HEARTS results: tools for sustainable planning

The HEARTS approach can be used to facilitate decisions about a particular policy adopted or proposed in a city. HEARTS tools are designed to support policy-makers, project managers and other local authorities, upon appropriate data collection providing input to the HEARTS models.

HEARTS aimed at harmonizing the design and the assessment of measures to reduce traffic emissions and their effects on human health. The adoption of an integrated approach, in which emissions are considered together with noise levels and accident occurrence, can have a remarkable socio-economic relevance. Tools allowing decision makers to identify an optimal strategy provide a step in this direction. HEARTS has defined how these tools should operate, and under which requirements, by identifying a procedure supporting decisions among different urban policy scenarios. This procedure allows to estimate human exposure for different traffic conditions in an accurate and realistic way.

From a policymaking point of view, the estimates calculated by the HEARTS modelling tools can provide an ex-ante evaluation of proposed urban policies through transport scenarios including estimates of the expected impacts associated to a set of policies/measures. If policies/measures are already in place, the estimates from HEARTS modelling tool could be assumed as ex-post evaluation, to carry out sensitivity analysis about the impacts that could be expected under different conditions.

HEARTS key features

- HEARTS methodology and tools are best suited to investigate data within a spatial context.
- Accident risk is integrated with air pollution and noise risks; multiple traffic-related effects can be evaluated; different datasets can be combined to assess population exposure to risks associated to traffic
- HEARTS can support the assessment of where and when vulnerable groups are in contact with traffic risks
- Complex data production, exchange and management can be handled by specific software through defined data warehouse and precise GIS approach.

The HEARTS Consortium: partners and responsibilities

- WHO Regional Office for Europe, European Centre for Environment and Health (WHO)
  (Coordination, Health effects models (dose-response functions), synthesis and interpretation)
- Imperial College, United Kingdom (ICSTM)
  (Air pollution models, Models linkage (overall integration in a GIS environment), Leicester case study)
- National Public Health Institute, Finland (KTL)
  (Population exposure to air and noise pollution in indoor, outdoor and transport micro-environments; time activity models)
- Italian Government Agency in the areas of Energy and Environment, Italy (ENEA)
  (Noise models, Transport and emissions models)
- French National Institute for Transport and Safety Research, France (INRETS)
  (Traffic accident models, Lille case study)
- Institute of Studies for the Integration of Systems, Italy (ISIS)
  (Transport policies and scenarios, Florence case study)
- Université de Versailles Saint-Quentin, France (PRISM) (Datawarehouse)
- National Technical University of Athens, Greece (NTUA) (Pedestrian behaviour)

Several consultants also contributed to the project, including: the National Institute of Public Health and the Environment (RIVM), Netherlands, Berry Environmental Ltd (BEL), Observatoire National de l'Aménagement Durable Accessible (ONADA) and the Institute for Transport Studies (ITS), United Kingdom.

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HEARTS

Health effects and risk of transport systems

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Traffic-related air pollution, noise, road crashes, both independently and jointly, cause of a wide range of adverse effects on health such as increased mortality, cardio-respiratory and stress-related diseases, cancer and physical injury. The impact goes beyond transport users, affecting the population at large. Children and the elderly, as well as cyclists and pedestrians, are the most vulnerable.

Focusing on single risk factors is not always satisfactory, as strategies and policies developed to address one risk might increase other risks. To develop sustainable road transport policies, policy-makers and stakeholders need tools for integrated risk assessment.

HEARTS, completed in October 2005, worked to match this need. It developed and tested a methodology for integrated impact assessment that evaluates changes in exposure patterns corresponding to different policies for urban transport and land use, and quantifies the associated health effects attributable to air pollution, noise and road crashes.

EUROPE

Urban transport: exposure and health

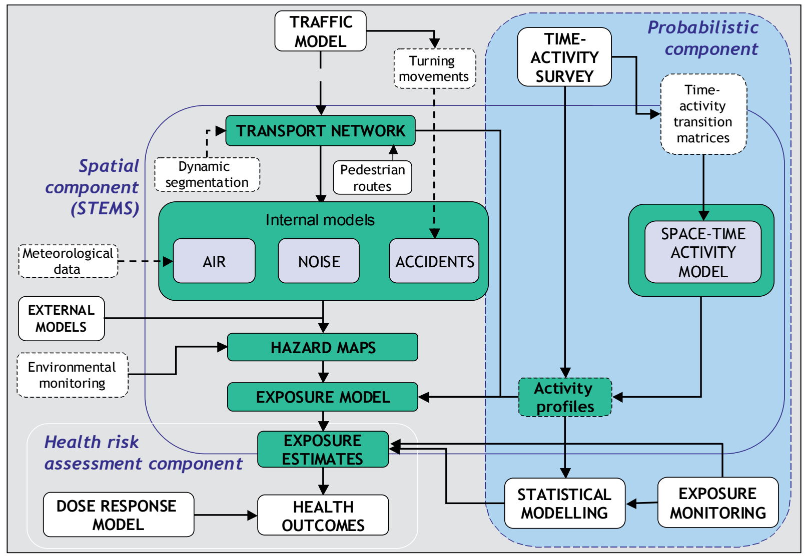
HEARTS estimates are based on the most significant health effects and exposures, selected through an extensive review of the large body of evidence on the effects of ambient air-pollution, noise and road accidents.

Exposure	Health effects
Air pollution	Cardio-respiratory and total mortality, lung cancer, hospital admissions for respiratory and cardio-vascular disease
Noise	Chronic effects on psycho-social conditions (for example annoyance, sleep disturbance)
Road crashes	Fatal and non-fatal injuries

The HEARTS methodology: integration of models

The HEARTS methodology is based on a modular structure that integrates a number of models addressing different risks and health effects. These models, either selected among those already available or developed ad hoc by the project, were tested and validated through case studies.

HEARTS models can use data from existing time-activity surveys or simulate time-activity profiles using a probabilistic modelling approach. Daily activity profiles are used in connection with hazard intensity maps to estimate exposure. When applicable, the health risk is modelled with the use of dose-response functions. A number of other external models and data sets are used depending on which of the internal models are in operation.



This approach allows using any of the internal models independently, or bypassing and exchanging data from external models.

Tools and models specifically developed by HEARTS

- Transport Energy and Environment (TEE) - A software that models emissions of air pollutant and noise and occurrence of road accidents.
  Specific efforts were dedicated to modelling the effects of vehicles kinematics on hot emissions, instantaneous emissions, or the innovative 'kinematics correction functions' model, and the modelling of parking processes which are relevant for both cold start and evaporative emissions.
- Space Time Exposure Modelling System (STEMS) - A GIS-based tool including modules that model dispersion of air pollution and noise as well as exposure with capabilities to include a wide range of situations.
- Model for road accident risk and pedestrian behaviour.
- STEMS-Trip - A software that models time-activity patterns on a geospatial basis.
- Model for time-activity patterns based on statistical simulations.
- Model for health effects associated to air pollution and noise, based on dose-response curves.

Case studies

Three case studies demonstrate and test the available methods, and helped develop and validate the models.

Florence (Italy)

This case study aimed at creating an integrated modelling system by linking the various models within a geographical information system (GIS). Based on monitoring of time-activity patterns, noise and air pollution exposure, two scenarios were modelled for 2003 (current situation) and 2010 (situation after implementation of a new transport management policy).

HEARTS estimates for the 2010 scenario indicate that the planned policy should entail a decrease of transport volume by 15% for private cars and by 1.6% for public transport. In terms of emissions, there would be a reduction of PM10 by nearly 40%, and a consequent reduction of 129 premature deaths per year among adults. For the 2003 scenario, HEARTS models estimate that a large proportion of the adult population is exposed to high noise levels, resulting in 38% of the population annoyed and 21% suffering from sleep disturbances. This proportion would decrease in 2010 after implementation of planned policy.

Lille (France)

This case study focused on pedestrian behaviour (children 5-10 year old and workers 18-60 year old) and accident modelling. A data warehouse and a GIS were developed to collect, organize and host data on mobility, networks, traffic, air pollution and road accidents.

The observations show that the morphology of the city and the network influence more the strategy of crossing than the individual characteristics of the pedestrian.

The traffic flow was also simulated in three scenarios: current situation, situation in 2015 with a proactive policy, situation in 2015 with no policy at all. In this case, HEARTS models estimated limited changes in traffic flow and associated risks.

Leicester (United Kingdom)

This case study focused on collection of primary data on children's time-activity patterns, and on personal exposures to air pollution in different transport micro-environments. HEARTS models for air pollution and noise were validated and tested against monitored data. Most children in the study area went to local schools; the majority walked to school (about 80%).

Model estimates indicated that travel behaviour has large effects on children's exposures to air pollution, and is likely to be important in determining health risks. In the context of this case study, models also estimated that the differences between exposures to air pollution whilst in-vehicle and while walking are significant: walkers have a 4-10 fold increase in exposure when compared to passengers or drivers in cars. This is due to concentrations of particulates tending to be greater for people walking on kerbside than in vehicles, and to longerexposure for people walking than for those travelling by car. This has important implications for policies aimed at encouraging walking, and highlights the need to design low-pollution walking routes for pedestrians. Modelling of the walk-to-school policy shows that effects on exposures to air pollution depend on the lifestyle of the individuals concerned.

Paradoxically, for the majority of children, air pollution exposure would increase if they changed from travelling by car to walking. For those who continue to use a car (or continue to walk), however, the reduction in local air pollution levels provides a slight alleviation of exposures. Nevertheless, the drawback in terms of air pollution exposure for those shifting their behaviour is likely to be offset by other advantages, including more exercise and opportunities for socialization.