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Final Report (DRAFT)

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ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

SUTRA

SUSTAINABLE URBAN TRANSPORTATION

DRAFT FINAL REPORT:

July 2000 – June 2003

Contract number:	EVK4-CT-1999-00013
Project title:	Sustainable Urban Transportation
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Executive Summary

This document constitutes the Draft Final Report from July 2000 to June 2003 for the project SUTRA (EVK4-CT-1999-00013), prepared by Environmental Software & Services GmbH based on the individual periodic reports from the members of the SUTRA consortium.

The Final Report describes the project achievements and results over the entire three year period and with emphasis onj the last, third year of the projects, i.e., July 2002 to June 2003. The report lists the resources used and provides an evaluation of progress and final result against the projects objectives and milestones, remaining problems, and strategies to ensure an efficient implementation, dissemination and exploitation of the work.

In summary, over the three years the project has achieved its major objectives. Main problems were related to the initial withdrawal of the Spanish partner ET&T and the planned case study of the city of Madrid, which, however, was successfully replaced with a case study of Thessaloniki, Greece; also, due to the political turmoil in Argentina and the consequent virtual economic collapse of the country, the University of Belgrano, funded by Argentinian national sources, was unable to contribute further to the case study of Buenos Aires, and the work package on Public Health Impacts – the latter part, however, was taken over the the technical University of Gdansk, concentrating on premature death and sick days due to traffic generated air pollution but deleting the problems of contagious deseases in public transport, which was a topic specifically introduced by and for the Argentinian partner.

The remaining set of cities, namely Gdansk, Geneva, Genoa, Lisbon, Thessaloniki and Tel Aviv has met the objectives of implementing the tools for the common set of scenarios as well as selected city specific cases, even though the data situation differs widely in terms of scope, coverage, detail, and quality.

The major constraint, as expected, proved to be data availability for the numerical models. While this has led to delays at various stages through the project, the overall schedule could be kept with a timely conclusion of all work packages.

The wealth of information generated by the scenario analysis has been subjected to a first round of analysis as planned, including the comparison in a benchmarking exercise against a much larger initial set of about 80 cities. These data are available on-line on the continuosly operating project web server, as part of the ongoing dissemination and exploitation tasks that transcend the actual project duration.

Basic results of the initial analysis show that no single measure included in the scenario analysis alone can make a major impact within the ranges of plausible rates of change in the driving forces. Clearly, a well balanced set of integrated measure is necessary to maintain and improve sustainable urban transportation. This set of measures must be defined for each city considering its structural, socio-economic, and technological constraints to find the best, cost-effective solution.

For this purpose, the approach and integrated set of tools developed by the SUTRA project is now being made available to potential end users world wide. Exploitation activities are exploring EU programs such as INTERREG, ASIA-URBS, but also UN sponsored efforts such as the WHO's Healthy Cities program in addition to direct, commercial offerings to individual city administrations.

SUMMARY OF THE APPROACH

SUTRA uses a **scenario analysis** approach, embedded in a framework of **Indicators** of suatiable urban transportation.

A set of common scenarios is defined across all case study cities (augmented by city specific scenarios representing local projects) using the basic framework of indicators to specify consistent change and development scenarios;

The four main scenarios are defined as follows:

1. Dynamic and virtuous (technologically and environmentally)
2. Dynamic and vicious (emphasis on individual transport)
3. Stagnant, aging, but virtuous (virtuous pensioners' city)
4. Stagnant, aging, but viciuous.

Where the vicious scenarios favour individual transportation, i.e., cars

SUTRA then uses a cascade of simulation models to represent the individual scenarios of urban development. The set of common and city specific scenarios is defined in D11. The core of the modeling system is a transportation model (VISUM, D03) that describes an equilibrium-based solution to satisfy the transportation demand expressed in an origin-destination matrix given a transportation network and its capacities and constraints.

The scenario, and in particular transportation demand and the market penetration of alternative transportation technologies are estimated with an energy systems optimisation model, MARKAL (D07).

Based on the model results, indicators of the performance, efficiency, and impacts of satisfying the transportation demand are generate the describe each scenario for the final comparative analysis (D13).

The assessment steps include:

1. Emission calculation using the TREM model
2. Environmental impacts (air quality):
    a. VADIS, a street canyon model, that generates maximum concentration estimates for selected hot-spots;
    b. AirWare, a city level Gaussian air quality model describing the near-field around the entire transportation network;
    c. OFIS, a regional ozone model describing seasonal standard violations in an around the city area.
3. Population exposure (derived from the AirWare spatial results);
4. Public health impacts (derived from the air quality models), calculated with an expert system based on fuzzy set methodology (D09).

The resulting set of indicators (see Deliverable D8.0) are then used in a multi-criteria analysis (D13) to define sets of non-dominated solutions, which are also compared in a benchmarking exercise (D14) with a much larger set of cities across Europe.

In summary, the differences between the scenarios in terms of environmental and public health impacts are considerable, with the virtuous pensioners the most environmentally compatible model. However, when including transportation efficiency in the considerations and economic growth as a desireable objective, dyncami but technology oriented becomes obviously attractive.

The effects of the measures included in the scenario definitions demonstrate that no single measure can have dramatic effects by itself. It is only the combination of several mechanisms that can lead to the desired effects in observable quantities.

While this may seem trivial and as expected, SUTRA has now developed an operational approach and set of tools, demonstrably working over a set of quite different cities, that will allow to perfom these analyses and the required fine-tuning for any interertsed city or region. In this, the projects has reached its original, and ambitious, objectives.

As a major product of the project, several of the tools and the basic results but also data, including comparative data from other cities and benchmarking tools, are available on-line, on dedicated servers, accessible through the project home page: http://www.ess.co.at/SUTRA/ . This extensive on-line presentation is not only a major results of the project and part of its dissemination strategy, but also an important element of the exploitation strategy, that will be continued in an ongoing eContent project: Env-e-City where SUTRA derived methodology and cases will be further developed and used.

SECTION1: MANAGEMENT AND RESOURCE USAGE SUMMARY

1.1 Objectives of the project

The primary objective of SUTRA was 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. This includes an integration of socio-economic, environmental and technological concepts including the development, integration, and demonstration of tools and methodologies to improve forecasting, assessment and policy level decision support.

From a technical perspective, the objectives were to develop:

An **indicator based approach** compatible with Agenda 21 and the indicators for urban sustainability used initially in the Dobris Report and by the EEA, for a baseline analysis, ranking and benchmarking (within the participating cities and across all of Europe) that will ultimately support a discrete multi-criteria selection mechanism.

Scenario analysis that uses:

- Traffic equilibrium modeling to evaluate alternative transportation policies, including multi-modal systems, technological development, socio-economic development, and spatial and structural urban development in general;
- Air quality modeling to translate transportation scenarios and their resultant emissions into ambient air quality estimates and population exposure;
- Economic analysis and energy systems analysis and modeling using well established modeling approaches such as MARKAL, to identify and evaluate cost effective transportation scenarios, consistent with the larger economic and technological framework.
- The concepts of environmental impact assessment for the comprehensive evaluation of alternative transportation scenarios, using on a rule-based checklist approach to cover all other environmental effects beyond air pollution including public health effects and accidents.

The **scenarios**, defined for each of the cities, will consider the current base line and a do-nothing alternative (naive projection of current trends) and a set of at least three probable development strategies in terms of demographic, socio-economic, spatial, structural, and technological developments over the next decade and beyond (30 year horizon).

Comparative **multi-criteria assessment**. Based on the comparative evaluation of the scenarios, again using the sustainable cities indicators, a multi-criteria decision support mechanism will be used to identify preferred strategies and policies.

Citizen and **stakeholder participation** in urban decision making processes, but also the underlying awareness building end educational aspects will be supported by making the project results and findings available as a public information system on the Internet.

1.2 Scientific/Technical progress and results of the work packages

The final and third project year covers Project Months 25 to 36 (according to the revised work plan and schedule proposed for the Amendment 2). This corresponds to Milestone 4 (PM 30) Scenario Analysis completed, and Milestone 5 (PM 36), Analysis and project concluded.

During the third project years, all workpackages with the exception of WP 1 (Requirements and constraint analysis, completed) and the final comparative analysis and benchmarking exercise (WP 13, 14) were active, with the emphasis on the scenario analysis in WP 12 and the analysis work packages WP 13 WP 14;. The methodological work packages, nominally completed, were active with minor adjustments to the tools based on the feedback from the city case studies. Work Package 2 (Data compilation), although nominally ended, continued at a low level of effort with new and additional data becoming available.

WP00 Project Administration:

Workpackage number: **00**

Start date/event: **PM 01**

Lead contractor: **P01, ESS**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
9	1	1	0	1	1	1	1	1	1	1		19

Resource summary: 84% used

WP00	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	578	883	2.077	1.605	2.371	88	68
Resources (Euros)	22.027	30.515	75.827	60.880	89.844	84	68

Objectives

The objective of the work package is the coordination of the project activities, monitoring of time tables, milestones, and Deliverables, as well as the quality assurance procedures. It should provide the basis for an efficient communication and cooperation within the team, and a maintain a constructive dialog with the Commission project officers.

A large part of ESS efforts were dedicated to project administration; major technical achievements here are the implementation of the project communication infrastructure with web server and mailing list. All partners contributed to Work Package with their contributions to the reporting and attending the project meetings in the reporting period:

- Kick-off Meeting in Gumpoldskirchen, Austria, 15-16 September 2000
- Management Board Meeting in Geneva, Switzerland, 5-6 February 2001
- Management Board Meeting in Aveiro, Portugal, 11 June 2001
- Management Board Meeting in Thessaloniki, Greece, 30 August-1 September 2001

- Management Board Meeting in Genoa, Italy, 27-29 January 2002
- Management Board Meeting in Geneva, Switzerland, 6-7 June 2002
- Technical Workshop in Eilat, December 2002
- Management Board Meeting in Milano, April 2003
- Coordination meeting at ESS (WP 9,13,14), May 2003
- Final board meeting and workshop, Gdansk, June 2003.

In addition, a number of bi-lateral meeting related to model implementation were held between individual partners and sub-groups, e.g., dedicated to MARKAL in Geneva, but also for WP 9 and 14 at ESS in Gumpoldskirchen..

All project meetings were held as planned, usually with full participation, with the agenda and later the minutes of the meetings available on the project web server http://www.ess.co.at/SUTRA/

The project mailing list traffic@ess.co.at was also extensively used, with more than 3,000 messages exchanged over the project period.

The work package will be completed after the final project meeting with the editing of the Final Report (D15.3) and Final Cost Statement.

WP 01 Requirements and constraints analysis

Workpackage number: **01**

Start date/event: **PM 01**

Lead contractor: **P01, ESS**

Person-months per participant

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
2	2	1	1	3	1	1	1	2	1	1	1	15

Resource summary: 85% used

WP01	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	144	140	1.205	1.355	1.505	80	90
Resources (Euros)	5.485	4.536	43.259	51.117	51.117	85	100

The objectives of this workpackage are:

- To develop a comprehensive overview of the information requirements for the project.
- The compilation of the technical, institutional, and data constraints for the project.
- The formulation of the basic conceptual and technical guidelines and blueprint for the subsequent work packages.

Work Package 01 has been completed as planned.

WP 02 Data compilation

Workpackage number: **02**

Start date/event: **PM 01**

Lead contractor: **P01, ESS**

Person-month per participant

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
6				3	3	2	3	4	6	3	1	31

Resource summary: 114% used

WP02	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	90	0	3077	2033	2483	124	82
Resources (Euros)	4.291	4.662	65.615	57.393	57.393	114	100

The objectives of the workpackage are:

- To develop a consistent set of background data for the indicator development, the scenario analysis and model applications
- Organise these into shared data structures in electronic form (text files, spreadsheets, data bases, GIS data) defined in the Requirements and Constraints Report.
- Develop a common data repository on an ftp server.

ESS has taken over the responsibility for WP 02 from ET&P after their withdrawal from the project. The status of data availability is summarised in deliverable D02, available on-line on the project web server: http://www.ess.co.at/SUTRA/DELIVERABLES/D02.html, updated periodically.

Though WP 2 should have been already concluded by the end of June 2002, several updates, improvements and further refining were necessary – in particular in answer to specific requests coming by the partners in the process of implementing and/or updating models and methodologies.

Generally, with respect to WP02, it could be argued that, even though the first data set has been built in the early stage of the project the data compilation has now turned into a part of thye continuing exploitation activities, with many of the data available on-line as part of the SUTR cities data base, on-line modeling tools (in support of WP 12), benchmarking of European cities (WP 14). The on-line data bases are accessible from a dedicated server under http://193.81.244.67/SUTRA/.

The work package was completed as planned, but is extended beyond the original scope as part of the ongoing exploitation efforts by making the basic city case study and scenario data available on-line over the Internet.

WP 03 Multi-modal transportation modeling

Workpackage number: **03**

Start date/event: **PM 01**

Lead contractor: **P02, PTV**

Person-months per participant

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
1	15				1	1	2	3				23

Resource summary: 73% used

WP03	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	837	913	1.951	2.978	2.978	65	100
Resources (Euros)	41.109	34.269	85.540	116.451	117.403	73	99

The objectives of this workpackage are:

- To adapt the existing traffic equilibrium simulation model for multi-modal traffic including private and public mass transport systems, high-occupancy vehicles, and other trip-reducing strategies, based on the requirements and constraints analysis.

- To develop the interfaces of the traffic simulation model to the related analytical components: emission model and near-field street canyon modeling (WP 04), air quality modeling (WP 05), general environmental impact assessment (WP 06), energy analysis (WP 07), economic assessment (WP 08).

The actual work performed by PTV included:

- Definition of the interface and the data exchange between the transport model and the relevant other models in coordination with the model developers
- Implementation of the interface and the data exchange between the transport model and the relevant other models in coordination with the model developers
- Support of the project partners in the application of the transport model software
- Implementation of methods to enable the transport model to deal with Park+Ride and High Occupancy Vehicles

Work Package 3 was completed successfully, with all city partners (with the exception of Buenos Aires) able to run the model for the common and city specific scenarios as planned.

WP 04 Emission and near-field modeling

Workpackage number: **04**

Start date/event: **PM 01**

Lead contractor: **P08, UAVR**

Person-months per participant

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
1	1					1	18	3				24

Resource summary: 106% used

WP04	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	1.040	1.061	3.297	3.140	3.140	105	100
Resources (Euros)	26.235	15.404	54.094	50.761	50.848	106	100

The objectives of this work package are:

- To adapt an available emission model for road traffic to the set of test case applications and develop the interfaces to both the traffic simulation model as well as the air quality model.
- To a adapt near-field, street canyon model of traffic generated air pollution for the project for the estimation of local hot-spot values.
- To develop the interfaces of the models with all other analytical components.

As the emission model TREM is a direct post-processor of the VISUM model output, PTV has closely involved in preparing interface and data exchange protocol and assisting emission/immission model development partners.

The Transport Emission Model for Line Sources (TREM), based on COST/MEET methodology and developed in accordance with the project objectives, was improved in order to implement the cold-start emissions and future vehicle technologies. To facilitate the model application, an user friendly interface was under development.

The street canyon model (VADIS) applications suffered final adjustments in order to complete the reference scenarios for all city cases. The results were distributed among the SUTRA partners. Also, VADIS interface was placed in the UAV team web site for download.

Work Package 4 was completed successfully, with all case study cities (with the exception of Buenos Aires) being able to perform the host-spot analysis as planned. An update of Deliverable 4 was submitted for the final meeting.

WP 05 Mesoscale meteo and air quality modeling

Workpackage number: **05**

Start date/event: **PM 01**

Lead contractor: **P07**

Person-months per participant

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
1						6	3	3				13

Resource summary: 132% used

WP05	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	775	804	2.303	1.877	1.892	122	99
Resources (Euros)	27.721	22.794	72.159	54.271	54.811	132	99

The work package is led by The Aristotle University of Thessaloniki.

The objectives of this workpackage are:

- To adapt the available photochemical air quality modeling tools (OFIS) for the set of application cases.
- To develop the interfaces between the regional photochemical air quality model OFIS and the traffic and emission models and the energy model, as well as the assessment methods (WP06, WP08).

AUTh/LHTEE co-ordinated the preparation of necessary data from partners and provided related assistance and guidance, carrying out a large number of e-mail communications. In addition, AUTh/LHTEE performed simulations for those cities that have provided a sufficient set of information, and authored the final drafts of the two deliverables associated with this WP, that were made available to the consortium and are updated and provided to the commision at the end of the corresponding reporting period. As additional effort was necessary to support the tasks of the WP, resources were transferred from WP 12 (a total of 1,5 pms, e.g. 210 hours). The delay in this work package was caused from the overall delay in progress regarding the collection of necessary data from relevant partners.

All the input data, concerning the Lisbon city case, was compiled and provided to the LHTEE investigation group, responsible for the OFIS model simulations. The OFIS simulation to the Lisbon baseline scenario is complete. This simulation was performed by the LHTEE group and the results were distributed for the final analysis and described in an appendix to Deliverable 5.

The work package 5 was completed successfully and as planned. A summary of model application results to the case study scenarios was submitted as an Appendix do Deliverable 5.

WP 06 EIA methodology: rule-based assessment

Workpackage number: **06**

Start date/event: **PM 01**

Lead contractor: **P01, ESS**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
9		1			1							11

Resource summary: 97% used

WP06	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	920	2.128	1.922	4.105	4.105	47	100
Resources (Euros)	26.431	32.190	57.528	59.472	59.472	97	100

The work package is led by ESS.

The objectives of this work package are:

- To develop a tool for comprehensive impact assessment of urban transportation that goes beyond the air quality aspects.
- To adapt a rule-based expert system for screening level environmental impact assessment to the project requirements defined in the Requirements and Constraints Report.
- To develop the checklists and rule-sets consistent with the indicators of sustainable urban transportation and sustainable urban development defined in WP08 and the economic assessment.

As the task leader, ESS has been working on the adaptation and testing of a rule-based expert system for generic environmental impact assessment, covering all impacts not addressed by any other model in the SUTRA approach. The developments are centered on a web-based implementation of the method, and its linkage to a city and scenario database. The access to the city data has been organized on a dedicated web server, http://193.81.244.67/SUTRA/ with a geographical selection interface. The assessment part of WP 13) is based both on the city indicators (from the city data base) and the model results and post-processing data such as population exposure.

WP 06 provides and important methodological component (togther with WP 10 on integrated assessment) for the final comparative multi-criteria analysis in WP 13.

The work package was completed as planned.

WP 07 Energy system analysis:

Workpackage number: **07**

Start date/event: **PM 01**

Lead contractor: **P09, UGE**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
1	1	1				1	1	18	2			25

Resource summary: % used

WP07	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	450	415	1.844	1.275	1.285	143	99
Resources (Euros)	17.607	10.496	54.808	31.711	32.158	170	99

This workpackage is led by the University of Geneva, the partner responsible for the MARKAL Energy model. The objectives of this workpackage are:

- To integrate an energy/technology/environment model within the SUTRA framework.
- To describe technologies and the appropriate supply system needed for providing the energy input in order to assess the costs associated with long term energy scenarios compatible with a sustainable city.
- To compute long term marginal costs associated with various objectives expressed in terms of air quality, noise levels, GHG emission levels, etc.
- To integrate the energy model with the traffic and air pollution models as it provides the description of the technology mix that flows on the traffic network and receives the emissions/immissions constraints that will drive the simulations, and
- To specify and develop the interfaces with these other analytical components.

The Markal-Lite model

A close exchange of information was established with UGE about functionality of Markal-Lite database interface, providing feed-back on bugs and on possible improvements of the remote inputting by City Partners. A Transmission Protocol was activated between CPs and UNIGE, and data inserted in the Markal-Lite interface were finally uploaded directly on the Geneva machines and the first runs were possible.

Subject to the constraint of the Swiss partner only being funded for 24 months, the MARKAL model could be applied to most city cases successfully. The results have been made available in a consolidated report (D07).

WP 08 Indicators os Sustainable development and economic assessment

Workpackage number: **08**

Start date/event: **PM 04**

Lead contractors: **P01, ESS and FEEM**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
10		1		1	1			3	7			23

Resource summary: % used

WP08	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	1.481	2.519	3.442	4.052	5.650	61	72
Resources (Euros)	24.648	30.928	83.482	56.518	77.019	108	73

The work package is led by ESS and FEEM.

The objectives of this work package are:

- To define a set of indicators for sustainable urban transportation within the framework of sustainable urban development.
- To prepare the tools for the economic assessment of the transportation scenarios within the framework of the overall urban development scenarios.
- To develop the interfaces with the analytical components (models) and the EIA methodology.

A final draft version of the ***Indicator and economic assessment report*** (D08) was produced. The refined version of the indicator system was discussed with partners in the Geneva meeting, June 2002.

The report reviews existing literature on sustainability indicators, discusses the approach used in SUTRA and provides also the list of indicators, whose data have been asked to the city partners and partially collected. The indicator system has been implemented in spreadsheets for an automatic computation of indicators starting from city partners' data collected in ad hoc spread sheets.

Deliverable 8 was updates several times to reflect the lessons learned from the initial analysis, with new and re-defined Indicators being added to the set. The work package has been completed as planned, but behind schedule.

WP 09 Public health impacts

Workpackage number: **09**

Start date/event: **PM 04**

Lead contractor: **P11, UBG**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
1								6		9		16

Resource summary: % used

WP09	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	56	160	152	280	439	35	64
Resources (Euros)	1.553	2.016	6.022	3.528	5.545	109	64

The work package is led by the University of Belgrano.

The objectives of the workpackage are:

- To analyse the relationships between urban transportation and public health.
- To develop basic assessment tools for health impacts including the spread of contagious diseases.
- To adapt the tool for use in all case studies.

Work package leader for WP 09 was the University of Belgrano, Argentina. Due to the political turmoil in Argentina and the consequent virtual economic collapse of the country, the University of Belgrano, funded by Argentinian national sources, was unable to contribute further to the case study of Buenos Aires, and the work package on Public Health Impacts – the latter part, however, was taken over the the technical University of Gdansk, concentrating on premature death and sick days due to traffic generated air pollution but deleting the problems of contagious deseases in public transport, which was a topic specifically introduced by and for the Argentinian partner.

With the Delivery of D09, Public health Impacts co-authored by the technical University of Gdansk and ESS, the work package was successfully completed despite the problems of the original work package leader.

WP 10 Integrated assessment and DSS

Workpackage number: **10**

Start date/event: **PM 07 (04)**

Lead contractor: **P01, ESS**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
6		1					2	3				12

Resource summary: % used

WP10	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	540	1.288	1.724	2.097	3.056	56	69
Resources (Euros)	16.474	23.643	47.541	36.034	48.132	99	75

The objectives of this work package, led by ESS, are:

- To develop an integrated framework for comparative multi-criteria assessment of the transportation and urban development scenarios.
- To adapt and implement a discrete multi-criteria optimisation approach for the efficient analysis of the complex scenario results defined by a high dimensionality.

Tool Integration, multi-criteria DSS: adaptation and implementation of the basic tools for integration and multi-criteria assessment. The tools are based on a discrete multi-criteria approach (reference point optimisation) and are being prepared for web-based implementation (cgi). The basic city-level air quality model is operation and accessible on the dedicated server http://193.81.244.67/SUTRA/

With the on-line implementation of the city-level air quality and population exposure models for all city case studies and scenarios, as well as the availability of the multi-criteria DSS (workstation version) providing inputs to mainly work package 13, the workpackage was successfully completed.

WP 11 Scenarios of sustainable urban transportation

Workpackage number: **11**

Start date/event: **PM 07**

Lead contractor: **P03, FEEM**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
		6		2	2	1	2	4	6	2	1	26

Resource summary: % used

WP11	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	882	1.158	3.432	2.574	2.594	132	99
Resources (Euros)	28.806	39.414	89.604	73.874	75.157	119	98

The objectives of this workpackage, led by FEEM, are:

- To develop a consistent set of common base scenarios for all cities.
- To develop a set of specific development scenarios for each city.

To ensure that the scenarios are consistent with the Requirements and Constraints Analysis as well as the set of indicators of sustainable urban transportation and sustainable urban development.

Scenario definition: related to WP08, Indicators and Economic Assessment. Main options for the development of the city specific development scenarios of future urban transportation system had been identified, addressing the whole range of issues required to represent the urban transportation system

A final draft version of the ***Scenarios of sustainable urban transportation report*** (D11) has been produced and main issues discussed in Géneve (June, 2002).

In the last six months of the project, emphasis was on the actual implementation of the scenarios through the model cascade, modifications from the feedback received, with PTV providing numerous ad-hoc tools to generate the corresponding model input data sets and FEEM tools to extract the corresponding indicators.

With the availability of the final scenario definitions (see D13 for a summary) and the tools for implementation and analysis being available and applied to all city case studies, the work package was completed successfully but behind the initial schedule.

WP 12 Scenario analysis: simulation and evaluation

Workpackage number: **12**

Start date/event: **PM 10**

Lead contractor: **P08, UAV**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
5	10			4	7	12	12	18	18	9	6	101

Resource summary: % used

WP12	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	4.003	5.716	4.847	7.189	10.706	45	67
Resources (Euros)	85.043	142.892	99.858	183.567	267.897	37	69

The objectives of this workpackage, coordinated by the University of Aveiro and involving all city partners with the support of the model developers, are:

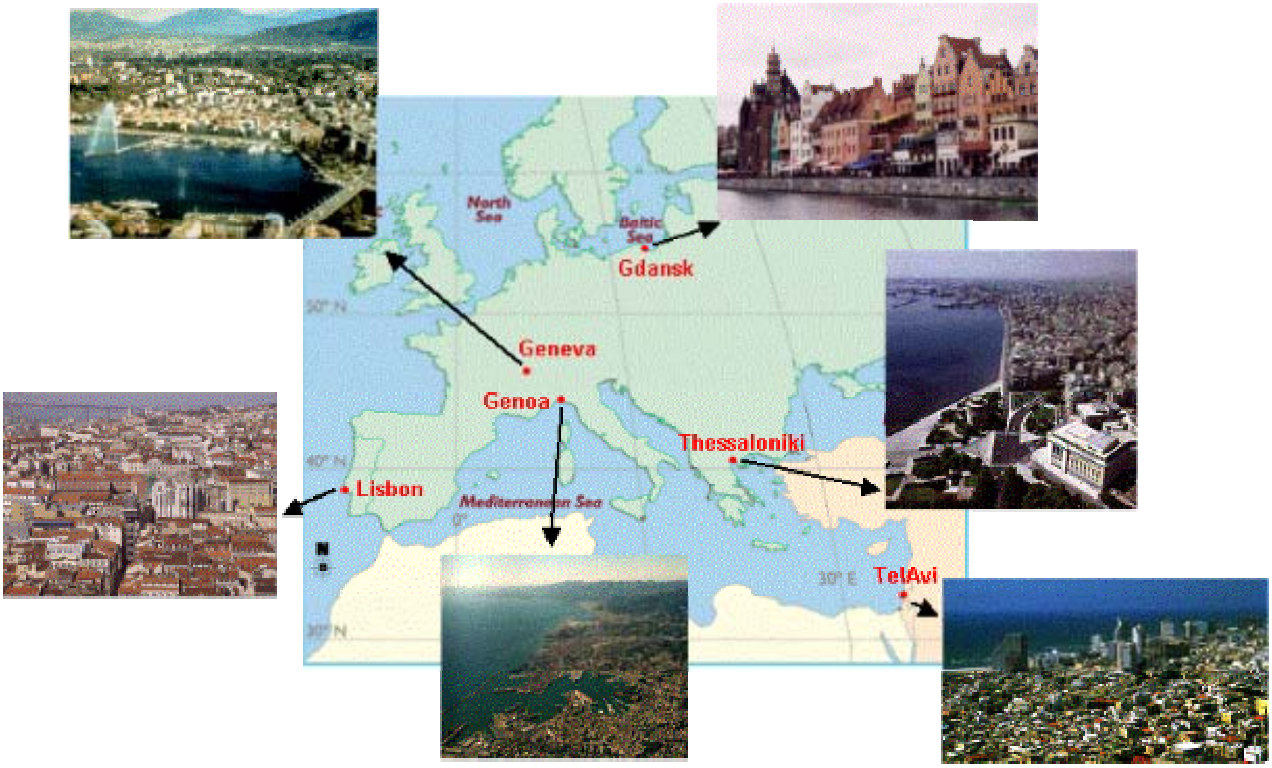
- The simulation and analysis of the set of scenarios defined in workpackage WP11 for each of the application sites;
- The evaluation of the scenarios in terms of the indicators of sustainable urban transportation defined in workpackage WP08.

The results of the city case studies have been summarised in the extensive set of deliverables:

D12.0 Summary and overview, and the individual city report from Gdansk, Genoa, Lisbon, Thessalonoki and Tel Aviv (please note that the Geneva results are part of the consolidated report in Deliverable D07, being updated by the Geneva team despite the ending of the operational funding with December 2002.

The Summary Report D12.0 results from the work developed under Workpackage 12, With Deliverable 12 a complete and consistent set of scenario results, for each of the municipalities, will be obtained, allowing the subsequent evaluation and comparative analysis. The cities involved in SUTRA (Gdansk, Geneva, Genoa, Lisbon, Tel Aviv and Thessaloniki) 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 related to air quality, noise, traffic congestion, but also related issues such as economic competitiveness, mobility, employment, maintaining their infrastructure and built environment while reducing social exclusion and promoting sustainable development.

To guarantee a well-structured analysis for direct comparison of alternatives within and between cities, a common framework was defined by a set of indicators of sustainable urban development. This common set of indicators is identified and defined for all cities, defining the status quo as a base line. Deliverable 12 summarizes this base line.



Scenario Analysis:

The common cenarios were defined in terms of relative changes to the main driving variables to generate a consistent scenario around a common theme:

SC1: Dynamic, young and virtuous

SC2: Dynamic, young and vicious

SC3: Stagnating, old and virtuous

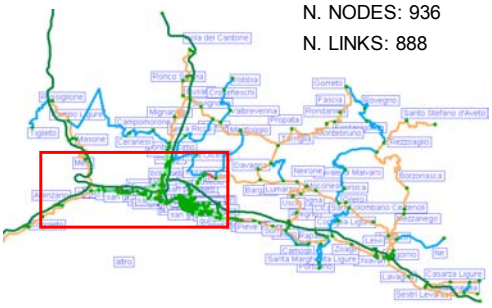
SC4: Stagnating, old and vicious

Definition of Common Scenarios in terms of consistent change patterns in the following aggregate domains:

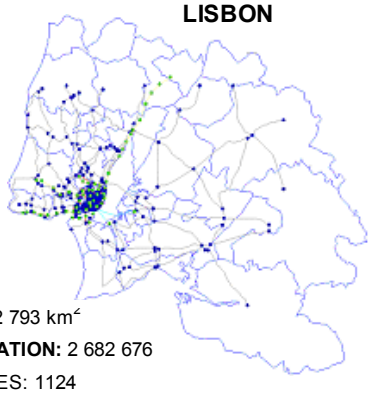
	SC1	SC2	SC3	SC4
Demographic Changes	+	+	-	-
Economic Structural Changes	+	+	-	-
Technological Changes	+	-	+	-
Land Use Changes	+	-	+	-

GENOA

AREA: 241 km²
POPULATION: 635 201
N. NODES: 936
N. LINKS: 888



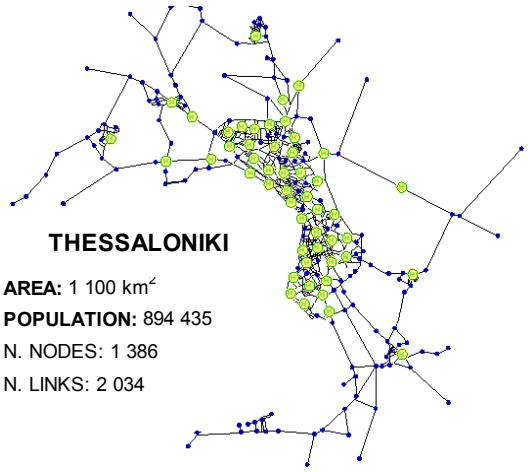
LISBON



AREA: 2 793 km²
POPULATION: 2 682 676
N. NODES: 1124
N. LINKS: 2940

TEL AVIV

AREA: 1 447 km²
POPULATION: 2 611 500
N. NODES: 3 144
N. LINKS: 11 850

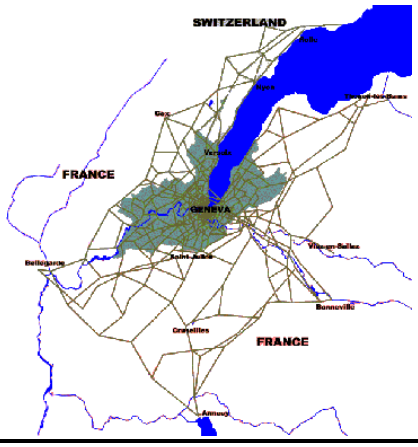


THESSALONIKI

AREA: 1 100 km²
POPULATION: 894 435
N. NODES: 1 386
N. LINKS: 2 034

GENEVA

AREA: 282 km²
POPULATION: 413 585
N. NODES: 936
N. LINKS: 2 900



The resulting parameter changes led to modified network assignements, shown here with the examples of Genoa and Lisbon, in the latter case with separate network for private and public transport, and the corresponding transportation model results:

GENOA:

- **CS1: Young and virtuous**

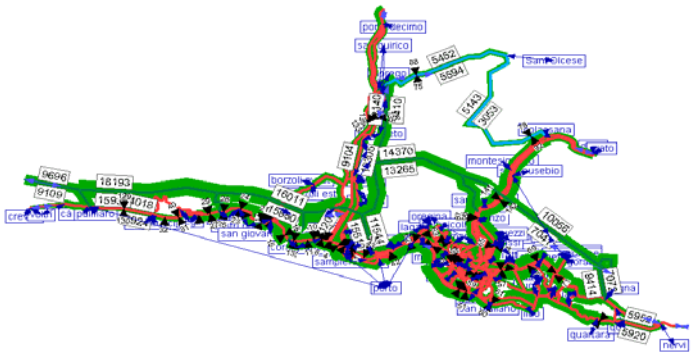


Figure 4.1.3 Genoa CS1 assigned network.

- **CS2: Young and vicious**

Figure 4.1.4 Genoa CS2 assigned network.

- **CS3: Old and virtuous**

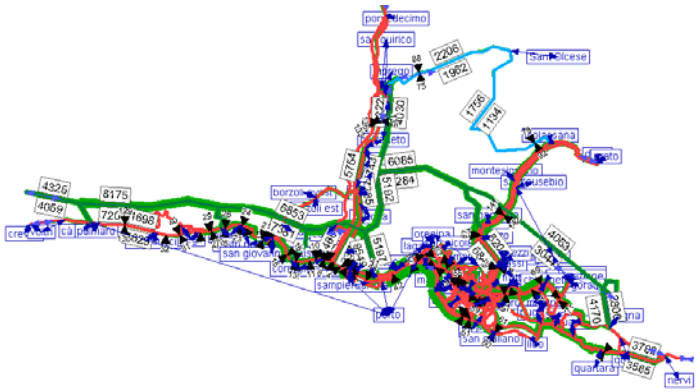


Figure 4.1.5 Genoa CS3 assigned network.

- **CS3: Old and vicious**

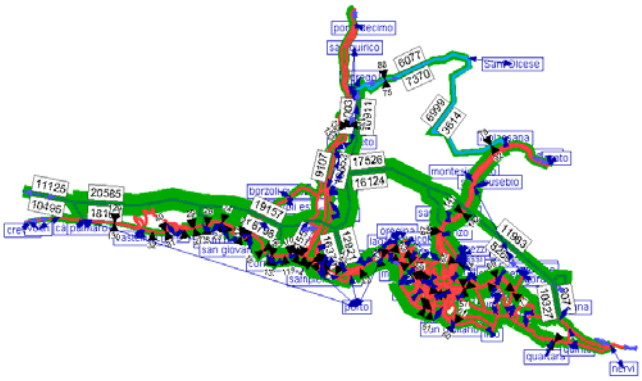


Figure 4.1.6 Genoa CS3 assigned network.

LISBON

- **CS1: Young and virtuous**

Private **Public**

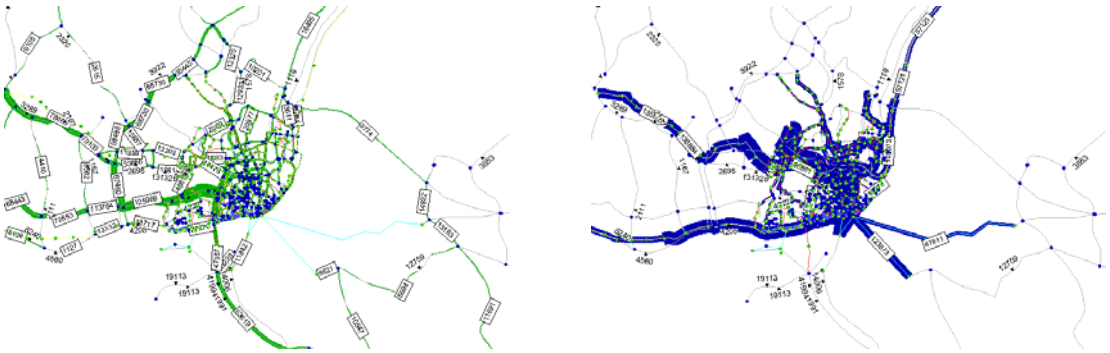


Figure 4.1.9 Lisbon CS1 assigned network .

- **CS2: Young and vicious**

Private **Public**

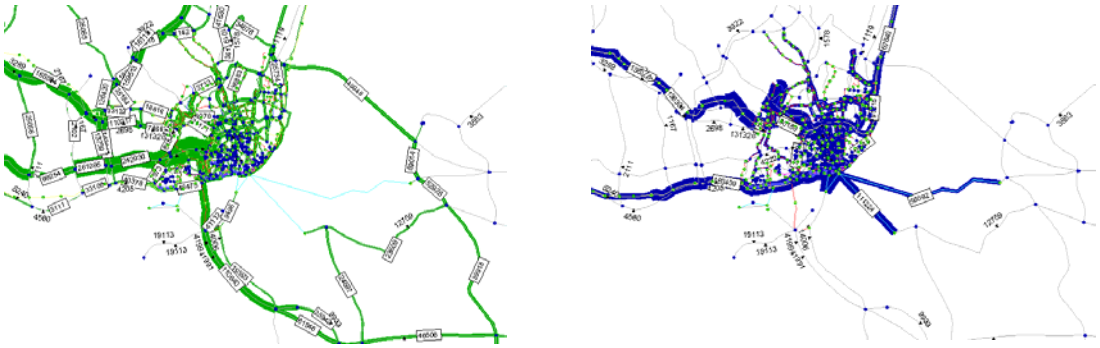


Figure 4.1.10 Lisbon CS2 assigned network .

- **CS3: Old and virtuous**

Private **Public**

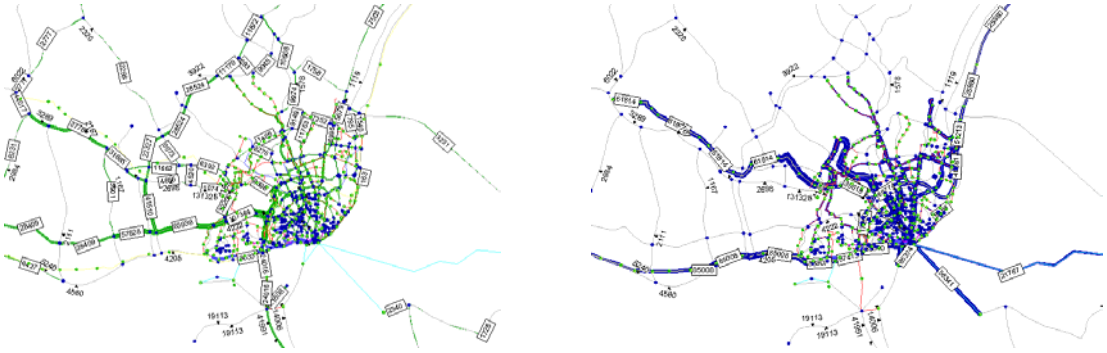


Figure 4.1.11 Lisbon CS3 assigned network .

- **CS4: Old and vicious**

Private **Public**

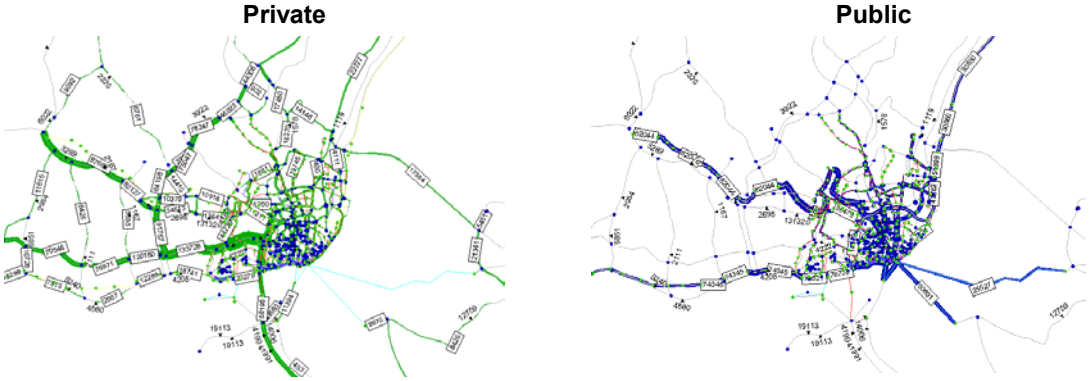
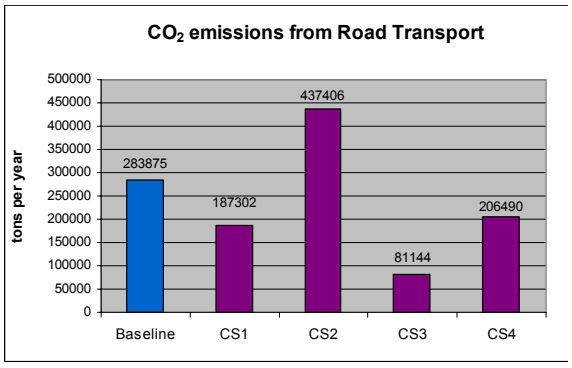
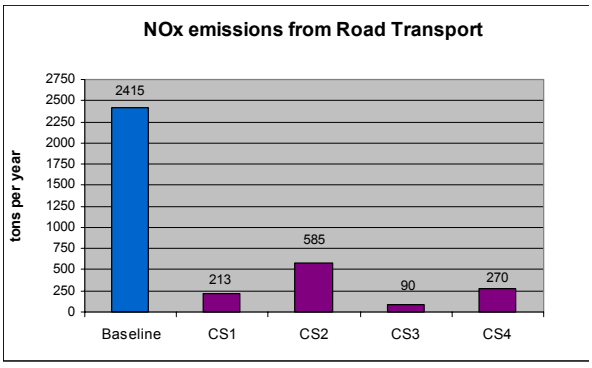
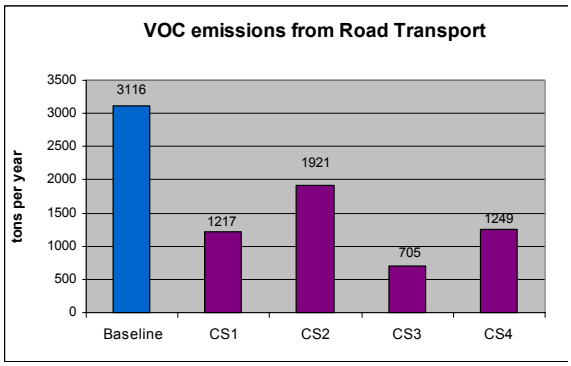


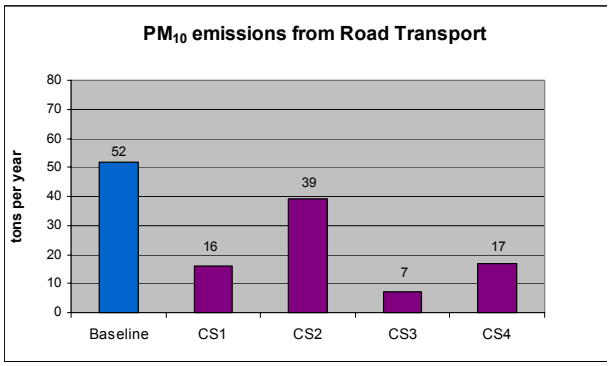
Figure 4.1.12 Lisbon CS4 assigned network .

From these networks and the VISUM transportation model, the results were processes with TREM to generate emission estimates. The example below id taken from Gdansk:









These emission estimates then in turn are processed by the air quality models, and subsequent assessment in terms of indicators such as population exposure or public health impacts (example from Gdansk)

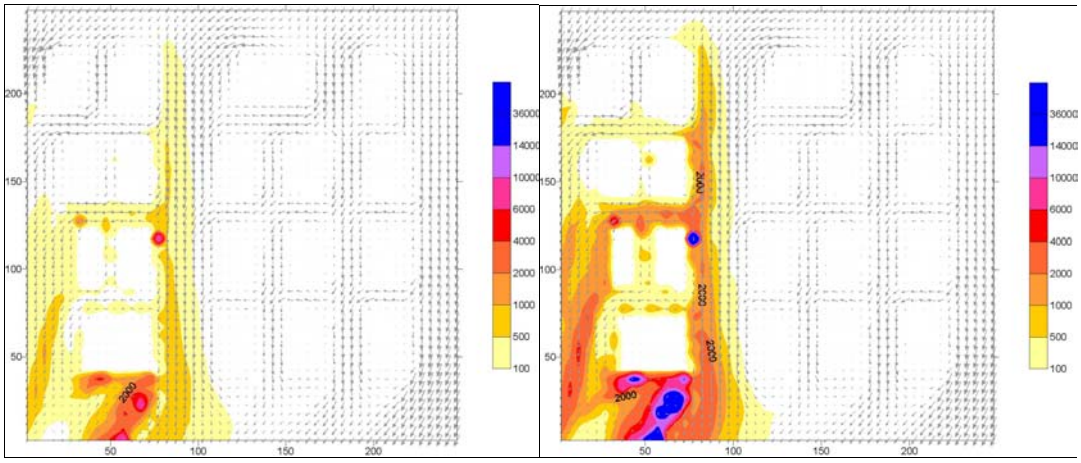
Data for common and specific scenarios

		BASE	C1	C2	C3	C4	S1	S2	S3	S4
Peak concentration NOx	ug/m3	2E+06	1E+06	3E+06	939800	2E+06	1E+06	4E+06	9E+05	1453035
Average concentration Nox	ug/m3	32000	11416	13951	7041,4	10093	13982	15534	6695	8724,324
Nonzero average concentrat	ug/m3	17654	3E+06	220088	11617	9059,9	4E+06	245059	11046	7831,302
Above max. Thres.	%	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
CO Emison (total)	kg/h	9579	10393	18343	8333	11399	7832	18123	6280	11262

Data for mortality and morbidity

		BASE	C1	C2	C3	C4	S1	S2	S3	S4
MORTALITY [number of dephs/year]		15365	30978	15365	15365	15365	30978	15365	15365	15364,74
MORBIDITY [number of days lost in a year, per capita]		0,186	0,23	0,1857	0,1857	0,1857	0,23	0,1857	0,186	0,185747

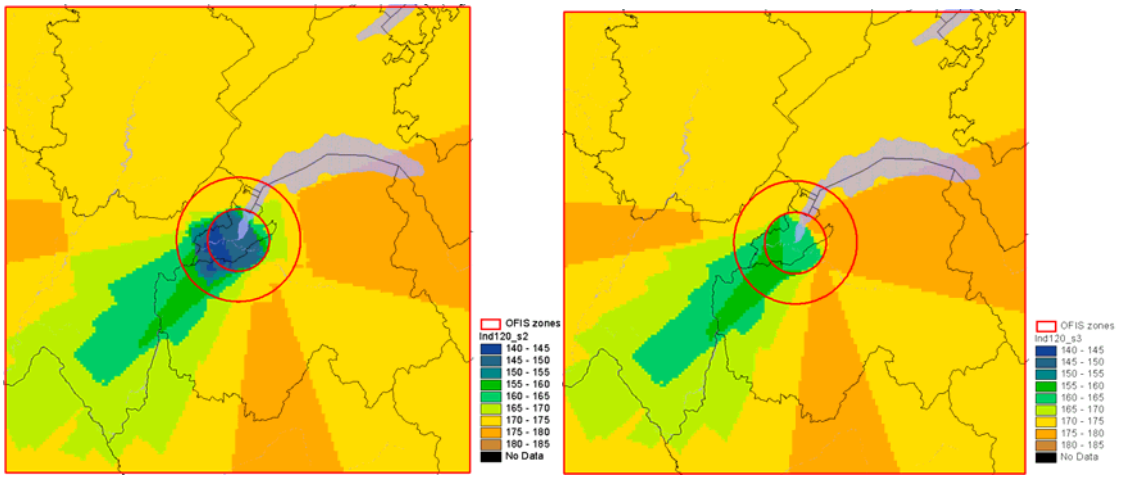
Local population exposure is estimated for selected hot-spots with the dynamic street canyon model VADIS (see WP 4):



The example (City of Genoa) compares the results for two scenarios, namely SC1 (young, rich and virtous) against SC2 (young, rich, and vicious) with the

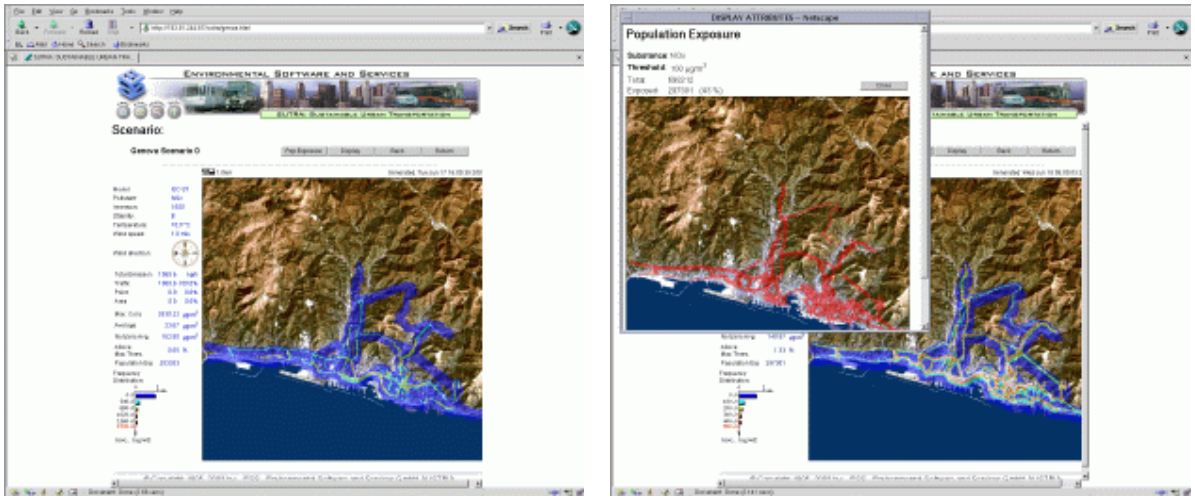
corresponding mix of assumptions on demographics (growing city population and lower average age compared to the baseline scenario), but different technology mix, share of pulic versus private transport and thus fleet composition, and land use changes (densifying and multipl-use versus sprawl).

Similar if not always as pronounced results can be seen at the resgional scale (OFIS ozone model):



The scenarios (City of Geneva), compare the two extreme cases Young and viciousand Old and virtuous.

TherResults of the city level air quality modelling, available on-line, and subsequent population exposure are shown for Genoa:



Basic model results (left) and population exposure (right) for the aseline scenario.

The details of the scenario analysis for each city case study are described in the associated DELIVERABLES, and summarised in D12.0 (Summary Report):

- **D12.0**: Scenario analysis, Summary Report
- **D12.1** City case study: Buenos Aires
- **D12.2** City case study: Gdansk
- **D12.3** City Case study: Geneva (integrated in D07)
- **D12.4** City case study: Genova
- **D12.5** City case study: Lisbon
- **D12.6**: City case study: Tel Aviv
- **D12.7** City case study: Thessaloniki

Clearly, the results in terms of the environmental impacts follow from the assumptions as expected. However, in combination with measures of transportation efficiency, more complex patterns emerge based on the trade-offs between meeting transportation demand (which in turn results from the basic demographic, socio-economic, technological, and land use developments) and the associated costs (economic, environmental, public health).

The analysis of these complex relationships is the primary objective of WP 13, multi-criteria analysis.

WP 13 Scenario comparison and multi-criteria analysis

Workpackage number: 13

Start date/event: PM 19 (13)

Lead contractor: P06, MEI

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
2		2		2	4	2	4	4	6	3		29

Resource summary: % used

WP13	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	1.108	1.535	1.108	1.535	2.787	40	55
Resources (Euros)	18.321	34.278	18.321	37.445	66.198	28	57

The objectives of this workpackage, led by the Ministry of the Environmnet of Israel, are:

- The comparative analysis of the set of scenarios for each city.
- The multi-criteria comparative analysis and selection of a non-dominated set of (Pareto optimal) alternatives.
- The identification of the most promising scenario or small set of candidate scenarios from each test site.

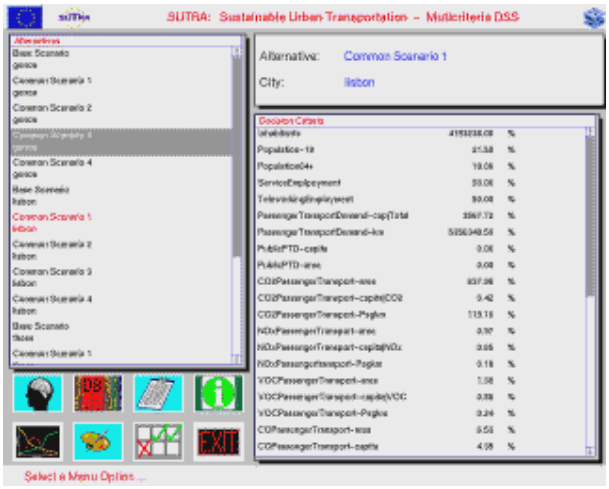
From the model results, a set of indicators (see WP 08) is generated, that measures various aspects of the transportation system and its costs in socio-economic, environmental, and public health terms. For each scenario, we obtain a list of indicators describing the scenario.

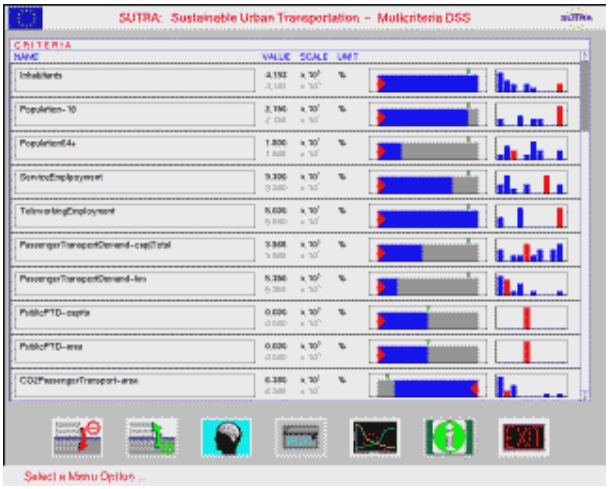
The list below shows a typical results file, here from tel Aviv, Scenario 1:

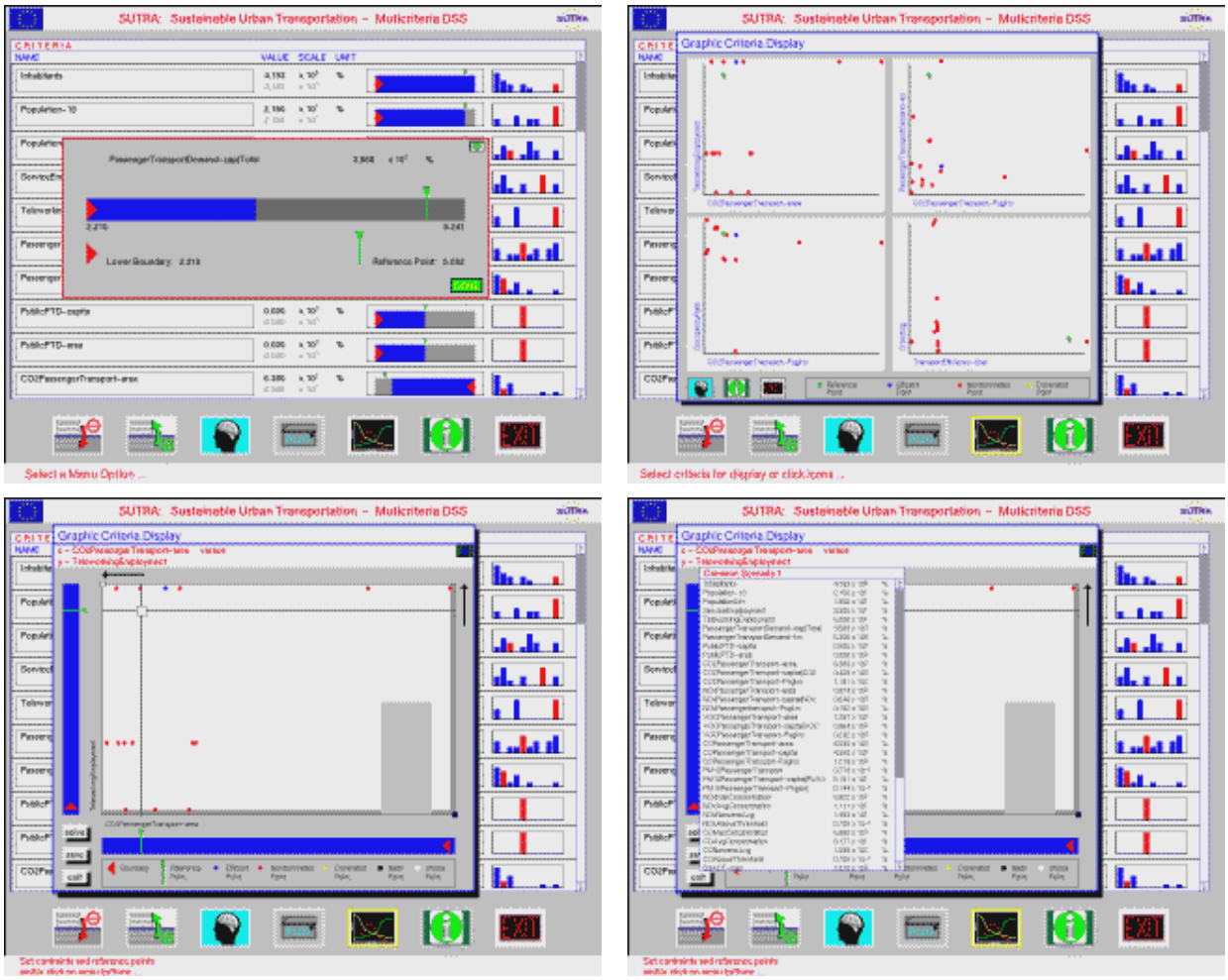
Inhabitants,4081984
Population under 18,33
Population over 64,15
% employment in services,97
% employment on teleworking,50
Total passenger transport demand per capita,3724.779577
Total passenger transport demand per km2,10507.59545
Public passenger transport demand per capita,682.7793306
Public passenger transport demand per km2,1926.119074
CO2 Total passenger transport emission per km2,1.226913058
CO2 Passenger transport emission per capita,0.434921645
CO2 Passenger transport emission per pass-km,0.000116764

NOx Total passenger transport emission per km2,0.003002181
NOx Passenger transport emission per 1000 inh,1.064226656
NOx Passenger transport emission per pass-km,2.85715E-07
VOC Total passenger transport emission per km2,0.001352995
VOC Passenger transport emission per 1000 inh,0.479615763
VOC Passenger transport emission per pass-km,1.28764E-07
CO Total passenger transport emission per km2,0.007350917
CO Passenger transport emission per 1000 inh,2.605785951
CO Passenger transport emission per pass-km,6.99581E-07
% of public transport over total passenger transport,18.33073116
Penetration rates of Electric Vehicles ,7
Penetration rates of Hybrid Electric Vehicles,13
Penetration rates of Fuel Cell Electric Vehicles ,7
Time loss for congestion,20882
Time in overcrowded veh per pass*10^6km,1.548008918
Time spent in traffic jams per pass*10^6km,0.054654906
Transport time use efficiency,0.995280706
Emissions efficiency,0.948773121
Transport efficiency,0.950799988
Crowding/emission unit,5.302509373
Traffic jams/emission unit,0.187213488
Transportation demand / emission unit,12758.76281

These sets of values can now be analysed by a discrete multi-criteria optimisation tool that computes non-dominated sets and pareto optimal solutions as well as an efficient solution given a reference point such as utopia.







The analysis tools supports the interactive selection of (sub)sets of indicators and the setting of constraints, so that the results depend on these selections. However, and as expected, when favouring environmental concerns, the virtuous pensionrs cities provide the most attractive model. When considering basic economic and efficiency criteria together with the environmental and public health, the dynamic, growing, young but virtuous (high-tech, favoring public transport, and avoiding urban sprawl) scenarios provide the preferred solutions.

Whilwe this results may be considered trivial, the tools now can be used to analysis large numbers of scenarios to find the **most efficient mix of strategies** over a large set of possibly policy alternative and design variants.

WP 14 Cross-comparison and benchmarking: general strategies

Workpackage number: 14

Start date/event: PM 22 (19)

Lead contractor: P05, ARPAL

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
2				2	1	2	1	3	3	1		15

Resource summary: % used

WP14	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	578	843	578	843	1.963	29	43
Resources (Euros)	11.866	17.332	11.866	17.331	43.417	27	40

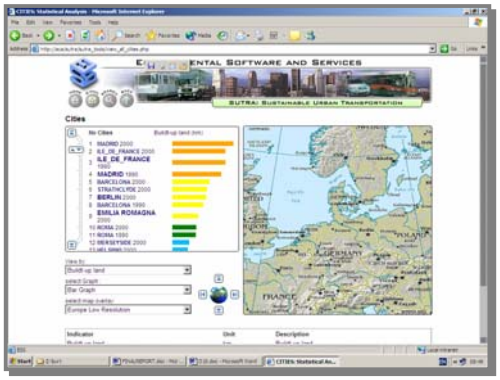
The objectives of this work package, led by ARPAL, are:

- The identification of generic strategies for sustainable urban transportation based on the comparative analysis of the most promising scenarios from each test application site.
- The comparison of the indicator set describing the scenarios within a larger group of (current situation) cities in a benchmarking exercise.
- The identification of promising strategies for sustainable urban transportation.

According to the revised work plan and time table, there were only preparatory activities in this work package during the reporting period.

With respect to benchmarking, the collection of data about mobility, pollution and health effects for a bigger group of European cities has led to a comparative city data base with more than 70 cities and about 40 indicators per city on average. This data colletion and associated benchmarking tools are available on line from the SUTRA project home page

http://www.ess.co.at/SUTRA/



WP 15 Documentation and Dissemination

Workpackage number: **15**

Start date/event: **PM 03**

Lead contractor: **P01 ESS**

Person-months per participants

P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	TOTAL
6				1	1			2	2			12

Resource summary: % used

WP15	Reporting Period		Cumulative		Total	% used	% value
	Used	Planned	Used	Planned	Planned		
Resources (hours)	696	1.101	2.046	2.080	3.042	67	68
Resources (Euros)	17.337	15.922	18.816	31.694	44.752	42	71

The objectives of this workpackage are:

- To develop and implement effective dissemination strategies for the project results;
- To document the project progress and results on a project home page.
- To maintain contact with the project user group.

Activities were primarily centered on the project web server, http://www.ess.co.at/SUTRA and selected publications, e.g., at the EUROTRAC workshop in Rhodos, April 3-7, 2002.

1.3 Milestones and deliverables obtained

Milestones: **M5: End of analysis phase, end of project**

An overview of all Deliverables, on-line versions or downloadable documents are available under: http://www.ess.co.at/SUTRA/PLAN/deliverables.html

The Deliverables themselves are availale on-line under:
http://www.ess.co.at/SUTRA/DELIVERABLES/

- D01: Requirements and Constraints Report (available on-line)
- D02: Data Availability Report (available on-line, continuing updates)
- D03.1: Multi-modal Transportation
- D03.2: Transportation Model Prototype
- D04.1. Emission modelling, report and user manual
- D04.2. Emission modelling, operational model
- D05.1: Mesoscale air quality modelling (incl. Appendix)
- D05.2: Operational air quality system.
- D06.1 EIA Methodology
- D07.1 Energy Systesm Analysis Methodology
- D07.2 Energy Systems Model, User Manual
- D08: Indicators and economic assessment report (internal review)
- D09: Public Health Impact
- D10: Integrated assessment and DSS methodology (also available on-line)
- D11: Scenarios of sustainable urban transportation report (internal review)
- D12.0: Scenario analysis, Summary Report
- D12.1 City case study: Buenos Aires
- D12.2 City case study: Gdansk
- D12.3 City Case study: Geneva (integrated in D07)
- D12.4 City case study: Genova
- D12.5 City case study: Lisbon
- D12.6: City case study: Tel Aviv
- D12.7 City case study: Thessaloniki
- D13: Multi-criteria Assessment
- D14: Comparative Analysis: benchmarking
- D15.1: Dissemination Report, web server
- D15.2 Technology Implementation Plan
- D15.3: Final Report (DRAFT)

In summary, all deliverables could be produced and were repeatedly updated reflecting the progress in the projects. Notable exception are d12.1 (Buenos Aires). D12.3 (City Report Geneva) was integrated into a consolidated Deliverable D07.

1.4 Deviations from the work plan and their impact to the project

In general, the project has submitted a request for an extensin for six months after the MTA; the current work plan and scheduling is oriented towards this extension, even though the contract amendment has not been made yet.

The major changes during the project relate to:

1. The initial withdrawal of ET&P from Spain, and the cancellation of the case study for Madrid; this was addressed in Amendment No.1, and solved by
    a. Adding Thessaloniki as a case study instead;
    b. Distributing the tasks of WP 02 (data compilation) across the consortium with ESS coordinating.
2. The resulting delays in the project, that were addressed by Amendment No2 (six months extension) bringing the project back to the original duration planned in the proposal and subsequently reduced by six months as part of the negotiation process;
3. The de-facto withdrawal of the Argentinian partner University of Belgrano; this was address at the MTA where TUG (Gdansk) offered to take over the main part of the methodological contribution proposed by UBG (Health Impact Modeling, WP 09) and the corresponding Deliverable. The case study for Buenos Aires had to be cancelled due to the lack of data inpouts from the Buenos Aires partner. Since the University of Belgrano was funded (or rather not funded in the end) by national Argentininan sources, this did not effect the tasks and deliverables directly suppored by the EU.
4. UGE, the University of Geneva, was funded by Swiss national sources. While UGE supported the project extension by six months, its funding ceased with December 2002, creating some difficulties for the team. However, UGE was nevertheless and most commendably able to continue to support the EU partners in their application of the MARKAL model even beyond their own funding.

1.5 Co-ordination between partners and communication activities

Meetings:

- Kick-off Meeting at ESS in Gumpoldskirchen, Austria, 15-16 September 2000
- Management Board Meeting in Geneva, Switzerland, 5-6 February 2001
- First MARKAL workshop, UGE, Geneva, Switzerland, February 7-9, 2001
- Transportation modelling workshop (VISUM) at ptv in Karlsruhe, April 23-27, 2001
- Management Board Meeting in Aveiro, Portugal, 11 June 2001
- Air quality modelling workshop, Aveiro, Portugal, 12/13 June 2001
- Second MARKAL modeling workshop, Geneva, August 27-29, 2001
- Management Board Meeting in Thessaloniki, Greece, 30 August-1 September 2001
- Mid Term Assessment (MTA) and Management Board Meeting in Genoa, Italy, 27-29 January 2002
- Management Board Meeting in Geneva, Switzerland, 6-7 June 2002
- Technical Workshop on assessment in Eilat, December 2002
- Management Board Meeting in Milano, April 2003
- Final board meeting and workshop, Gdansk, June 2003.

In addition, a number of bilateral meetings (MTPG, ARPAL, ESS) and in Geneva for the MARKAL applications as well as dedicated to work packages 9, 13 and 14 (held at ESS) with representatives from ARPAL and TUG.

Meeting schedules, agenda and minutes are published on the project web site:

http://www.ess.co.at/SUTRA/PLAN/meetings.html

Website and Mailing List:

- Project Website: http://www.ess.co.at/SUTRA/
- Project Mailing List: traffic@ess.co.at

Over the project duration, more than 3,000 individual eMail messages were exchanged between the partners, not counting the multiplier effect of the mailing list.

Publications:

ESS:

Fedra, K. (2002)

AirWare: an urban and industrial air quality assessment and management information system. (presented at the EUROTRAC workshop on Urban air quality management, Rhodos, April 2002).

UAVR:

Peer Reviewed Articles:
Authors, Date Title, Journal, Reference

Non-refereed literature:
Authors, Date, Title, Event, Reference, Type

Borrego C., Tchepel O., Monteiro A., Barros N., Miranda A. (2001): Influence of Traffic Emissions Estimation Variability on Urban Air Quality Modelling, *The Third International Conference on Urban Air Quality. 19-23 March, Loutraki, Greece, CD-ROM proceeding.*

Borrego C., Miranda A.I., Tchepel O., Costa A.M., Amorim J.H. and Magalhães S. (2002): Development of an integrated air quality management system for urban areas. *EUROTRAC –2 Symposium 2002*. 11-15 March, Garmish-Partenkirchen, Germany (In press).

Tchepel O., Costa A.M., Amorim J.H., Miranda A. and Borrego C. (2002): Transport emission model and dispersion study for Lisbon air quality at local scale.11th Int. Symp. Transport and Air Pollution, 19-21 June, Graz, Austria, pp. 109 – 116.

Others: Planning of future publications: Borrego C., Miranda A.I., Costa A.M., Tchepel O. and Amorim J.H. (2002): Air quality modelling in European cities: a local scale perspective. 8th Int. Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, 14-17 October, Sofia, Bulgaria (accepted).

CGOA:

Non refereed literature:
Objectives and features of SUTRA has been shown in some meetings held in the reporting period and attended by MTPG:

1) Authors: V.M. Contursi;

Date: from 9th to 12th of October, 2001;

Title: no-title;

Event: 5th National Conference ASITA 2002 – Scientific Association for Environmental and Territorial Information – Title: “Geographic Information Quality”

Reference: the event was organized by: SIFET (Topography and Photogrammetry Italian Society); AIT (Tele-Survey Italian Association); AMFM (Automated Mapping Facilities Management); AIC (Cartography Italia Association).

Type: Informative Pannel in a dissemination point

2) Authors: V.M. Contursi; Date: 12/04/2002;

Event: E-MUNIS Workshop: Municipal IT Best Practice

Reference: Association GISIG in collaboration with the Municipality of Genoa

Type: Oral Presentation and Paper

AUTh:

Abstract titled “The application of air quality models for the development of a methodology for optimised urban transport in the Greater Thessaloniki Area” was submitted and accepted for the HELECO International conference that will take place from 30th January to 2nd February 2003 in Athens.

GOVIS:

Not relevant

TUG:

ORŁOWSKI C., THE EVALUATION OF THE IT PROJECTS WITH THE USE OF FUZZY MODELS, **Cybernetics and Systems**, (accepted to go into print).

ORŁOWSKI C., SZCZERBICKI E. THE FUZZY MODEL FOR MANAGING IT PROJECTS, **Cybernetics and Systems**, (accepted to go into print)