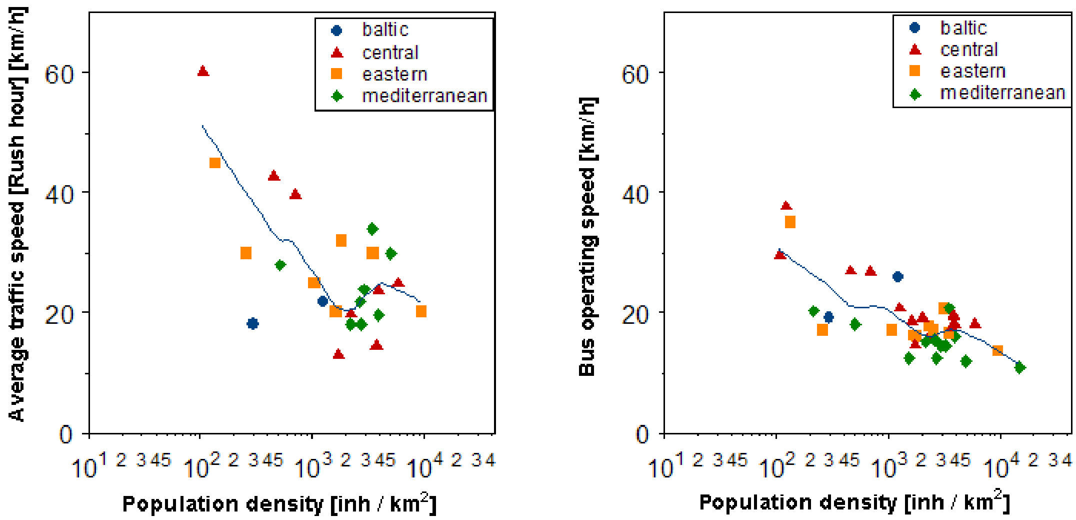


Figure 20 Dependency of average traffic speed and of the bus operating speed as a function of population density

The description of this web interface will be the topic of the next Section.

To conclude this Section in the following table it is shown, as reference, the Minimum, Median and Maximum values for each of the indicators included in the SUTRA Extended City database.

Indicator associate at Urban Conglomerate level	Minimum value	Median	Maximum Value
Latitude	36.72	49.51	65.02
Longitude	-9.15	7.12	26.25
Total Population	24,619	297,163	10,569,997
Total Urban Area [km^2]	7.2	78.3	5210
Population Density [inhabitants / km^2]	21.1	3859.2	27506.2
Average annual population change in interval 1981/1996 [%]	-1.79	0.15	1.87
Proportion of Population in Age Groups 0-15 years [%]	10.6	17.4	28.1
Proportion of Population in Age Groups 16-24 years [%]	8.6	13.5	21.3
Proportion of Population in Age Groups > 64 years [%}	8.8	16.2	24.1
Economically Active Population [%]	32.8	45.4	56.3
Employment in Services [%]	39	75.1	88.4
Gross Domestic Product GDP/Capita [euros 1998 prices]	2,494	19,459	55,742
Urban Area Road/Rail Network [%]	1.09	9.72	24.91
Cars Registered in City Boundary per 1000 inhabitants [Cars/1000 inhabitants]	142.7	390	697.8
Powered two-wheelers Registered in City Boundary per 1000 inhabitants [Powered two-wheelers/ 1.000 inhabitants]	2.7	28.2	501.9
Proportion of households without a car [%]	10	36.9	76.4
Total number of jobs in the metropolitan area [employed working in Urban Conglomerate]	5,500	415,378	4,924,415
Share In-commuters [%]	2.7	21.8	56.0
Share Out-commuters [%]	1.7	13.1	73.1
Percentage of non motorised modes over all trips [%]	10.7	30.6	51.4
Modal split of motorised trips: Private car contribution [%]	30.3	77.7	96.2
Modal split of motorised trips: Public transport contribution [%]	3.8	22.3	69.7
Modal split of motorised trips: Non Motorized + Public transport [%]	29.5	45.4	78.9
Proportion of journeys to work by public transport (rail / metro / bus /tram) [%]	6.9	23.15	56.1
Proportion of journeys for non-work purposes [%]	38.2	84.4	90.5
Proportion of trips for journey to work [%]	8.4	13.4	61.8
Average number of occupants of motor cars	1.25	1.31	1.43
Average traffic speed: rush hour speed [km/h]	13	24	60
Average traffic speed: off-peak speed [km/h]	18	38	70
Operating speed: Bus speed [km/h]	11	17.8	37.9
Operating speed: Tram/light-rail speed [km/h]	12.4	16	35
Operating speed: Metro speed [km/h]	23.2	30.4	47
Operating speed Heavy-rail speed [km/h]	22.4	41.3	63
Number of trips/capita and year on Private car	135.0	486.4	972.9

Number of trips/capita and year on Public transport	3	168.7	762.1
Average trip length for private car [km]	1.7	8.5	17
Average trip length for Public transport [km]	1.7	8.7	25
Overall (private + public transport) average trip length [km]	4.4	7.5	16.9
Passenger-km / (capita and year) for private car [km/inh year]	423.5	2,948	8,360
Passenger-km / (capita and year) [Public transport] [km/inh year]	63.3	1,394.8	4,754.7
Total annual distance travelled per person (by all modes [including walking, cycling, etc) [km]	2,910	4,385	21,900
Bus-km [millions vehicle km]	2.1	34.2	190.8
Passenger-km by bus [millions km/year]	19.6	862.4	4,216
Tram/Light-rail-km [millions vehicle km]	0.26	9.4	43.9
Passenger-km by tram/light-rail [millions km/year]	9.85	236.1	1,201
Metro/heavy-rail-km [millions vehicle km]	1.07	15.8	648.5
Passenger-km by metro/heavy-rail [millions km/year]	29.3	1,358	18,737
Tram/light-rail + metro/heavy-rail[millions vehicle km]	5.7	24.7	646.2
Passenger-km by tram/light-rail + metro/heavy-rail [millions km/year]	9.85	1,678	18,846
Passenger-km all vehicle-km [millions km/year]	2.09	33.65	793.3
Number of Taxis/ 1.000 inhabitants [Taxis/1000 inhabitants]	0.1	1.66	10.3
Car taxes [EUR/year]	50.6	129.5	1,160.9
Parking costs/hour [EUR]	0.05	1.04	3.28
Public Transport One-trip-Ticket (single ticket in city centre) [EUR]	0.17	0.81	2.65
Public Transport Monthly commuter ticket [EUR]	7.3	26.8	76.4
Road accidents resulting in death or serious injury per year (per 1000 population)	0.02	1.5	11.6
Traffic accident injuries [total seriously injured] / 10.000 inhabitants	0.25	7.03	152.4
Total fatalities / 10.000 inh.	0.165	0.60	7.37
Proportion of residents exposed to outdoor noise levels above 65 dB (24hr averaging time) (%)	1	20.2	74.5
CO_2 Emissions (Tonnes per person)	1.76	4.96	69.8
Winter smog: Days per year SO_2 exceeds125 $\mu g/m^3$ (24hr averaging time)	0	0	25
SO_2 Emissions per inhabitant [kg/year] 1995	0.77	4.96	229.5
Reduction factor for SO_2 Emissions 1995 vs 2010 [%]	-57.2	39.3	87.97
"observed" SO_2 Concentrations (µg/m3) 1990-1994	2.3	16.55	83
NOx Emissions per inhabitant [kg/year] 1995	6.95	22.84	188.5
Reduction factor for NO_X Emissions 1995 vs 2010 [%]	1.83	46.77	61.2
"observed" NO_2 Concentrations [$\mu g/m^3$] 1992-	9.21	40.36	86.0

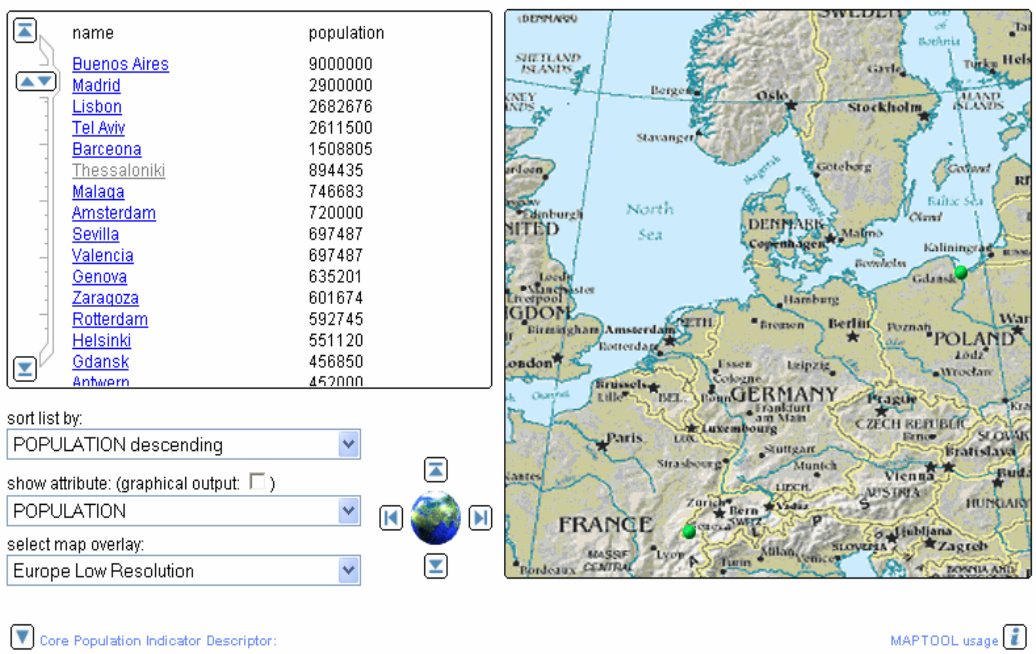
1996			
CO Emissions per inhabitant [kg/year] 1995	30.35	97.95	310.6
Reduction factor for Emissions 1995 vs 2010 [%]	13.46	47.57	70.23
estimated concentrations UAQAM <CO> (mg/m3) annual mean 1995	0.57	0.95	2.52
Pb Emissions per inhabitant [g/year] 1995	10.82	25.10	320.10
Reduction factor for Pb Emissions 1995 vs 2010 [%]	-45.32	66.29	87.47
estimated concentrations UAQAM Pb 1990	0.045	0.144	2.23
Benzene Emissions per inhabitant 1995 [g/year]	362.95	574.73	1136.5
Reduction factor for Benzene Emissions 1995 vs 2010 [%]	36.72	56.81	72.07
estimated concentrations UAQAM benzene 1995	1.29	3.79	18.46
PM10-Emissions per inhabitant 1995 [kg/year]	1.42	2.34	85.80
Reduction factor (%) for PM10 Emissions 1995 vs 2010 [%]	-18.53	18.84	56.50
PM10 Concentrations (µg/m3) 1992-1996	12.83	28.0	75.0
Summer smog: Days per year Ozone O3 exceeds120 µg/m3 (8hr averaging time)	0	7	145
Summer smog: Days per year Ozone O3 exceeds120 µg/m3 (8hr averaging time) OFIS simulations 1995 (urban average)	0	10	66
Summer smog: Maximum number of days per year Ozone O3 exceeds120 ug/m3 (8hr averaging time) OFIS simulations 1995	0	22	117

Table 9. Median and Maximum values for each of the indicatorson the Extended City List Minimum

5.2 The MAPTOOL utility

The results from SUTRA have been online since the beginning of the project. The idea was to create a friendly interface in order to display all the data available at the moment and make it accessible to everyone interested on the project.

The MAPTOOL is a dynamic web page that displays an array of objects both textually in a list and graphically on a map. The textual listing provides different sorting methods and can display additional attributes of the objects (like population for a list of cities). The attributes in the list can also be visualized in colored bars. The graphical map can display different overlays for the map and icons for the objects.



Screen Capture for the MAPTOOL interface

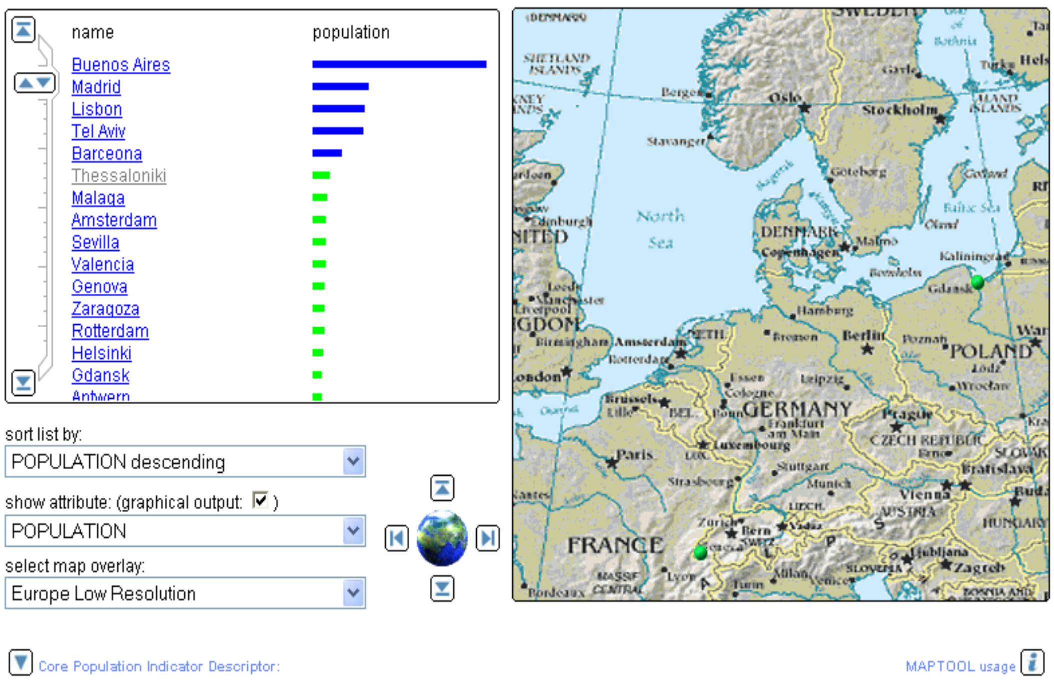
The MAPTOOL utility will be online after the SUTRA project is over, making available all the data from the SUTRA city cases and the Extended City List, to eventually interested external users allowing a friendly Internet interface implementing some basic utilities as ranking and graphical interface,

We will be adding new features to this tool in order to potentially increasing the quantity and quality of the available data by making them available to potential end-user, in the hope of triggering a positive feed-back.

Some of this new features would be: online data update, personalized indicators comparaison, personalized graphics and charts…

We aim to convert this tool in the way of divulging all SUTRA results and hoping that it serves to improve comparability among indicators and provides a basis for examining data series over different periods of time or for comparing data from different local and regional contexts.

MAPTOOL is intend to be a tool that makes a comprehensive picture of the level of transport infrastructure and services available in a city or region and the main travel behaviour patterns.



Screen Capture for the MAPTOOL interface

6 Conclusions and Outlook

Benchmarking is only as good as the quality and availability of the data it is based on: solid data collection and assessment techniques are therefore the basis for a meaningful benchmarking exercise.

Furthermore, the process of the development of indicators and of the collection and homogenisation of data are often two of the most challenging aspects of carrying out any benchmarking exercise.

Inconsistencies and poor data quality are a key impediment to understanding trends in urban travel patterns and the forces behind the trends. Several factors are no doubt involved, among them: data collection methods can be often inconsistent within and among cities, measurements and definitions can be divergent from one city to the next and often do not fit those requested in statistical inquiries.

Furthermore, in some countries, private public transport operators are not communicating key public transport traffic trends citing privacy rights. The importance of data confidentiality for operators is evident. There seems to be at present a great deal of mistrust among operators towards sharing information with public authorities. As a matter of fact, some sectors of transport may be particularly sensitive to the issue of data confidentiality because they are in a process of transition from the public to the private sector.

Several experiences of transport benchmarking have already been undertaken, most of them and pointed out that the potentiality of the benchmarking exercise can be severely limited by the quality and quantity of the available data. For example, the 1992 and 1999 surveys of cities organized by ECMT-OECD in the frame of the project on *“Implementing Sustainable Urban Travel Policies (ECMT-OECD, 2001)”*, have demonstrated that data, particularly as concerns urban travel and land use and their interactions, remain sparse, inconsistent and often of overall poor quality, i.e., they are insufficient in both quantity and quality and are often not available and in many cases not easily accessible in useful form to National Governments. Furthermore, data are not collected in a consistent way among cities and collection methods are often subject to modification within a given city.

The result is that opportunities for monitoring the impacts of policies based on transport and land use statistics are seriously compromised and potentially helpful benchmarking exercises can be difficult to carry out. The actual application of benchmarking methodologies at urban scale to European urban conglomerates seems to be still in an “experimental stage”, particularly in terms of benchmarking performances of holistic supply chains, due to the complexities of the supply chains and limitations in data availability.

Well conscious of these intrinsic difficulties, a benchmarking task was undertaken in the frame of the SUTRA project. Due to the aforementioned basic difficulties, intrinsic in any benchmarking exercise - not only at urban level but even at a national level (where the availability of quality certified data should be guaranteed by national statistical offices), the emerged results should be taken with due care.

The main idea at the basis of the Work Package is the collection of data available in literature an their critical merging in a unique database of demographic, economic, environmental and transport indicators at urban level. The data collection process was limited to European data on the scale of urban conglomerate.

The first part of the task was therefore the identification of potentially useful previous surveys and databases and the attempt to acquire the available data.

A considerable number of surveys (usually limited to the study of few city cases) as well as four main data sources covering a wide set of European urban conglomerate have been identified:

- UITP Millennium Cities Database for Sustainable Transport
- Auto Oil II Programme
- Urban Audit
- Citizens' Network Benchmarking Initiative

These data sources are described in details in Section 3: “Cross-comparison and Benchmarking: Identification of Indicators and data needed”.

After the data were collected one of the main tasks of the Work Package consistent in the merging of the available data in order to obtain a “consistent” database to be used for the “benchmarking” exercise. Having no access to the data collection procedure that, in principle, could allow an “a priori” quantification of data quality, a “post-analysis” of the “robustness” of the merged data was undertaken, mainly based on the verification that the “variability” in the quantification of the same indicator for the same urban conglomerate (extracted, i.e., by several independent data sources) is consistently smaller than the “city to city variation” of the same indicator.

Only after passing this check, we became confident enough that statistically significant information could be extracted - without necessarily getting stuck in a meaningless analysis of a signal completely overwhelmed by “noise” (i.e., the inaccuracy intrinsic to the quantification of the indicators).

The results of the “benchmarking exercise” have been reported in Paragraph 5.1: “Benchmarking strategy and results”, where we believe of having shown that the data, even if obtained by the merging of several different and heterogeneously data sources, appear to possess a quality suitable enough to a proper statistical investigation. On the other side, one has to remember again that the significance and success of the benchmarking analysis unavoidably depends on both the quality as well as the quantity of the available data.

One of the main aim of this benchmarking exercise was the analysis of the broad pattern of transportation dependences found in the collected data. A first approach to this problem was the analysis of the relationship between different sustainable transport indicators. This was mainly done through a series of graphical analysis and focused discussions concentrating on a limited selection of the main data. It was extremely useful and straightforward to see how some of the selected key variables relates (or not) to each other.

This overview analysis shows, as a matter of fact, that certain basic relationships either exist or do not exist between key variables across the extended WP14 benchmarking database (within the accuracy and statistical significance of the available data, of course).

The SUTRA benchmarking exercise shows moreover, that there are still many measurement issues to be solved. In addition to the limitations of data availability, aggregated benchmark results can be misleading, since changes in important factors may be buried in the aggregation process.

- No data set seems to contain information covering the full range of desired outcomes, inputs and outputs. Different information has been sought from different surveys for different sets of regions, cities and towns.

- There is currently little information relating to peri-urban, inter-urban and rural areas largely because such areas have not been involved in previous European best practice studies.

- Definitions of indicators can be inconsistent both between surveys and between different countries, regions, cities and towns.

- Different surveys provide data for different years as well as for different areas and hence it is not straightforward to control for exogenous factors such as changes in global economic and political conditions.

- Rates of change in indicators requires comparison of time series data or at least data for two points in time. In many cases information is available for only one point (a snap shot) in time and where data is available for more than one point the precise date and hence rate of change is sometimes unclear.

- Establishing and enforcing consistency in data collection, collation, analysis and interpretation is in itself a major exercise and one that remains largely unaddressed.

- People and Bodies involved in main European benchmarking surveys appear to start to be giving increasing attention to these problems and, from our point of view, it is likely that any ‘second generation’ benchmarking of integrated transport will be preceded by further significant work on defining data requirements

With fully agree with the suggestions of the previously mentioned ECMT-OECD report *(ECMT-OECD “Implementing Sustainable Urban Travel Policies” , 2001)* , i.e., that *national governments could take initiatives or support on-going activities to improve consistency of data collection and that it would be valuable to develop a consistent methodology at international level that can be used in all such inquiries.*

With the outlook and the aim of:

- potentially increasing the quantity and quality of the available data by making them available to potential end-user, in the hope of triggering a positive feed-back,

- make the collected data available to eventually interested external users allowing a friendly Internet interface implementing some basic utilities as ranking and graphical interface,

A web interface to the “SUTRA WP14 database” have been developed and made available to any interested user via Internet.

We hope this could contribute to the divulgation of the potentiality of data benchmark and that our efforts could be useful for future users interested in benchmarking and ranking their data with a background significant data set specific to European urban conglomerates.

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8 Literature Review and related projects

- europa.eu.int/comm/regional_policy

Structural actions in support of transport.

- www.citizensnetwork.org

Initiative supported by the European Commission, DG Energy and Transport.

- www.sustainable-cities.org

Campaign Interactive supports transfer of knowledge and exchange of experience in the field of urban sustainability and Local Agenda 21 in Europe.

- www.eltis.org

The European Local Transport Information Service Europe's portal for local transport news and events, transport measures, policies and practices implemented in cities and regions across Europe.

- www.voyager-network.org

VOYAGER aims to create a vision and make recommendations for the implementation of attractive, clean, safe, accessible, effective, efficient and financeable European, local and regional public transport systems for the year 2020.

- www.civitas-initiative.org

The CIVITAS Initiative addresses ambitious cities that are introducing, or that are seriously committed to introduce, sustainable urban transport policy strategies.

- www.tellus-cities.net

TELLUS has brought together five European cities keen to demonstrate that integrated urban transport policies can significantly contribute to fighting today's traffic problems in Europe.

- www.uitp.com/home/index.cfm

A world-wide association of urban and regional passenger transport operators. UITP seeks to promote a better understanding of the potential of Public Transport. It provides information, research and analysis on all aspects of Public Transport including infrastructure, rolling stock, organization and management. It also lobbies on behalf of its membership with international institutions such as the EU, UN and OECD.

- Irpud.ramplanung.uni-dortmund.de/irpud/pro/sasi/sasi.htm

The project "Socio-Economic and Spatial Impacts of Transport Infrastructure Investments and Transport System Improvements" (SASI) was conducted in the years 1996-1999 for DG VII (Transport) of the European Commission as part of the 4th Framework Programme for Research and Technological Development.

- www.eurocities.org

EUROCITIES wants to foster a networking spirit amongst Europe's large cities: whilst having different cultural, socio-economic and political realities they share common challenges and solutions. We encourage our members to exchange their expertise, and to be proactive in shaping national and EU policy.

- www.t-e.nu

T&E is a European umbrella for non-governmental organisations working in the field of transport and the environment, promoting sustainable transport in Europe; which means an approach to transport that is environmentally responsible, economically sound and socially just.

- www.access-eurocities.org/frameset_news.html

ACCESS - Eurocities for a New Mobility Culture has been promoting a new mobility culture while assisting cities to bring about a positive change in urban transport.

- www.unece.org/trans/

The Transport Division provides the secretariat to the ECOSOC Committee of Experts on the Transport of Dangerous Goods and on the Global Classification and Labelling of Chemicals as well as to the Administrative Committees of a number of UNECE legal instruments on transport.

- www1.oecd.org/cem

The European Conference of Ministers of Transport (ECMT) is an intergovernmental organisation established by a Protocol signed in Brussels on 17 October 1953. It is a forum in which Ministers responsible for transport, and more specifically the inland transport sector, can co-operate on policy.

- www.travelmatters.org

A website for those interested in learning more about how travel habits and transportation choices affect global climate change. TravelMatters offers a trio of resources - interactive emissions calculators, on-line emissions maps, and a wealth of educational content - to emphasize the close relationship between more efficient transit systems and lower greenhouse gas emissions.

- www.bestransport.org

BEST: Benchmarking European Sustainable Transport web site – a thematic network (under the 5th Framework Programme for Research Technological development and Demonstration, Key Action 2,"Sustainable Mobility and Intermodality" DG Tren) to bring together European policy makers, professionals and stakeholders working in the transport sector to share their expertise and experiences of benchmarking as a practical tool to improve performance.

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  November 2001.

10 Tables and Figures

11 Annexes

ANNEX 1 – Millennium DB Indicators

1. List of raw indicators

Study year
Country
City
Currency
Geographic macro-zone
Annual average income
Definition of the metropolitan area
Definition of the CBD

Town planning, demographic and economic data
1. Total surface area of metropolitan area
2. Total surface area of built-up (urbanised) area
3. Population of metropolitan area
4. Number of jobs of metropolitan area
5. Number of jobs in CBD
6. Gross Domestic Product of the metropolitan area
Qualitative data on the planning system

Traffic data
8. Number of private cars
9. Number of two-wheeled motor vehicles
10. Vehicle x km of travel in private cars
11. Vehicle x km on two-wheeled motor vehicles
12. Passenger x km in private cars
13. Passenger x km on two-wheeled motor vehicles
14. Average road network speed

Road and parking data
15. Total length of road network
16. Total length of express road network
17. Number of off-street parking places in CBD
18. Number of on-street parking places in CBD
19. Maximum charge for on-street temporary parking in CBD
20. Maximum charge for off-street temporary parking in CBD
21. Fines for illegal CBD parking : fine for parking in no parking zone
22. Fines for illegal CBD parking : fine for obstructing public transport
23. Fines for illegal CBD parking : fine for exceeding allowed parking time
23a. Park and Ride car park number
23b. Park and Ride total capacity
Qualitative Data on the road transport system

Data on taxis
25. Total number of taxis
26. Total number of shared taxis
27. Total vehicle x km in taxis
28. Total vehicle x km in shared taxis
29. Annual passenger trips in taxis
30. Annual passenger trips in shared taxis

31. Annual passenger x km in taxis
32. Annual passenger x km in shared taxis

Data on public transport

Qualitative Data on the public transport fare system

34. Total public transport fare box revenue including reimbursement for reduced social fares
34a. Total public transport fare box revenue excluding reimbursement for reduced social fares
35. Total public transport vehicle fleet
35a Bus fleet
35b Minibus fleet
35c Tramway fleet
35d Light rail fleet
35e Metro fleet
35f Fleet of suburban/regional railways
35g Fleet of other public transport modes
36. Total length of public transport lines
(36a to 36g : total length of lines by modes)
37. Length of reserved public transport routes
(37a to 37g : length of reserved routes by modes)
38. Average public transport operating speed
(38a to 38g : average operating speed by modes)
39. Annual public transport vehicle x km
(39a to 39g : annual vehicle x km by modes)
40. Annual public transport seat x km
(40a to 40g : annual seat x km by modes)
41. Annual public transport boardings
(41a to 41g : annual boardings by modes)
42. Annual public transport passenger x km
(42a to 42g : annual passenger x km by modes)

Qualitative data on organisation of public transport

Data on mobility and modal split

44. Average number of daily trips by all modes
44a Number of walking trips
44b Number of mechanized, non-motorised trips
44c Number of motorised trips on public modes
44d Number of motorised trips on private modes
45. Average number of daily trips by mechanized modes

Modal split : all modes

46a % of daily trips in mechanized, non-motorised modes
46b % of daily trips in motorised public modes
46c % of daily trips in motorised private modes

Modal split : mechanized modes

47a % of daily trips in mechanized non-motorised modes (mechanized modes)
47b % of daily trips in mechanized public modes (mechanized modes)

47c % of daily trips in mechanized private modes (mechanized modes)

Average trip length

48. Average length of a trip (all modes)
49. Average length of a trip (mechanized modes)
49a Average length of a car trip

Trip length for the work commute

50. Average length of a home-work commute (all modes)
51. Average length of a home-work commute (mechanized modes)

Data on costs and performance of transportation system

52. Average annual spending on public roads (investment and maintenance)
(52a to 52e : spending for the last 5 years)
53. Average annual investment on pubic transport
(53a to 53e : investment for the last 5 years)
54. Annual operating expenses of public transport including financial costs and depreciation
54a Annual operating expenses of public transport excluding financial costs and depreciation
55. Public transport operating cost recovery from traffic revenue
56. Average user cost of a car trip
(56a to 56h : elements of the cost of a car trip)
57. Average user cost of a trip by public transport
58. Annual cost of the « passenger transportation function » for the community
(58a to 58i) : elements of the annual passenger transportation function for the community)
59. Annual cost of the « passenger transportation function » for the community as a % of the GDP
60. Private transport energy use
61. Public transport energy use
(61a to 61g : public transport energy use by modes)
62. Average time of a car trip (excluding walking)
63. Average time of a public transport trip (excluding walking and waiting time)
64. Number of annual transport fatalities
65. Air pollutants emissions (annual inventory)
65a CO
65b SO2
65c VHC
65d Nox

Qualitative data on the combat of air pollution

2. List of standardized indicators

1. Population (millions)
2. Density of population (inhabitants per hectare)
3. % of jobs in CBD
4. Modal choice : % of daily trips by walking, cycling and public transport
5. Passenger transport cost for the community (% of GDP)
6. Passenger transport cost for the community : private modes (% of GDP)
7. Passenger transport cost for the community : public transport (% of GDP)

8. Annual energy consumption for passenger transport (megajoules per inhabitant)
9. Annual transport fatalities per million inhabitants
10. Annual emission (CO, SO2, VHC, Nox) due to passenger transport per inhabitant (kg per inhabitant)
11. Annual emission (CO, SO2, VHC, Nox) due to passenger transport per hectare (kg per hectare)
12. Cost of passenger x km by public transport vs Cost of passenger x km by private motorised modes (ratio)
13. Cost of a trip by public transport vs Cost of a trip by private motorised modes (ratio)
14. Energy consumption per passenger x km (public transport) vs Energy consumption per passenger x km
15. (private motorised modes) (ratio)
16. Public transport operating cost recovery (%)
17. Public transport operating cost per seat x km (% of GDP)
18. Public transport operating cost per passenger x km (% of GDP)
19. Annual public transport boardings per habitant
20. Modal choice : % of daily mechanized trips by public transport
21. Modal choice : % of mechanized passengers x km by public transport
22. Investment in road (% of GDP)
22. Investment in public transport (% of GDP)
23. Investment in public transport vs Investment in road (ratio)
24. Number of cars per 1,000 inhabitants
25. Length of road network per inhabitant (km per million inhabitants)
26. Length of express roads per inhabitant (km per million inhabitants)
27. Length of reserved public transport routes per inhabitant (km per million inhabitants)
28. Length of reserved public transport routes vs Length of express roads (ratio)
29. Number of parking places per 1,000 jobs in CBD
30. Private motorised transport speed vs Public transport speed (ratio)
31.User cost per private transport trip vs User cost per private motorised transport trip (ratio)
32. Number of annual public transport seats x km per inhabitant (in thousands)
33. % of public transport seats x km by light rail, metropolitan railway and suburban rail
34. % of public transport seats x km by tramway, light rail and metropolitan railway
35. Annual public transport passenger x km vs Annual public transport seats x km (ratio)

2. List of standardized indicators

Population (millions)
Density of population (inhabitants per hectare)
% of jobs in CBD
Modal choice : % of daily trips by walking, cycling and public transport
Passenger transport cost for the community (% of GDP)
Passenger transport cost for the community : private modes (% of GDP)
Passenger transport cost for the community : public transport (% of GDP)
Annual energy consumption for passenger transport (megajoules per inhabitant)
Annual transport fatalities per million inhabitants
Annual emission (CO, SO2, VHC, Nox) due to passenger transport per inhabitant (kg per inhabitant)
Annual emission (CO, SO2, VHC, Nox) due to passenger transport per hectare (kg per hectare)
Cost of passenger x km by public transport vs Cost of passenger x km by private motorised modes (ratio)
Cost of a trip by public transport vs Cost of a trip by private motorised modes (ratio)
Energy consumption per passenger x km (public transport) vs Energy consumption per passenger x km
(private motorised modes) (ratio)
Public transport operating cost recovery (%)
Public transport operating cost per seat x km (% of GDP)
Public transport operating cost per passenger x km (% of GDP)
Annual public transport boardings per habitant
Modal choice : % of daily mechanized trips by public transport
Modal choice : % of mechanized passengers x km by public transport
Investment in road (% of GDP)
Investment in public transport (% of GDP)
Investment in public transport vs Investment in road (ratio)
Number of cars per 1,000 inhabitants
Length of road network per inhabitant (km per million inhabitants)
Length of express roads per inhabitant (km per million inhabitants)
Length of reserved public transport routes per inhabitant (km per million inhabitants)
Length of reserved public transport routes vs Length of express roads (ratio)
Number of parking places per 1,000 jobs in CBD
Private motorised transport speed vs Public transport speed (ratio)
User cost per private transport trip vs User cost per private motorised transport trip (ratio)
Number of annual public transport seats x km per inhabitant (in thousands)
% of public transport seats x km by light rail, metropolitan railway and suburban rail
% of public transport seats x km by tramway, light rail and metropolitan railway
Annual public transport passenger x km vs Annual public transport seats x km (ratio)

ANNEX 2 - Urban Audit DB Indicators

Quality of life domains Indicators

I SOCIO-ECONOMIC ASPECTS

1. Population Total population with distribution by sex and age (13 age groups)

Total population change (by sex and age)
Percentage of the Population aged below 16 and above the national retirement age - Demographic Dependency Index.

2. Nationality Nationals as a proportion of total population

Other EU nationals as a proportion of total population
Non-EU nationals as a proportion of total population

3. Household structure Total number of households

Average size of Households
Percentage of households that are one person households
Percentage of households that are lone parent households
Percentage of households that are lone pensioner households
Number of unemployed (ILO Labour Force Survey)
Unemployment rate (by sex)
Percentage of unemployed who are male/female
Percentage of unemployed who have been unemployed continuously for more than one year
Percentage of unemployed who are under 25
Employment/population ratios (male-female-total)

4. Labour market and

Unemployment
Activity rate (male-female-total)
Household income, median and average income for each quintile
Male/Female earnings, Full-time/Part-time earnings, median and average earnings for each quintile
Ratio of first to fifth quintile earnings
Percentage of households receiving less than half of the national average household income
Percentage of households without cars

5. Income, disparities and

poverty
Number of households reliant upon social security-national definition
Number of homeless people
Number of homeless people as a percentage of total resident population
Average house prices to average annual household income ratio
Average weekly social housing rents as a percentage of average weekly household income
Percentage of dwellings lacking basic amenities
Useful living area per person (m2)
Percentage of households buying or owning their own dwellings

Percentage of households that are social housing tenants
Percentage of households that are private renting tenants

6. Housing

Number of conventional dwellings
Percentage of households living in houses
Percentage of households living in apartments
Percentage of households living in "other" dwellings
Life expectancy at birth for males and females
Infant mortality rate: 0-1 year per 1000 births
Low birth rate : Number of children born weighing less than 2.5 kg (or national definition of low birth weight) per1000 births

7. Health

Mortality rate for individuals under 65 from heart diseases and respiratory illness
Infant mortality rate: 0-1 year per 1000 births
Low birth rate : Number of children born weighing less than 2.5 kg (or national definition of low birth weight) per1000 births

8. Crime Total number of recorded crimes per1000 population per year

Total number of recorded crimes per1000 population per year
Recorded crimes against people per 1000 population per year
Recorded crimes against commercial and residential properties per 1000 population per year
Recorded crimes against cars (including thefts of and from vehicles) per 1000 population per year

9. Employment Employment by sector-male/female, part time/full time, by sector (Nace Rev.1)

Employment by sector-male/female, part time/full time, by sector (Nace Rev.1)
Percentage change in employment

10. Economic activity

GDP per capita at city level (if available) or at the regional level
Number of companies with headquarters in the city quoted on the national stock market
Net level of business registrations (new registrations minus deregistrations per year)
Proportion of net office space that is vacant
Number of tourist overnight stays in registered accommodation per year
Number of air passengers

II CIVIC INVOLVEMENT

11. Civic involvement

Percentage of registered electorate voting in European, national and city Elections. For each of the last three European
Parliament Elections; and for each of the last three national elections; for each of the city elections (nearest dates to the last
three national elections)

Percentage of the resident population of voting age eligible to vote
Percentage of the eligible electorate registered to vote
Percentage of young (aged less than 25 years) eligible electorate voting in city elections
Percentage of elderly (above retirement age) eligible electorate voting in city elections
Percentage of elected city representatives who are women
Annual expenditure of the municipal authority per resident
Annual expenditure of the Municipal Authority per resident as a proportion of GDP per capita
Proportion of Municipal Authority income derived from: local taxation; transfers from national government; charges for services
and "other".

III LEVELS OF TRAINING AND EDUCATION

12. Education and Training

Number of crèche places (public and private provision) per 1000 population
Percentage of students not completing their compulsory education
Percentage of students completing compulsory and achieving the national minimum standard
Percentage of students completing compulsory but not achieving the national minimum standard
Percentage of the age cohort (i.e. total number of students registered for the last year of compulsory education in the reference
year) that continues education and training after leaving compulsory education
Provision
Number of places in universities and further education establishments located within the above specified boundary per 1000
resident population

13. Level of Educational

Qualifications
Percentage of resident population -male/female who have completed lower secondary education (ISCED level 2) (International
Standard Classification for Education)
Percentage of the resident population – male/female - who have completed upper secondary education (ISCED level 3)
Percentage of the resident population – male/female - who have completed tertiary education (first stage) not leading to first
university degree (ISCED level 5)
Percentage of the resident population – male/female - who have completed tertiary education(first stage) leading to first
university degree or equivalent (ISCED level 6)
Percentage of the resident population – male/female – who have completed tertiary education (second stage) leading to a postgraduate
university degree or equivalent (ISCED level 7)

IV ENVIRONMENT

14. Air Quality and Noise

Winter Smog: Number of days SO_2 exceeds 125μg/m3 (24 hour averaging time)

Summer Smog: Number of days Ozone O3 exceeds 120µg/m3 (8 hour averaging time)
Number of days per year that NO2 concentrations exceed 200mg/m3 (1 hour averaging time)
Proportion of the population exposed to outdoor noise levels above 65 db (24 hour averaging time)
Number of determinations (total number of annual tests on all parameters on drinking water quality) which exceed the prescribed values, as specified in the Directive 80/778/EEC - 'Directive relating to the quality of water intended for human consumption'
Consumption of water (cubic metres per annum) per inhabitant

15. Water

Percentage of dwellings connected to potable drinking water supply Infrastructure
Percentage of dwellings connected to the sewerage treatment systems

16. Waste management

Amount of solid waste collected within the boundary (domestic and commercial) tonnes per capita per annum
Proportion of solid waste (domestic and commercial) arising within the boundary processed by landfill, incinerator, recycled
Green space to which the public has access (sq meters per capita) Percentage of the population within 15 minutes walking distance of urban green areas
Percentage of the urban area unused and in main land uses
Percentage of the urban area subject to special physical planning /conservation measures

17. Land use

Population density -total resident population per square km
Mode of journey to work : rail/metro, bus, tram, car, cycle, walking
Characteristics of all travel by residents (purpose, distance and mode of travel)

18. Travel patterns

Number of cars registered within the specified boundary per1000 population
Road accidents resulting in death or serious injury per 1000 population
Average number of occupants of motor cars
Total energy use by fuel type (coal, petrol, electricity, natural gas, fuel oil)
Total energy use by sector (transport, industry, domestic, commercial [services])
Percentage of final energy consumption by different sectors (transport, industry, domestic, commercial)
Electricity consumption per capita (toe)
Gas consumption per capita (toe)

19. Energy use

CO2 emissions per capita
Number of days of rain per month (averaged over one year)

20. Climate/Geography
Average number of hours of sunshine per day (averaged over one year)

V CULTURE AND RECREATION

21. Culture and Recreation

Number of cinema showings and annual attendance per resident
Number of cinema seats
Number of concerts and annual attendance per resident
The number of theatres and annual attendance per resident
Number of museums and annual visitors per resident
The number of sports facilities and annual users per resident
The number of public libraries and total book loans per resident