GUIDELINES FOR IMPLEMENTERS OF

Using Environmental Pollution Data in Traffic Management Centres

NICHES+ is a Coordination Action funded by the European Commission under the Seventh Framework Programme for R&D, Sustainable Surface Transport

What is it about?

Characteristics

Environmental Pollution Data (EPD) are increasingly available in many urban areas. The ability to gather, manage and process such data enables a local authority to fully understand the impact of transport in its city or region.

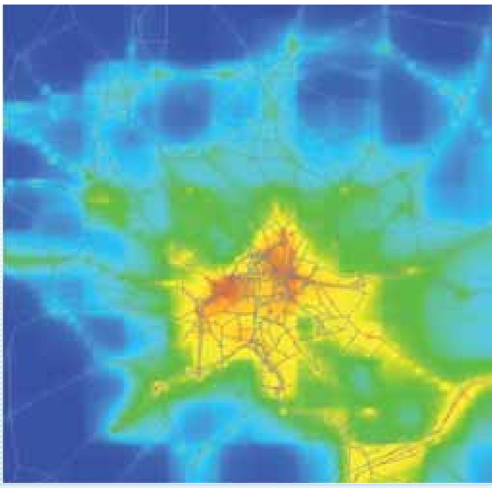
Provision of EPD in meaningful formats can:

- influence policy decisions in transport, land use, environment, health, carbon reduction and climate change;
- assist the public to make informed travel choices;
- provide an opportunity for detailed environmental profiling, for example, the location of pollution hotspots;
- help meet EU directives and national targets.

The concept is potentially transferable throughout Europe. However, it must be tailored to the local (or national) context, taking into account environmental targets and initiatives.

Concept definition

Large amounts of pollution data are becoming available in many urban areas. Provision of such data in meaningful formats can be used to agree policy decisions, and can be presented to the public to help them make informed travel choices.



Spatial variation in air quality across a city
Photo: UNEW

Key benefits

Using Environmental Pollution Data in Traffic Management can improve:

- the understanding of the true environmental impacts of traffic;
- the attractiveness of green transport policies and use of alternative, non-motorised modes (walking, cycling);
- the policy and travel choices which can make a measureable difference to health quality at the local level, both in the short and long term;
- the compliance with EU Air Quality and Noise legislation.

Example: Leicester Area Traffic Control, UK

Leicester's Area Traffic Control Centre (ATC) incorporates over 800 sets of signals, 31 car park guidance variable message signs (VMS), over 100 traffic cameras, and 13 pollution monitors.

The feature that sets Leicester apart from many similar systems is the role that air quality monitoring plays in the city.

The key for a city considering this concept is to identify appropriate uses for the large amounts of data collected, including how to manage those data, and how to employ them as a traffic management tool.

The facilities available in Leicester allow the ATC to do all of the above. Leicester uses data from its pollution monitors to supply environmental and meteorological data, as well as traffic and travel information to the public via its website. This includes information about ozone, CO, NO_x, SO_2 and particulates.

Is this something for us?

Do you think that there is - or could be in the future - an air quality problem in your city or region?

As data gathering, management and processing becomes more sophisticated, the EPD that emerge become more comprehensive and precise, enabling decision-makers to be better informed.

Key conditions for implementation are:

- strong political leadership. Support and co-operation of different departments and agencies will be required, as well as public support, possible community working, and partnerships. Joined-up thinking is a "must";
- robust environmental policies to alleviate traffic pollution;
- inter-departmental working within the local authority, as different departments may have different goals, objectives or targets;
- inter-authority and inter-agency working – pollution does not stop at geo-political boundaries!

Health impact of selected pollutants	
Pollutant	Health Impact
Ozone	Accentuate lung disease/asthma
Nitrogen dioxide	Accentuate lung disease/asthma
Sulphur dioxide	Accentuate lung disease/asthma
Particulates	Accentuate heart and lung disease
Carbon dioxide	Reduces oxygen supply

"Urban Traffic Management and Control (UTMC), when integrated with Air Quality Management, can provide tools for supporting the implementation of environmental policies covering transport, air and noise quality, health, carbon reduction and climate change.

Benefits increase with multi-disciplinary working, and as you move from a simple to a more sophisticated highway network."

Nick Hodges, previously Team Leader Special Projects, Leicester City Council, United Kingdom

Check list

City size	Environmental zone, city, region.
Costs	Marginal, if monitoring and processing infrastructure exists, otherwise considerable (over phased implementation programme). Modelling and low cost pervasive sensing technologies are available which can help minimise initial outlay.
Implementation time	3-5 years, although "quick win" practical measures can be accomplished at short notice.
Stakeholders involved	• Local authorities; • Traffic managers, police and planners; • Environmental managers; • Residents; • Local businesses; • Local health authorities; • Technical experts, including research institutions.
Undesirable secondary effects	• Possible disincentives in publicising EPD and other pollution information; • Potential public opposition to restrictive measure taken to improve pollution levels and air quality.

Benefits & Costs

Benefits

The main aim of using EPD in traffic management is to encourage local authorities to manage and process large amounts of data to assist them in meeting specified policy targets.

EPD can provide a true picture of the air quality across an area, providing a 24-hour forecast of pollution levels and helping to identify pollution hotspots. EPD can:

- improve environmental management over a whole area, e.g. the implementation of smog (Smoke Free) or ozone plans and measures;
- minimise the impact of transport on air quality in localised areas;
- enable effective local and network traffic management using urban traffic management and control (UTMC) systems;
- reveal long-term environmental trends when near real-time and historic data are compared.

EPD can also be presented to the public to provide the opportunity for travellers to feel empowered by selecting greener motorised, or sustainable non-motorised modal choices.

"Action Plan Air Quality 2008" (ALU2008)

Utrecht, The Netherlands

The city of Utrecht implemented the Utrecht Air Quality Action Plan on 30th September 2008. The plan consists of a wide range of measures to ensure that air quality in Utrecht meets European Standards by 2015.

Although the overall air quality situation in Utrecht is currently deemed to be satisfactory, levels would not comply with the European Standards in 2015 unless this plan was implemented now, and additional measures taken in future years. The aim is to promote public transport, park & ride, cycling and car circulation, whilst reducing NO_2, PM_{10} and $PM_{2.5}$.

Costs

In **economic** terms, costs and benefits of EPD cannot be directly identified. Green models can be barriers to some implementers as they may require new equipment, or re-engineered management or business cases.

Key cost areas are as follows:

- **project implementation.** The scheme would be run by the local authority and managed at a local level. The private sector would supply equipment and technical input and support;
- **deployment of measuring devices or a sensor network.** It would be desirable to obtain central government capital funding. However it is possible that the financial burden would fall primarily on the local authority;
- **computing capacity.** Substantial amounts of EPD can be collected, managed, stored, processed and disseminated. This requires investment in computing hardware (e.g. data servers) and software (e.g. modelling packages) and specialist data processing skills, possibly from the private sector;
- **alternative transport policy.** Finance mitigation measures (e.g. public transport deployment, alternative routes, etc.).

IMMIS System, Berlin, Germany

The IMMIS monitoring system currently covers an area of approximately 24 km^2, containing 116 km of major roads in Berlin. Measures were introduced to reduce traffic levels by 12% at a local pollution hotspot at the Altewiekring.

Analysis of the EPD collected indicates a reduction in the mean concentration of NO_x by 10.2% and of PM_{10} by 4.2%.

Users & Stakeholders

Users and target groups

There are two main target user groups: government authorities and the public.

Government authorities
These are high stake, high influence organisations. According to national culture, these may be national or regional agencies or regional and/or local authorities. The main departments within local authorities with an immediate interest in EPD are the transport and environmental departments, as well as their strategic planning colleagues. They require quality EPD to influence policy. Care must be taken as there may be wider political objectives which may not benefit from publicity about pollutants.

Health Authorities and Environmental Enforcement Agencies require EPD to gain a wider understanding of the profile of pollutants, their cause and their impact upon all citizens.

The public
There is a diverse range of citizens for whom EPD can be of benefit, including pedestrians, cyclists, children, older people, road users, research institutions and environmental groups.

These are high stake bodies but with minimal influence. These citizens are beneficiaries from knowledge provided by EPD and the policies introduced through knowledge gained by the policy-maker. However, it may be necessary to "sell" the idea to the public in general.

Lamp post-mounted wireless sensor for monitoring NO_x, CO, noise, temperature and humidity
Photo: UNEW

Key stakeholders for implementation

Key stakeholders fall into two main categories: authority/management, or technical.

Politicians
Work with other partners to assist in the development of the overall policy aims and objectives, and engage with the public.

Transport and environmental authorities
Design and implement an appropriate system for EPD management and processing in liaison with others.

Technical providers and research
Monitoring technology, data processing technology and pollution modelling technology may be developed by sub-contracted technology providers or through R&D projects. Liaison is required to discuss possible new opportunities.

Leicester Area Traffic Control, UK

The main stakeholder is Leicester City Council ATC. Other local authorities are also involved, including Leicestershire County Council and neighbouring local authorities, as well as the UK Meteorological Offices and Research Institutes. The air quality data are collected via a series of monitoring stations around the city, and information is made available to the public through a website, benefitting trip-makers, residents, businesses, and health professionals.

This information is valuable in providing a better understanding of local pollution problems and the sources of the pollution, allowing Leicester City Council to adopt a proactive role in air quality management and policy development.

From concept to reality
Preparation

The main aim of using EPD in traffic management is to encourage local authorities to manage and process large amounts of data to assist them in meeting specific policy targets.

Key aspects at this stage

Identify a strong champion
A committed champion needs to be identified, who is independent of political parties. This strong individual will help sell the concept to politicians and the public. He takes ownership and drives the concept forward.

EPD can affect the image of a city, both positively and negatively. Pollution-related policies can be politically sensitive: for example, influencing pollution location by altering traffic signals can alienate people in the vicinity of the re-allocated traffic. Therefore, strong political leadership is essential from the outset.

Understand the local context
There is a need to understand the context conditions in an adopting city, in terms of technology, political climate, demographic/social, physical and environmental characteristics. For example, do alternative, sustainable modes exist? Are there alternative routes available to re-allocate traffic? Are there mutual policy benefits such as pedestrianisation or low emission zones?

Success factors or barriers which are deemed 'minor' in some cities could assume greater significance in other cities, whilst providing EPD to the public could cause uncertainty in local politicial systems. It is therefore important to understand exactly the context conditions and what the different stakeholders need or want.

Identify the business case
The first step should be to identify a set of key objectives to work towards based on the local, regional or national context and needs.

One of the key barriers to successful implementation of EPD is the difficulty of achieving a direct monetary return on investment, as costs and benefits cannot always be directly identified and quantified. The solution may be to **identify and quantify "impacts"** rather than a direct monetary cost. This could be achieved using an environmental impact matrix.

Addressing "green issues" usually generates a positive response from both policy-makers and the public. Appropriate application of EPD can raise awareness of such issues which may lead to changes in driver behaviour and good practice ("green choices").

Improved EPD will lead to changes in traffic management and policies (e.g. reduction in air quality management areas, modal switch to public transport, carbon and greenhouse gas reduction). These could lead to changes in travel habits, activity location and participation.

Local culture may have an impact, but this is not easy to quantify. For example, there may be other more pressing policy objectives, or clean air and improved social interaction opportunities may not be perceived as a benefit for particular stakeholder groups or cities because there is no direct return. On the other hand, health impacts can be large even if the average air quality reduction is small.

Provide appropriate training

Better EPD enable more appropriate traffic management for an overall network or localised area(s). However, personnel need to be trained to make the best use of the data.

Data can be used in many different ways. One example is combining them with meterological data and a dispersion model to understand how the pollutants disperse over time and in different weather conditions. This can provide policy-makers with very specific information about hotspots and the need for strategic or local mitigation actions.

Such expertise allows more accurate management to take place. However, there are substantial volumes of EPD combined with specialist modelling software, so operators, managers and other employees responsible for using EPD should be suitably trained to understand the processes involved. Specifically, experts are required who understand the interactions between traffic, management and achieving air quality targets.

Lamp post-mounted wireless sensor located in residential area
Photo: UNEW

Understand technical limitations and barriers

Technical issues are based around good decisions on infrastructure, making sure any system will be open and interoperable.

EPD require pollutant monitoring technology (e.g. wireless sensors to augment existing Air Quality Monitoring). Existing technology may need upgrading, whilst new technology may need integrating with current systems. Technology must serve a purpose and shouldn't lead a scheme. Adopters must also be aware of new technologies that may have a role to play in the future (e.g. iPhones and iPods).

Selecting and procuring appropriate technologies is imperative. They must be future-proof, interoperable and open, and appropriate given the scheme's objectives and budget (e.g. can policy be sufficiently informed by accurate technology that measures high or low levels of pollutants but not very high or very low levels?).

Regular liaison with technical providers and research institutions can help foster strong working links and opportunities through sharing EPD, and exchanging new knowledge and ideas.

Air Quality Monitoring (AQM) should be integrated with traffic modelling data, whilst monitoring should be used to assess impacts, network status, and model validation.

Check list

Ready for implementation?	✓
Strong political support at the local level	
Local context understood	
Establish a business case	
Understand technology	
Appropriate training for employees	
Dry run and testing	

From concept to reality
Implementation

Key aspects at this stage

Involve external influencers
It is recommended that the travelling public, residents and businesses are involved in a clearly defined co-operative process. This is important when delivering user-specific information from the collection and processing of EPD. For example, even within the category of "vulnerable" people, there may be a different set of impacts for children, disabled or older people.

Engaging the public and businesses is essential in order to challenge (but at the same time empathise with) different interest groups such as manufacturers, retailers, freight operators, private motorists and property developers, all of whom are contributors to environmental emissions. Getting them "onside" with the project's aspirations will be of great assistance to policy-making in the future, leading to support for mitigation measures.

EU Air Quality Legislation

Air Quality Directive 96/62EC: set framework for monitoring and reporting air pollution

Daughter Directives: (1999) nitrogen dioxide and oxides of nitrogen, sulphur dioxide, lead particulate matter PM_{10} benzene and carbon monoxide; (2000) ozone; (2002) arsenic, cadmium, mercury, nickel; (2004) polycyclic aromatic hydrocarbon

Air Quality Directive 2008: revised ambient air limit values for $PM_{2.5}$ and integration of Daughter Directives

Provide different channels for dissemination of information
The key user groups to involve are high influence stakeholders, these being local/city authorities, and transport, health and environmental authorities. These are the stakeholders concerned with delivering the project and utilising EPD, so they will require detailed information about how EPD can complement or influence policies.

The delivery of appropriate services to the travelling public to extend their knowledge and influence their behaviour is likely to be a prime objective, and one that makes use of information delivery technologies. Many citizens (residents, the travelling public, local employees) have a high stake but minimal influence, although well co-ordinated lobby groups can undoubtedly exert a relatively high level of influence.

Delivering EPD information to the public can be controversial for politicians, and may present challenges in terms of engagement (e.g. risk of apathy or over-reaction). A supportive local media is an advantage.

Trip-makers can be encouraged through dissemination to make a "green choice", whilst the public in general can make "health choices". EPD information can be delivered by:

- VMS to road users;
- website (e.g. Leicester, AirParif, DCMR Environmental Protection Agency);
- newspapers;
- radio broadcast;
- personal portable devices.

Develop integrated policy frameworks which are flexible

It is crucial to link the policy framework to the key objectives of the scheme. There are different types of integration that need to take place:

- people and transport systems integration;
- policy integration;
- institutional integration;
- technology integration (monitoring, modelling).

Depending on the type of EPD collected, and what time period it covers, greater priority may be afforded to traffic management or environmental management strategies.

It is necessary to define traffic management and environmental management strategies that are appropriate for different types and levels of pollution, and balance the policy objectives of both. This may change over relatively short periods of time, due to factors such as weather conditions (i.e. temperature inversion or trans-boundary background pollution) or traffic patterns (e.g. at peak periods, during sports events, or during the school holidays).

Engage with research institutions

Traffic Management should be developed around open systems which should cater for transferability.

New technologies might become available, especially in the field of monitoring, data processing and pollution modelling. Therefore, it may be necessary to involve new technical research at certain times, possibly depending on evolving policy objectives.

In particular, the following technology-related questions should be addressed:

- benefits of moving from sparse, low-density monitoring technologies (e.g. Automatic Urban Rural Network (AURN) stations) to widespread, high-density, ad-hoc sensor networks;
- the level of technical sophistication that can be achieved under certain budgets;
- collection of reliable and accurate EPD by new technologies (piloting schemes should be implemented);
- precision of technology (e.g. 100ppm is high), so does future technology need to be even more powerful?

Pervasive monitoring of pollutants in Leicester (sensors circled) and close-up of sensor (right)
Photo: UNEW

From concept to reality
Operation

Preparation → Implementation → Operation

Time range: 1-2 years | Time range: 1-2 years

The following elements are seen as fundamental to ensure long-term efficiency of EPD schemes.

Key aspects at this stage

Demonstrate the benefits
Improved EPD enable more appropriate transport and environmental policies to be implemented. EPD must be shared with other organisations to maximise their benefits.

Pollution hotspots can be identified to focus action on minimising the impact of transport on air quality in localised areas. A crude picture is currently given by AQM stations, but can be improved by combining with dispersion models and population density to assess exposure.

Meterological data plus modelled traffic flow provide emissions to estimate hourly pollution levels over one year periods. Substituting modelled traffic flows with archived measured traffic flows and dynamic measurement of traffic flow regimes can provide hourly "nowcast" estimates in real time.

Training of personnel is essential to maximise the use of all these integrated technologies.

EPD could warn of "high pollution days" based around events, and help manage "pollution incidents" allowing the Health Authority and emergency services to make preparations.

Be aware of possible new pollutants
In the future, small particulates (below PM_{10}) and ammonia may have greater health implications. Schemes like Personal Emission Allowances or CO_2 personal credit schemes and carbon tokens may be considered to influence personal decision making.

Understand geographical implications
Different physical and climatological conditions may impact on a scheme. Agreed standards or measurements provide understanding of the impact on neighbouring areas, as pollution does not stop at geopolitical boundaries. DEFRA in the UK have guidelines and standards for air quality, plus a methodology for measurements (see next page). Integrating European, UK (from Met Office) and local "nested" data with pollution models enables forecasting of pollution over 1-3 days. This can be done automatically from existing systems.

Be open to future technologies
- Low-power "motes" have been designed for applying ad-hoc LAN for monitoring localised pollution.
- Electric Vehicles are likely to become more commonplace, changing traffic flows and emission levels.
- I-pods will soon pick up EPD in Leicester and Newcastle (UK) with a link to mobile phone providers.

Build up a data bank of historical data sources
Data are used to build a time-series picture, helping to increase understanding of the links between land use, traffic management and transport planning.

Understanding trends can help guide real-time TMC operations, improve public transport services, manage traffic congestion, respond to pollution incidents, improve air quality and health conditions, and ultimately contribute to health, environmental and economic benefits.

Further information & contacts

Case Studies

Traffic and Air Quality Information, Leicester
http://rcweb.leicester.gov.uk/pollution/asp/home.asp

http://www.leicester.gov.uk/your-council-services/ep/environmental-health-licensing/pollution-control/air-quality/

http://www.airqualitynow.eu/index.php

Utrecht Air Quality Plan (in Dutch)
http://www.utrecht.nl/utrechtselucht

IMMIS, Berlin
http://www.ivu-umwelt.de/upload/download/publikationen/2009_Mettools/Vortrag_Langfassung_Lq4_l_Diegmann_etal.pdf

http://www.stadtentwicklung.berlin.de/archiv_sensut/umwelt/uisonline/envibase/handbook/traffic2.htm

Legislation & Guidelines

http://ec.europa.eu/environment/air/quality/legislation/directive.htm

http://www.defra.gov.uk/environment/quality/air/airquality/local/index.htm

http://www.airquality.co.uk/

Reports

Air Quality (Fifth Report of Session 2009-10), House of Commons Environmental Audit Committee, UK

Air Quality Management Guidebook, Citeair (Interreg IIIC)

Air Pollution: Action in a Changing Climate, DEFRA (UK), March 2010

Projects

Heaven (Healthier Environment through Abatement of Vehicle Emission and Noise) EU 5FP 1999-2001

Equal (Electronic Services for a Better Quality of Life) EU 2000-2002

Citeair (Common Information to European Air) EU Interreg IIIC 2004-2007

Citeair II (Common Information to European Air) EU Interreg IVC 2008-2011

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The mission of NICHES+ is

to build on the success of the first NICHES project by stimulating a wide debate on innovative urban transport and mobility between relevant stakeholders from different sectors and disciplines across the EU and accession countries, in order to promote the most promising new urban transport concepts, initiatives and projects and promote them from their current "niche" position to a mainstream urban transport application.

This publication is part of a series of 13 publications presenting the NICHES+ outcomes.

Title page picture:

Lamp post-mounted wireless sensor located in residential area (Photo: UNEW)

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Further information on NICHES+

www.niches-transport.org
www.osmose-os.org

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