"Satellite-assisted Management of Air Quality (SMAQ)"

LIFE05 ENV/GR/000214

Task Technical Report

LIFE ENVIRONMENT PROGRAMME

The View from Above

The Potential for Satellite-Assisted Management of Air Quality in Central and Eastern Europe

Deliverable D3.4

Edited by Jerome Simpson

REGIONAL ENVIRONMENTAL CENTER

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Foreword

Project and Report Rationale

"SMAQ" is the moniker of a GIS-enabled environmental and health information management system that integrates ground-based air pollution measurements with readily available satellite data and forecasting models, allowing the derivation of a highly accurate and continuous picture of regional[1] and urban air quality and more importantly, exposure levels. The information system, piloted in western Macedonia, north-west Greece from January 2008, is a tool for enhancing the quality of decision making processes. It is now ripe for transfer and implementation within any regional or urban hotspot experiencing environment and health concerns.

This report summarises the conditions and potential for the information system's transfer to eight European Union new member states stretching from Estonia to Bulgaria. It scopes the feasibility for the adoption of the SMAQ air quality information system by exploring the availability of a minimum set of data requirements, besides challenges and obstacles to system implementation. The findings are intended to help standardise SMAQ, so as to facilitate its transfer primarily - although not exclusively - to member state regions. The report's preparation and publication has already indirectly supported the dissemination and exploitation of SMAQ and the project's results.

[1] "Regional" in this instance applies to a zone of approximately 80 km * 80 km

Executive Summary

Project Goals and Report Objectives

SMAQ (an acronym for "satellite-assisted management of air quality") is the moniker of a GIS-enabled system dealing with environment and health information. It integrates ground-based air pollution measurements with readily available satellite data and forecasting models, allowing the derivation of a highly accurate and continuous picture of regional[2] and urban air quality and more importantly, exposure levels. The information system, developed in the context of the SMAQ project and subsequently piloted in western Macedonia, northwest Greece from January 2008, is a tool for informing and improving decision making. It is now ripe for transfer and implementation in regions and urban areas with concerns regarding environment and health.

This report seeks to support that process by looking at the potential and summarising necessary conditions for the information system's transfer to eight new member states of the European Union stretching from Estonia to Bulgaria. It scopes the feasibility for the adoption of the SMAQ system by investigating the availability of required data and foreseeing challenges to system implementation. The findings are intended to help standardise SMAQ, so as to facilitate its transfer to to member state regions and beyond. The report's preparation and publication have already indirectly supported the dissemination and exploitation of SMAQ and the project's results.

Accompanying workshops, the first in Prague in February 2009, will optimise the monitoring network design. A second workshop in Venice in March will seek to evaluate SMAQ's overall applicability. After completion of the piloting and feedback phase, the SMAQ project team will conduct technology transfer workshops from autumn 2008 tospring 2009 in north-west Greece (Kozani), Thessaloniki and Budapest, Hungary.

SMAQ's website is at: www.smaq-life.org

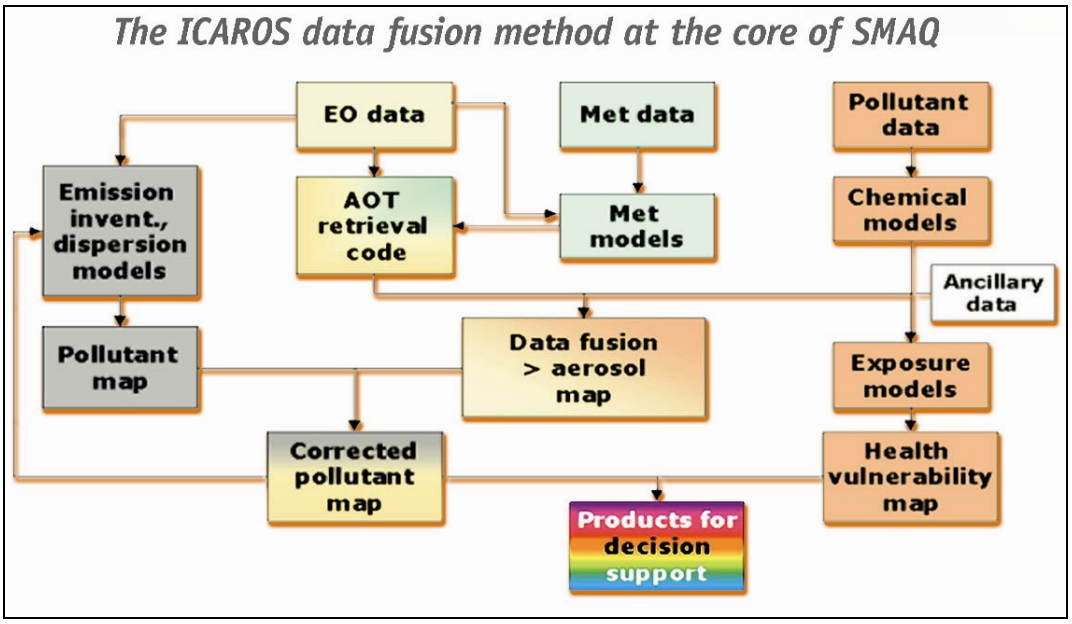
What is an environmental information system?

Environmental information systems are comprised of networks of institutions relying on electronic tools and traditional mechanisms to support the manipulation and flow of information, from the monitoring station to the interested stakeholder. These systems vary in structure and complexity, but generally consist of monitoring networks; data correlation, management and storage systems; reporting frameworks; and a variety of tools used for dissemination. In today's information society, electronic tools, such as computer networks for the rapid transfer of data and composite databases for information storage and management, form the basis of effective environmental information systems. Other important parts include proper operational plans, adequate and well-trained staff devoted to environmental information management, supportive legal frameworks, and mechanisms to raise awareness among potential users of this information.

[2] "Regional" in this instance applies to a zone of approximately 80 km * 80 km

The SMAQ air quality management information system

Local emissions data from diverse institutional sources, pollutant inventories, the most recently available satellite images, along with population data and biodiversity indicators have been screened and fed into the SMAQ GIS, as illustrated in the diagram below.



By applying various models, forecast maps have been elaborated that enable decision makers as well as the public to see exposure levels for the focus area, under various meteorological conditions.

SMAQ in practice

SMAQ implementation may proceed in one of two ways: 1) the SMAQ system, complete with a selection of satellite images, is run locally on a standard PC for a focus area, along with a range of non-real time air quality and ancillary data (population density and epidemiological data). *Offline* assessment for exposure to air pollution and the potential health impacts is made according to an algorithm that takes into account the current weather conditions and season. The investment outlay for this option would typically be in the region of: EUR 20,000-30,000 2) the SMAQ system is run locally on a standard PC connected to a ground station that receives satellite data (covering an area within a 50 km radius), which together with units for interpreting current meteorological and air pollution data from ground stations and for mapping risk, perform an *online* exposure assessment. Coupling this information with population density and epidemiological data, the potential health impacts of air pollution in the focus area can be reckoned. In both cases, the data can be published to the web. This set-up has been achieved in western Macedonia with limited investment in technological hardware (approximately EUR100,000 over three years, including operation).

Status of environmental information systems in the EU new member states

All countries have invested considerably in establishing environmental information management and reporting systems, driven in particular by European Environment Agency membership and participation in the European Environment Information and Observation Network (EIONET).

Typically all key pollutants of interest to SMAQ (PM10s, SO_2, NO_2, O_3) are monitored and regularly reported upon. In many instances, PM2.5s are also monitored and reported on. The availability of ancillary (meteorological, epidemiological and population) data is also widely available in almost all countries, although some question marks hang over certain categories in Romania.

The use of GIS and satellite data varies across the new member states, with wealthier countries such as Slovenia, Hungary, Estonia and the Czech Republic being more advanced than poorer ones such as Romania.

Challenges and obstacles to (SMAQ) technology transfer

By and large the challenges concern technical know-how, where in places like Poland it was noted, "Little practical use is made of satellite data … and GIS application tends to be disparate and according to an institution's own wishes." In Romania limited experience in satellite image use was observed, while the degree of know-how with respect to GIS software is limited. In Slovenia, the concern was more at the local authority level.

In other member states, for instance Bulgaria, the challenge was foreseen to be in acquiring the necessary data sets from the various players, besides finding the necessary technical know-how to integrate them for the target area. In Hungary, possible pilot application could be thwarted by the need to gain the support and collaboration of all 23 of Budapest's districts. In Slovakia, the concern was that the Slovak Hydro-Meteorological Institute was already very involved in international projects.

Future priorities and opportunities

In many countries, SMAQ's potential to support the implementation of the Infrastructure for Spatial Information in the European Community (INSPIRE) directive was seen as an opportunity to foster SMAQ technology transfer. Either INSPIRE could present an opportunity to acquire funding, or those working groups (Czech Republic), boards (Estonia) and inter-ministerial committees (Hungary) being set up to support the directive's implementation could in turn become SMAQ "ambassadors" or "champions." Other opportunities highlighted included the development or restructuring of environmental information systems (Czech Republic, Hungary/Budapest, Poland, Romania), general development programmes in Budapest (monitoring systems), Slovenia (for air quality) and Poland (development of a national emissions inventory), besides general interest in further information and an introduction to SMAQ (Estonia).

The potential of a "public-private partnership" in Slovakia with US Steel in the rather polluted Kosice agglomeration was also a suggestion put forward.

Recommendations

According to the survey findings, almost all EU new member states suffer from air quality hotspots. In spite of major air quality improvements over the last two decades, there is still room to diminish the impact on citizens everywhere. Budapest appears to be a prime test site for SMAQ, given its population of over 2 million. In any case, more should be learned about the incidence of hospital admissions for respiratory infections and other pulmonary diseases, since it is perhaps this statistic more than any other that might tip the balance in favour of SMAQ implementation, as opposed to opportunity to optimise on-the-ground monitoring networks and harmonise reporting in line with EU policy targets.

In general vis-à-vis SMAQ and the technology innovation it brings, broadly similar actions are suggested: awareness raising to convince the relevant authorities (environment ministries, health ministries, environmental agencies, regional inspectorates etc.) of the benefits of SMAQ and its unique approach. More specifically the following should be implemented:

- Explain the *educational and practical aspects* of SMAQ and GIS technology.

- Clearly demonstrate the *tangible benefits, cost effectiveness, required investments, annual operating expenses* for authorities, and the *conditions* under which implementation could be successful.

- Arrange *formal introductions* and a *personalised letter* of interest from SMAQ's project managers, followed up by *detailed negotiation* with key players.

An interesting suggestion is exploring the possibility of public-private partnerships with industry and targeting the energy sector directly.

These recommendations require that an effective presentation on SMAQ should be prepared (or the communications tools which have been prepared are adequately utilised and disseminated). Further suggestions, some in this regard, can be considered:

- Present good practical examples regarding the application of SMAQ within a pilot area;
- Deliver practical information on GIS technology;
- Demonstrate how legal solutions can be adapted to achieve implementation, and explain the coordination process;
- Share existing experiences with meta-data web applications (available on the Internet) from other sectors (health, agriculture); and
- Explore the potential of seed funding under the Structural Funds' Environment and Energy Operational Programme.

Although this report has surveyed eight new member states, a separate survey performed by the REC in 2008 showed that there may be opportunities elsewhere in Eastern Europe to pilot SMAQ. Short assessments of the urban environments of the West Balkan countries online at: www.rec.org/sector/assistance/urban.html show that most suffer from poor air quality (besides the new member states) including high levels of SO_2, PM2.5s and O_3. In a number of locations this is caused by heavy industry and/or growing levels of traffic, exacerbated by poor quality fuel (lead has yet to be phased out) and an aging vehicle fleet. Although, as

in all transition countries, environment is typically low on the policy priority agenda, and other challenges may arise, such as the adequacy of the air quality monitoring and reporting network[3], or GIS know-how, it could be interesting to explore the potential for technology transfer here, where funding also might more easily be available through pre-accession assistance. The author therefore recommends extending this same survey to the west Balkan countries.

These recommendations as well as the above conclusions will be considered as the SMAQ project team prepares for the Prague and Venice workshops regarding monitoring network design and SMAQ applicability, and which in themselves serve as opportunities to disseminate the project's results and informally get underway consultations with the above-listed agencies and institutions. The Budapest-based training in the spring of 2009 is an opportunity to explain the *educational and practical aspects* of SMAQ and GIS technology to would-be SMAQ champions and ambassadors. Western European counterparts will naturally be invited to get acquainted with SMAQ and to share their experiences also.

[3] A 'recent' survey is online at:
www.rec.org/REC/Programs/REReP/InformationSystems/PDF/Snapshot-EIS.PDF

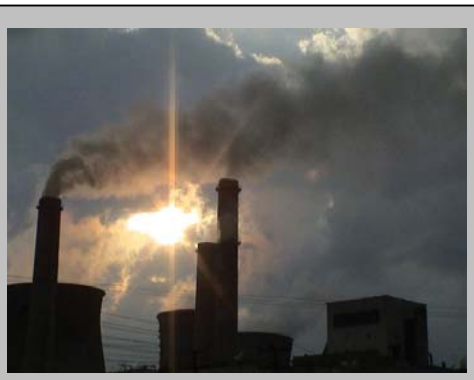
Introduction

The project and its goals

SMAQ is a GIS-enabled environmental and health information management system that integrates ground-based air pollution measurements with readily available satellite data and forecasting models, allowing the derivation of a highly accurate and continuous picture of regional[4] and urban air quality and more importantly, exposure levels. The information system, piloted from January 2008, is a tool to better inform decision making.

SMAQ stands for satellite-assisted management of air quality. Treating western Macedonia as a pilot region, SMAQ has been developed to give its decision makers an indispensable geographic information system (GIS) to help them address respiratory problems and chronic morbidity that arises amongst its citizens from exposure to emissions of SO_2, NO_x, VOCs, and particulate matter (PM), besides the acidification, eutrophication and loss of biodiversity within its natural environment.

"The real innovation" according to the EC's Joint Research Centre, one of the project's protagonists, "is the integration of ground and satellite data within forecast models. This enables the derivation of a highly accurate and continuous picture of regional and urban air quality, and more importantly, exposure levels, thus enhancing the quality of decision making." A principle aim has been to reduce the margin for error in interpreting the pollutant levels and their potential impact on health and the environment.



Western Macedonia's atmosphere in north-west Greece is highly polluted. The region's power stations are responsible for generating some 80 percent of the country's energy requirements. This has a detrimental effect on citizens' health and on the environment, with exposure to emissions of SO_2, NO_x, VOCs, and particulate matter (PM) - and consequently Ozone - above acceptable levels. The natural environment – pristine mountain territory – suffers acidification, eutrophication and loss of biodiversity. Citizens experience respiratory problems and chronic morbidity

SMAQ has enabled the authorities in Western Macedonia to test and refine pollution abatement strategies. Combined with technological improvements administered by local industry, this is forecast to yield a 20 percent reduction in human and environmental exposure to air pollution. The economic benefit from the reduction of medical costs and the increased life expectancy among the local population is considered to be €756,000 per year. At the same time, SMAQ has enabled optimisation of on-the-ground monitoring networks and helped to harmonise reporting in line with EU policy targets (the 2005 Thematic Strategy on Air Pollution and pertinent air quality directives).

Accompanying workshops, the first in Prague in February 2009 to discuss and optimise the monitoring network design followed by one in Venice in March to evaluate SMAQ's overall applicability, will help disseminate the project's results. Following completion of the piloting and feedback phase, the SMAQ project team will conduct technology transfer workshops between autumn 2008 and spring 2009 in north-west Greece (Kozani), Thessaloniki and Budapest, Hungary.

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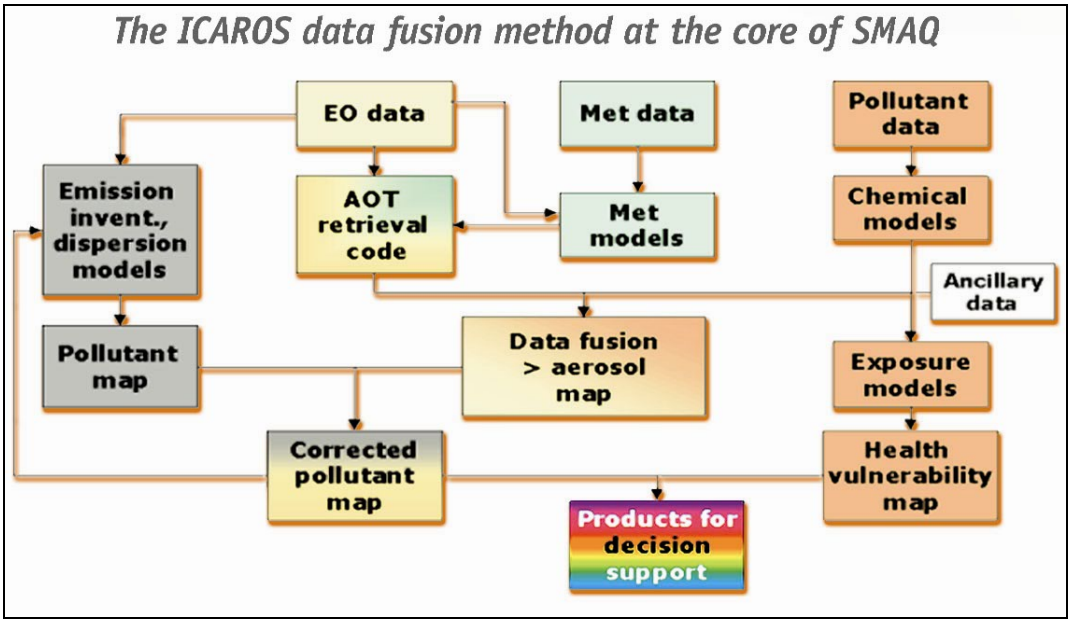

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TECHNICAL SPECIFICATIONS

SMAQ's information system is based on the concept of a geodatabase. A geodatabase is a database management system (DBMS) that can include spatial data (e.g. longitude/latitude coordinates) alongside other types of data (e.g. pollution measurements, dates) for those entities referenced within (i.e. industrial facilities, monitoring stations). The information system includes support for structured query language (SQL), a programming language used to establish relational databases and manage data within them, and the ability to generate complex geospatial queries. The geodatabase's client/server architecture supports multiple users simultaneously and lets them view, edit and query the database without conflict.

The database schema was built using ESRI CASE tools, which are used in conjunction with the VISIO 2000 modelling environment. Unified modeling language technology is used in collaboration with the ESRI ArcObjects Component Library.

The SMAQ platform itself utilises extended mark-up language (XML) technology for any data handling that is necessary from outside (e.g., via the Internet). This provides great flexibility and expendability as far as the external data sources are concerned, although it remains completely independent of any formatting changes those sources encounter, thanks to data conversion utilities.

The XML schema offers a convenient means to define the tags used for data within the SMAQ information system because the platform has to deal with measurements, dates and data structures more complex than simple text. Using the schema, data files can be validated even before data import begins. Inconsistent files can be directly rejected.

Data imported into the geodatabase through the XML file filter includes:

- **Informative data -** general information about the origin of the data file; a short description of its contents, conversion dates, etc.

- **Monitoring stations -** any information about air quality and weather monitoring stations which allows platform users to consistently import either a grid of ground base monitoring stations or a single station recently added to the network.

- **Station measurements -** each station's measurements of different pollutants or those readings from meteorological entities that arrive continuously.

- **Model grids** - grids of points on which a model gives results on. Usually only one grid is required for data "fusion" to occur. The SMAQ platform incorporates additional functionality to handle coexisting grids of differing resolution within the geodatabase. Modelling results are then bound to their corresponding grid.

- **Model grid results –** These are stored in the XML file in the form of "x-value, y-value, measurements, measured quantity." Values can be geographically projected on the corresponding grid and then imported into the geodatabase, according to the measured quantity type.

Within the general architecture of the SMAQ platform, a further geodatabase containing an auxiliary dataset is foreseen. This data can be imported into the auxiliary geodatabase through the XML file filter and include information on the road network, administrative boundaries, population density, water bodies, main cities, etc. This information need only be imported once into the geodatabase following system set-up and configuration, and then only if updated data becomes available.

For each theme or dataset, metadata are associated with the descriptive and spatial elements. The metadata description refers to the keywords, abstract, purpose, status of the data, time period, data storage and access information, constraints on accessing and using the data and details about the document. Spatial information is relevant to the coordinates system used as well as for the raster dataset, the raster properties and cell information. The metadata elements relevant to the different themes or datasets within the SMAQ geodatabase are also listed in Annex 1 of the *Technical Report on the Implementation of the Inspire Guidelines in the Air Pollution Information System* (Deliverable 4.4). When the INSPIRE Directive's list of spatial datasets (or themes) have been delivered (as part of the "implementing rules for data specifications"), these attributes can also be incorporated into the SMAQ geodatabase.

Further details on the technical set-up of the SMAQ information system are described and illustrated in the *SMAQ Platform User Manual* (Deliverable 5.1). Both this and deliverable 4.4 are available for download from: www.smaq-life.org

Report structure and target audience

A series of eight country reports form the backbone of this report, which intends to map the potential for SMAQ technology transfer. It does this by assessing a series of boundary conditions in new European Union member states, including:

- environment (defining, for instance, air quality "hotspots");
- current status of environmental (air-quality) information (being derived from pollution and meteorological monitoring networks and pollutant inventories) besides ancillary data;
- current status of environmental (air quality) information systems (including their legal basis and, for instance, steps towards INSPIRE directive implementation); and
- challenges and obstacles for SMAQ technology transfer.

These four categories broadly establish the structure of the country reports. Each also includes a short discussion on future domestic priorities and opportunities for environmental information system development before concluding with recommendations by the country report author.

The information contained within the country reports is then synthesised in the conclusions and recommendations. The conclusions digest the key country findings broadly according to the four categories outlined above. Non-scientific scores are given for each of the categories and then aggregated to give an overall SMAQ suitability ranking. The editor then draws his own conclusions. The recommendations sub-section reflects country report authors' recommendations, and makes some overall suggestions for promoting SMAQ take-up.

An executive summary prefaces this report and presents the most salient points, based on the sub-sections outlined above. Annexes detail the report's contributors and the template upon which the country reports were strictly based.

The report's target audience is first and foremost the project team. The findings are intended to help standardise SMAQ in order to facilitate its transfer to member state regions and beyond. The findings also provide useful input to those planning the project's workshop series (detailed at the beginning of this introduction), when the SMAQ information system will be discussed and presented.

A secondary target audience includes environmental information system and air quality managers with an interest in new member states' information systems. Within this group one may consider those taking a leading role in implementing the EU's Ambient Air Quality and Cleaner Air for Europe Directive (CAFÉ) and the INSPIRE directive. This part of the audience may include so-called *Spatial Data Interest Communities* or SDICs, and in particular the *Data Exchange Group for Air Quality and Air Pollution* (DEG) composed of representatives of member states, the European Environment Agency (EEA) and Eionet (this group is also the nominated INSPIRE SDIC in the air quality application domain). This group is mentioned because SMAQ fully implements the currently available data specifications of INSPIRE, while this report also serves to scope country's potential to fully implement INSPIRE's "data specifcations" (spatial datasets such as transport networks, hydrology, digital elevation, landcover, etc.) based on the themes enumerated in annexes I, II and III of the directive.

A third target group may include those with an interest in implementing SMAQ, although strictly speaking, other information sources could be considered more useful (for instance the SMAQ Platform User Manual (Deliverable 5.1). This last group would include local authority personnel responsible for environment and health exposure assessment, IT staff responsible for implementing SMAQ, representatives of hydro-meteorological institutes that oversee monitoring networks, and those responsible for the implementation for the INSPIRE directive.

Survey methodology

The country reports were drafted according to a simple template and very clear terms of reference, both of which were written in July 2007 in close collaboration with the EC's Joint Research Centre (the country report template is included as Annex II). Particular emphasis was placed on clearly defining the information required to assure comparability among all country reports and ease the extrapolation of data and trends. The template, a sort-of query form, combines requests for quantitative and qualitative data that subtly balance and mutually reinforce one another. For instance, authors were encouraged to fill the qualitative sections by: "reflecting on 3D, describe the responsibilities for the maintenance of emission inventories for the substances listed in 3A and current practices" (where section 3 relied on a series of simple tables that require completion with yes/no answers and details). Sections pertaining to challenges and obstacles proffered a shortlist of criteria from which authors could choose (for instance insufficient data, poor infrastructure and equipment, cost and even "after-sales SMAQ service.") A similar shortlist was included with respect to scoping future domestic priorities and opportunities.

Country office representatives of the Regional Environmental Center (REC) in new EU member states (stretching from Estonia to Bulgaria) were asked to spend approximately 10 days performing desk research, site visits and interviews with qualified persons during the autumn of 2007. This typically included meeting with environment ministry staff and hydromet and/or air quality monitoring institutes' representatives. All report contributors are listed in Annex I. Most of the writing was completed by the end of October 2007. Two new member states' reports eventually had to be omitted.

Editorial review commenced at the REC's head office in Hungary in November 2007 and together with project team peer review, copy-editing and final layout, the report was completed by July 2008.

COUNTRY REPORT: BULGARIA

Sofia suffers levels of NO_2 above EU limits, unacceptable concentrations of of O_3 and, in some districts, exceptionally high levels of PM2.5s and PM10s owing to metallurgical facilities.

Pernik exceeded allowable levels of PM2.5s on more than 50 occasions in 2005. Acceptable limits of O_3 have also been exceeded.

© The Regional Environmental Center for Central and Eastern Europe

Dimitrovgrad suffers very high levels of SO_2 owing to thermal power plants, while high levels of PM2.5s have also been noted. Acceptable limits of O_3 have also been exceeded.

1. Key findings

- Three hotspot areas exist for which SMAQ's feasibility could be scoped (Sofia, Pernik and Dimitrovgrad), with pollution caused by thermal power plants (the latter two) and metallurgical plants/heavy traffic (Sofia).
- The air quality information system appears to be well founded and the essential data required for SMAQ operation (including private sector pollutant plus ancillary data) is regularly collected.
- Although mechanisms for information exchange are well established between the principle authorities, a real challenge for implementing scenario 1 (offline exposure assessment) will be acquiring the necessary data sets from the various players and finding the necessary technical know-how to integrate them for the target area.
- The implementation of the INSPIRE directive may present an opportunity to acquire some funds to implement SMAQ. At any rate, INSPIRE and SMAQs training and dissemination workshops should be seen as occasions to involve senior expertise from various key institutes in better understanding the practical aspects of SMAQ.

2. The environment

Three main hotspot districts were defined with a size of approximately 80 km * 80 km:

1. **The Sofia pan** (including Sofia city and the region around the Kremikotzi black-metallurgy plant)
2. **Pernik district** owing to the ferrous metallurgy plant (Stomana AD), as well as the Republika thermo-electrical plant.
3. **Dimitrovgrad district** (including the villages of Gulubovo and Radnevo) owing to the thermo-electrical power plants complex Maritza Iztok I, II and III, and Maritza 3.

The nature of contamination in each of these areas is described below by pollutant (the ambient levels of SO_2, NO_x, PM10s and PM 2.5s, and O_3 per hotspot). Descriptions are based on the 2005 annual state of environment and air quality reports of the Bulgarian Executive Environmental Agency (BEEA) and vis-à-vis Bulgarian legislation and the EU directives Bulgaria has introduced.

SO_2: *The threshold value is 350 µg/m^3 (average value per hour) with 24 permissible exceedances per year.*

Dimitrovgrad district registered the highest levels. The Radnevo monitoring facility registered levels up to 1,231 µg/m^3 and recorded 15 exceedances in 2005. The Gulubovo monitoring station recorded a high of 953 µg/m^3 and 44 exceedances. The sources of the pollution are the Maritza Iztok thermo-electrical power plant complex and at the Maritza 3 plant in Dimitrovgrad, both of which lack sulphur scrubbers. The absence of this equipment resulted in a legal procedure against Bulgaria by the EU in October 2007.

NO_2: *The threshold value was reduced between 2003 and 2005. In 2005 the limit was 250 µg/m^3 (average value per hour), with eight permissible exceedances per year.*

The highest levels were measured in the towns of Varna and Plovdiv but among the hotspots mentioned above, only **Sofia (city)** sees exceeded permitted values. The EU Council Directive 1999/30/EC specifies an annual average limit of 40 µg/m^3 NO_2 per year (this will only be applied after 2010 in Bulgaria). According to current measurements, only Sofia exceeds these levels.

PM 2.5s: *The threshold value is 52 µg/m^3 (average daily value) with 14 permissible exceedances per year.*

The highest levels were measured in **Sofia (city**), mainly in the Pavlovo quarter, which hit the 263.1 µg/m^3 mark, five times the average daily limit. During 2005 this value was exceeded on 45 occasions. Heavy motor traffic is the cause. In **Pernik**, 51 exceedances were noted in 2005 (but with low levels). In **Dimitrovgrad**, 11 exceedances were reported.

PM 10s: *The threshold value is 65 µg/m^3 (average daily value - 39 µg/m^3) with 25 permissible exceedances per year.*

Sofia's Pavlovo quarter charted the highest levels, followed closely by the Gara Yana quarter **of Kremikovtzi** . In Pavlovo, a concentration of 910 µg/m^3 — 14 times the average value — was measured, while Gara Yana quarter hit a high of 850 µg/m^3.

O_3: *The threshold value is 110 µg/m^3 (an average value over an eight-hour period) according to health safety protocols. The threshold value for informing the population is 180 µg/m^3 (the average hourly value).*

According to Ministry of Environment and Waters regulation No. 4 (which transposes Directive 2002/2/EC), a new short-term quota of 120 µg/m^3 per eight hour period is being gradually introduced, with a view to implementation by 2010. This limit has already been exceeded in **Sofia (city)** (166 µg/m^3 at the Orlov Most monitoring station), in **Pernik**, and in **Dimitrovgrad** district (140 µg/m^3 at the Rakovski station).

3. Current status of environmental (air quality) information

Existing Air Quality and Ancillary Data

A. Time series **air quality** data is available via the monitoring networks for Sofia, Pernik and Dimitrovgrad districts, for the following pollutant parameters:

The Sofia pan

Data Type	Availability [Y/N]	Detailed Description
PM10 ambient air concentrations (ug/m^3). 65 µg/m^3 (threshold value) 39 µg/m^3 (average value per 24h)	2002 [N] 2003 [Y/207 exceedances made by MSs in Sofia city] 2004 [Y/114 exceeds - MS "Orlov Most"] 2005 [Y/132 exceeds - MS "Gara Yana"; 115 exceeds - MS "Pavlovo"] 2006 [N]	Time resolution available; daily The available data period; 5 years (2002–2007) 2002–2006 (4 SoE quarter bulletins per year, and SoE an annual report, 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format Data for chemical composition is not available
PM2.5 ambient air concentrations (ug/m^3). 52 µg/m^3 (threshold value) 40 µg/m^3 (average value per 24h)	2002 [N] 2003 [N] 2004 [N] 2005 [Y/ 41 exceedances - MS "Pavlovo"] 2006 [N]	Time resolution available - daily The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarter bulletins per year, and SoE an annual report, 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format Data for chemical composition is not available
PM1 ambient air concentrations (ug/m^3).	N.A.	N.A.
SO_2 ambient air concentrations (ug/m^3). 350 µg/m^3 (threshold value)	2002 [N] 2003 [Y/5 exceedances] 2004 [Y/1 exceedance] 2005 [Y/1 exceedance - MS "Orlov most" and MS "Nadejda") 2006 [N]	Time resolution available - hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarter bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
NO_x ambient air concentrations (ug/m^3).	N.A.	N.A.
NO_2 ambient air concentrations ug/m^3). 270 µg/m^3 (threshold value) for 2003 260 µg/m^3 (threshold value) for 2004 250 µg/m^3 (threshold value) for 2005 200 µg/m^3 (threshold value) after 2010	2002 [Y/10 exceedances] 2003 [Y/61 exceedances] 2004 [Y/2 exceedances] 2005 [Y/3 exceedances] 2006 [N] (monitoring at "Orlov most", and "Hipodruma")	Time resolution available - hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
O_3 ambient air concentrations (ug/m^3). 110 µg/m^3 (threshold for "health safety protocols") 180 µg/m^3 (threshold value)	2002 [N.A.] 2003 [Y/ no exceedances] 2004 [Y/ no exceedances] 2005 [9 exceedances of threshold for "health safety protocols"] 2006 [N] (monitoring at "Orlov most")	Time resolution available - hourly The available data period - 4 years (2003–2007) 2003–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
NH_3 ambient air concentrations (ug/m^3). 0.1 µg/m^3 (threshold value)		Time resolution available - hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
Data Source:	http://nfp-bg.eionet.eu.int/ncesd/bul/index.html (Executive Environmental Agency) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2003/index.htm (SoE Annual report 2002) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004/index.htm (SoE Annual report 2003) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004-1/index.htm (SoE Annual report 2004) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004-2/index.htm (SoE Annual report 2005)	

Pernik district

Data Type	Availability [Y/N]	Detailed Description
PM10 ambient air concentrations (ug/m^3). 65 µg/m^3 (threshold value) 39 µg/m^3 (average value per 24h)	2002 [Y/184 exceedances at "Iztok"] 2003 [Y/257 exceedances at "Dimova mahala"] 2004 [Y/138 exceedances at "Dimova mahala"] 2005 [Y/154 exceedances at "Shahtior"] 2006 [N]	Time resolution available - daily The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format Data for chemical composition is not available
Data Type	Availability (y/n)	Detailed Description
PM2.5 ambient air concentrations (ug/m^3). 52 µg/m^3 (threshold value) 40 µg/m^3 (average value per 24h)	2002 [N] 2003 [N] 2004 [N] 2005 [Y/51 exceedances at "Tzurkva"] 2006 [N]	Time resolution available - daily The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format Data for chemical composition is not available
PM1 ambient air concentrations (ug/m^3).	N.A.	N.A.
SO_2 ambient air concentrations (ug/m^3). 350 µg/m^3 (threshold value)	2002 [N] 2003 [Y/17 exceedances at "Dimova mahala") 2004 [Y/32 exceedances] 2005 [Y/6 exceed exceedances at "Shahtior"] 2006 [N]	Time resolution available - hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
NO_x ambient air concentrations (ug/m^3).	N.A.	N.A.
NO_2 ambient air concentrations ug/m^3). 270 µg/m^3 (threshold value) for 2003 260 µg/m^3 (threshold value) for 2004 250 µg/m^3 (threshold value) for 2005 200 µg/m^3 (threshold value) after 2010	2002 [no exceedances] 2003–2005 [no exceedances] 2006 [N] (Readings made at "Shahtior" and "Tzurkva")	Time resolution available - hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
O_3 ambient air concentrations (ug/m^3). 110 µg/m^3 (threshold for "health safety protocols") 180 µg/m^3 (threshold value)	2002 [N] 2003–2005 [no exceedances] 2006 [N] (Readings made at "Shahtior")	Time resolution available - hourly The available data period - 4 years (2003–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
NH_3 ambient air concentrations (ug/m^3). 0.1 µg/m^3 (threshold value)		Time resolution available - hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
Data Source:	http://nfp-bg.eionet.eu.int/ncesd/bul/index.html (Executive Environmental Agency) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2003/index.htm (SoE Annual report 2002) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004/index.htm (SoE Annual report 2003) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004-1/index.htm (SoE Annual report 2004) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004-2/index.htm (SoE Annual report 2005)	

Dimitrovgrad district

Data Type	Availability [Y/N]	Detailed Description
PM10 ambient air concentrations (ug/m^3). 65 $\mu g/m^3$ (threshold value) 39 $\mu g/m^3$ (average value per 24h)	2002 [no exceedances] 2003 [N] 2004 [Y/51 exceedances at "Rakovski"] 2005 [Y/26 exceedances at "Gulubovo"] 2006 [N]	Time resolution available - daily The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format Data for chemical composition is not available
PM2.5 ambient air concentrations (ug/m^3). 52 $\mu g/m^3$ (threshold value) 40 $\mu g/m^3$ (average value per 24h)	2002 [N] 2003 [N] 2004 [N] 2005 [Y/27 exceedances at "Gulubovo"] 2006 [N]	Time resolution available - daily The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format Data for chemical composition is not available
PM1 ambient air concentrations (ug/m^3).	N.A.	N.A.
SO_2 ambient air concentrations (ug/m^3). 350 $\mu g/m^3$ (threshold value)	2002 [N] 2003 [Y/6 exceedances at "Rakovski"] 2004 [Y/104 exceedances at "Gulubovo"] 2005 [Y/44 exceedances at "Gulubovo"] 2006 [N]	Time resolution available - hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
NO_x ambient air concentrations (ug/m^3).	N.A.	N.A.
Data Type	Availability (y/n)	Detailed Description
NO_2 ambient air concentrations ug/m^3). 270 $\mu g/m^3$ (threshold value) for 2003 260 $\mu g/m^3$ (threshold value) for 2004 250 $\mu g/m^3$ (threshold value) for 2005 200 $\mu g/m^3$ (threshold value) after 2010	2002 [N] 2003 [Y/65 exceedances at "Rakovski"] 2004 [N] 2005 [Y/62 exceedances at "Rakovski"] 2006 [N]	Time resolution available - hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
O_3 ambient air concentrations (ug/m^3). 110 $\mu g/m^3$ (threshold for "health safety protocols") 180 $\mu g/m^3$ (threshold value)	2002 [N] 2003 [no exceedances] 2004 [no exceedances] 2005 [Y/5 exceeds of threshold for "health safety protocols" 2006 [N] (Readings made at "Rakovski")	Time resolution available - hourly The available data period - 4 years (2003–2007) 2003–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
NH_3 ambient air concentrations (ug/m^3). 0.1 $\mu g/m^3$ (threshold value)		Time resolution available – hourly The available data period - 5 years (2002–2007) 2002–2006 (4 SoE quarterly bulletins per year, and an SoE annual report; 2007 - 2 quarterly bulletins to date) The data is available in Excel and ASCII format
Data Source:	http://nfp-bg.eionet.eu.int/ncesd/bul/index.html (Executive Environmental Agency) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2003/index.htm (SoE Annual report 2002) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004/index.htm (SoE Annual report 2003) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004-1/index.htm (SoE Annual report 2004) http://nfp-bg.eionet.eu.int/eea/bg/publicat/2004-2/index.htm (SoE Annual report 2005)	

B. Time series of **meteorological** data from the monitoring network for the following parameters (data within the table is national):

Data Type	Availability (y/n)	Detailed Description *(Please indicate for all categories what time-resolution is available? (generally hourly or bi-hourly averages are available, if hourly averages are not). What is the data period available (min: 1- 2 years, but ideally 2-4)? What is the data format: ASCII text (.TXT) or EXCEL (*.xls)?*
Relative humidity (RH)	Y [within in monthly reports]	Time resolution = hourly. Data period available – more than 4 years.
Wind speed (m/s)	Y [within in monthly reports]	Time resolution = hourly. Data period available – more than 4 years.
Wind direction (degrees)	Y [within in monthly reports]	Time resolution = hourly. Data period available – more than 4 years.
Temperature (Celsius)	Y [within in monthly reports]	Time resolution = hourly. Data period available – more than 4 years.
Mixing Layer Height (m)	N	N
Data Source:	The information is available at the National Institute of Meteorology and Hydrology (NIMH) www.meteo.bg.	

C. **Exact coordinates** of all the monitoring stations (both air quality and meteorological) supplying the above data (3A & 3B)

Coordinates	Availability (y/n)	Detailed Description *(Please indicate the type and name of the coordinates system used, e.g. WGS84 or UTM34N etc). If necessary please distinguish for the different data types indicated above.*
Air quality monitoring stations	Y	The monitoring stations have GPS coordinates in WGS84 (dec. degrees)
Meteorological monitoring stations	N	
Data Source:	Executive Environmental Agency – GIS Department, Mr. Doichin Delichev, Senior Expert, kadastre@nfp-bg.eionet.eu.int, +359 2 940 64 31, http://chm.moew.government.bg/iaos/	

D. **An emission inventory** exists in standard GIS *raster* format for the pollutants listed in 3A above

Emission Inventory Data	Availability (y/n)	Detailed Description
Raster Grid GIS Format (.grd) regarding pollutants listed in A.	Y [2006]	a) The most recent information available, concerning yearly average emissions is from 2006. There are three seasonal (quarterly) reports already available at the BEEA. The highest reading for the year is available for each pollutant described in 3A. b) The average value is not available in the SoE annual reports (i.e. .not in units of mass of pollutant emitted (e.g. tons) per year). c) No information was provided regarding the instrumentation and analytical method used to derive the values provided, the methodology used for emissions inventory development and estimation of local emission factors
Data Source:	Executive Environmental Agency – GIS Department, Mr. Doichin Delichev, Senior Expert, kadastre@nfp-bg.eionet.eu.int, +359 2 940 64 31, http://chm.moew.government.bg/iaos/	

For each of the hotspots described above, the following key ancillary data is available:

E. **Road network** data

Road Network Data	Availability (y/n)	Detailed Description
Shapefile GIS format (.shp)	Y[2006]	The most recent road network register is for 2006
Data Source:	Executive Environmental Agency – GIS Department, Mr. Doichin Delichev, Senior Expert, kadastre@nfp-bg.eionet.eu.int, +359 2 940 64 31, http://chm.moew.government.bg/iaos/	

F. **Population density** data in standard GIS *raster* format

Population Density Data	Availability (y/n)	Detailed Description
Raster grid GIS format (.grd) The data is available in GIS raster grid format	Y [2004]	a/b) The population information is available only for the main cities in Bulgaria (that includes the hotspot areas) although the spatial resolution of this data is not indicated c) Data available is from 2004 to the present d) The data is differentiated by gender and age
Data Source:	Executive Environmental Agency – GIS Department, Mr. Doichin Delichev, Senior Expert, kadastre@nfp-bg.eionet.eu.int, +359 2 940 64 31, http://chm.moew.government.bg/iaos/	

G. **Epidemiological data**

Epidemiological Data	Availability (y/n)	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases	Unknown	This information is not available at the BEEA. Follow up to ascertain whether this is available on a yearly basis (or finer temporal resolution) must be made with the below listed institutes.
Data Source:	HEI (Health and Epidemiological Institute) and the Ministry of Health.	

H. **Administrative boundaries** in standard GIS *raster* format

Administrative Boundary Data	Availability (y/n)	Detailed Description
Raster Grid GIS Format (.grd)	Y [2007]	For all hotspot areas
Data Source:	Executive Environmental Agency – GIS Department (JICA technical advisor), c/o Mr. Doichin Delichev, Senior Expert, kadastre@nfp-bg.eionet.eu.int, +359 2 940 64 31, http://chm.moew.government.bg/iaos/	

I. **Digital elevation model (DEM)** in standard GIS *raster* format

Digital Elevation Model Data	Availability (y/n)	Detailed Description
Raster Grid GIS Format (.grd)	Y [2007]	Available via the DEM GIS raster at the BEEA GIS System for all hotspot areas
Data Source:	Executive Environmental Agency – GIS Department, Mr. Doichin Delichev, Senior Expert, kadastre@nfp-bg.eionet.eu.int, +359 2 940 64 31, http://chm.moew.government.bg/iaos/	

J. **Land use/land cover** in standard GIS *raster* format

Land Use/Land Cover Data	Availability (y/n)	Detailed Description
Raster Grid GIS Format (.grd)	Y [2007]	Available within the CORINE land cover/land use map for all hotspot areas
Data Source:	Executive Environmental Agency – GIS Department, Mr. Doichin Delichev, Senior Expert, kadastre@nfp-bg.eionet.eu.int, +359 2 940 64 31, http://chm.moew.government.bg/iaos/ CORINE Project at EEA : http://nfp-bg.eionet.eu.int/ncesd/eng/clc/first.html	

K. **Hydrology data** (lakes, rivers, etc.) in Shapefile GIS format

Land Use/Land Cover Data	Availability (y/n)	Detailed Description
Shapefile GIS Format (.shp)	Y [2007]	Available via the GIS raster at the BEEA GIS System for all hotspot areas
Data Source:	Executive Environmental Agency – GIS Department, Mr. Doichin Delichev, Senior Expert, kadastre@nfp-bg.eionet.eu.int, +359 2 940 64 31, http://chm.moew.government.bg/iaos/	

L. **Biodiversity (ecosystem) indicators** in standard GIS *raster* format

Biodiversity Indicators	Availability (y/n)	Detailed Description
If not Raster Grid GIS Format, please indicate the format available	Y [2007]	The available format is included in the databases on biodiversity held by the BEEA. An indicator-based approach for data collection/management has been used. The indicators are species-related.
Data Source:	Executive Environmental Agency – Biodiversity CHM Department, Mr. Radoslav Stanchev, Senior Expert, pafmon@nfp-bg.eionet.eu.int , +359 2 940 64 73; http://chm.moew.government.bg/iaos/	

4. Current status of environmental (air quality) information systems

Air quality data collection and management

The responsible institutions for environmental monitoring are the Bulgarian Executive Environmental Agency (BEEA) and the Ministry of Environment and Waters (MoEW). Since 2006 all monitoring stations have been under the jurisdiction of the BEEA, with the national monitoring system centralised through the agency. Meteorological conditions are monitored by the National Institute of Meteorology and Hydrology (NIMH), which is under the auspices of the Bulgarian Academy of Sciences (BAS). Besides the state monitoring system, there are 250 industrial installation operators who maintain their own private monitoring stations. They share their monitoring data with regional environmental inspectorates and the BEEA (the combinaiton of this data helps in determining whether to issue/renew each operator's licensing permit).

The public information department within BEEA handles requests for data and information from the authorities, public or private institutions, and citizens. The IT department is responsible for GIS development and formatting and processing the acquired monitoring data in appropriate formats for GIS usage. The database type used for general dissemination or information transfer between the monitoring stations, regional inspectorates and BEEA is ORACLE. The data storage and export format is ASCII, but Excel conversion is feasible (.csv). The software used for the GIS development within BEEA is mainly ArcView ver. 9.x, ArcInfo. etc. The agency is not yet certified to use tools for temporal analysis. Their ArcGIS ver. 9.x software has seldom been used.

It has not been deemed effective to compile information derived from both ground-based monitoring stations and satellite, although the National Cosmology Institute within the BAS does collect and process satellite data under contract. However, the use of Ikonos/IRS/Meteosat/SPOT/Landsat and MODIS satellite data for air quality monitoring is rare.

The main weakness identified with respect to air quality monitoring and data management is the limited information available to the public (except upon request). It is not clear what steps have been taken to implement the INSPIRE directive.

Inter-agency cooperation

The information exchange between the responsible bodies, including the regional inspectorates of environment and waters (RioEWs — subunits of the MoEW) and the environment agency, the health and epidemiological institute (part of the ministry of health) and the National Institute of Meteorology and Hydrology is well organised, having been grounded in law. Information exchange occurs via ORACLE database or ASCII files.

Public accessibility

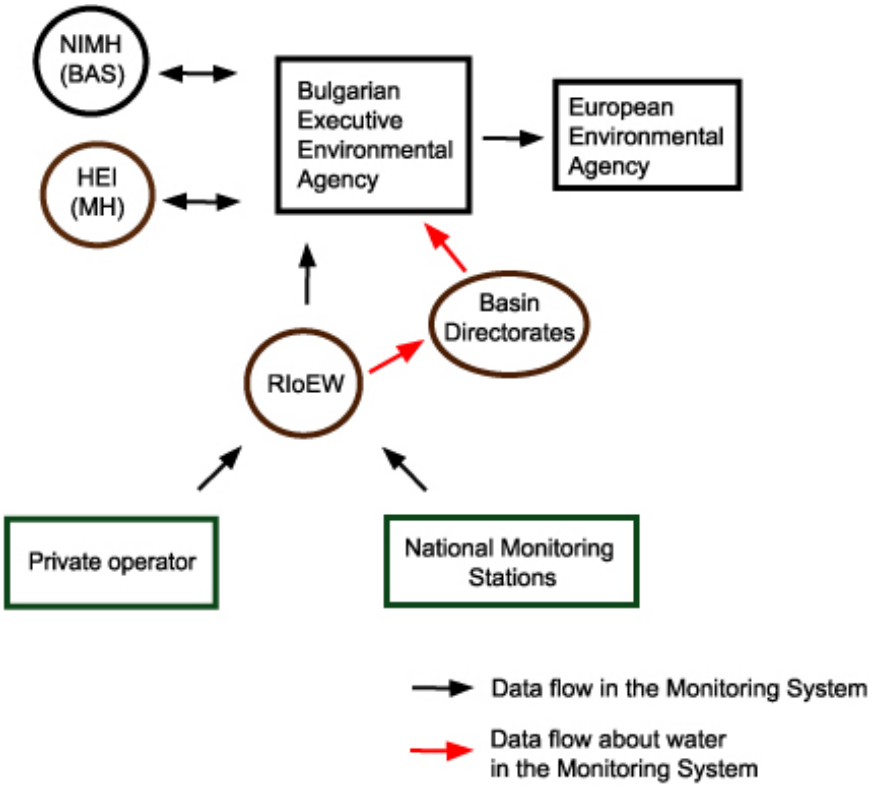
Public access to specific data for specific regions will generally be upon written request through the institutions' respective information centres, as per the Aarhus Convention and Bulgarian legislation for public access to information (although there seem to be no specific guidelines or reports describing the national monitoring system's methodology for providing knowledge to end users).

Nevertheless, the following mechanisms also ensure passive provision of information to the public:

- the Internet sites of the information centres of BEEA and NIMH, where fresh data is made available hourly, as well as the annual and quarterly state of environment reports.
- library resources of BEEA.

The available information is strongly scientific and not easily understood by the layperson.

Schematic diagrams of the EIS, including air quality data management components



5. Obstacles and challenges for SMAQ technology transfer

The most technically feasible scenario for Bulgaria to operate SMAQ is Scenario 1 (offline exposure assessment) where the potential health impacts of air pollution would be gauged according to an algorithm that takes into account the current weather conditions and season.

The challenges to implementing SMAQ include:

1) The cost, which although unknown, must be considered in view of the fact that the first priority is to meet EU requirements to adopt and implement new regulations and directives.

2) Although coverage and data provided through the air quality monitoring infrastructure are quite good, the method for combining ground monitoring station and satellite data is less well understood and processing and surveying equipment may not be adequate.

3) The third challenge is authority awareness of the potential of SMAQ and the products and results it could deliver in the context of the national monitoring system. In this context it is important to note that technical assessments of satellite data tend to be tendered to outside organisations, such as the National Cosmology Institute.

6. Future domestic priorities and opportunities for EIS development

The adoption of the INSPIRE Directive in 2008 will see the establishment of a new policy framework for information exchange. This is expected to be accompanied by financial assistance for upgrades to the monitoring network and emission inventory, and for enhancing the use of ancillary data in digital format. New opportunities for the use of satellite data and GIS technology adoption by the responsible authorities and organisations are also anticipated.

7. Recommendations

Senior experts from the above mentioned authorities (environment ministry, health ministry, environmental agency, regional inspectorates etc.) should be involved in the educational and practical aspects of SMAQ in order to gain an appreciation of the required skills to effectively implement it in conjunction with the monitoring network and stations.

List of Contributors

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SMAQ COUNTRY REPORT: Czech Republic

Ostravsko-Karvinsko suffers exceedances of air pollution thresholds for PM10s and PM2.5s and higher than acceptable levels of NO_2 owing to the local metallurgical and fuel processing industries.

1. Key findings

- The main hotspot region in the Czech Republic is Ostravsko-Karvinsko, which suffers from poor air quality on account of the presence of metallurgical and fuel-processing industries, heavy traffic and transboundary pollution from the Katowice region of Poland.

- The Czech air quality information system, managed the Czech Hydrometeorological Institute, is well-established and experienced in monitoring ambient levels of SO_2, NO_x, O_3, PM10s and PM2.5s in line with EU standards. Auxiliary data is also widely available (meteorological, epidemiological and population information).

- SMAQ implementation can be considered feasible, although there is very limited use of satellite data by either commercial or public sources.

- The upcoming rules and requirements for INSPIRE implementation as well as new development guidelines regarding the EEA's Shared Environmental Information System would appear to be the best opportunity for piggy-backing potential SMAQ transfer given the attention likely to be given to its implementation.

- Further introductions to SMAQ should be made for key state institutions in the Czech Republic to determine whether it could be useful and, if so, under what conditions.

2. The environment

There is one principal "hotspot" area within the Czech Republic: "Ostravsko-Karvinsko." Here ambient air levels of PM 10 and PM2.5 exceed air pollution limit thresholds (both daily and annual limits), as do benzene, arsenic and benzo(a)pyrene. Traffic monitoring stations are known to record higher than acceptable levels of NO_2. The area is well known to suffer from poor air quality. Besides traffic and local sources, the situation is caused by the metallurgical and fuel processing industries (these are the most significant polluters within the Czech Rep.). Transboundary pollution from Poland (especially from the industrial area of Katowice) exacerbates the situation.

3. Current status of environmental (air quality) information

Existing air quality and ancillary data

A. Time series of **air quality** data from the monitoring network:

Data Type	Availability [Y/N]	Detailed Description
PM10 ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: from 1996 to the present Data format: *.dbf / *.xls Neither distribution size or chemical composition is available
PM2.5 ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: from 2004 to the present Data format: *.dbf / *.xls Neither distribution size or chemical composition is available
PM1 ambient air concentrations (ug/m^3).	N	Measurement is under implementation (but neither distribution size or chemical composition is available)
SO_2 ambient air concentrations (ug/m^3).	Y	Time resolution available; hourly averages The available data period; from 1993 to the present Data format: *.dbf / *.xls
NO_x ambient air concentrations (ug/m^3).	Y	As above
NO_2 ambient air concentrations (ug/m^3).	Y	As above
O_3 ambient air concentrations (ug/m^3).	Y	As above
NH_3 ambient air concentrations (ug/m^3).	N	
Data Source:	Czech Hydrometeorological Institute (Cesky hydrometeorologicky ustav) Address: Na Sabatce 17, 143 06 Praha 4, Czech Rep.	

B. Time series of **meteorological** data from the monitoring network:

Data Type	Availability [Y/N]	Detailed Description
Relative humidity (RH)	Y	Time resolution: hourly Data period available: since 1996 Data format: *.dbf / *.xls
Wind speed (m/s)	Y	As above
Wind direction (degrees)	Y	As above
Temperature (Celsius)	Y	As above
Mixing layer height (m)	N	Measurements have been made by meteorological baloons within Prague and in Prostejov (cca. 100 km from the Ostavsko "hotspot"), 4 times/day, since 1971. Only the temperature profile is available, from which the mixing layer height can be deduced, but no time-series data is available.
Data Source:	Czech Hydrometeorological Institute (Cesky hydrometeorologicky ustav) Address: Na Sabatce 17, 143 06 Praha 4, Czech Rep.	

C. **Exact coordinates** of all the monitoring stations (both air quality and meteorological) supplying the above data (3A and 3B):

Coordinates	Availability [Y/N]	Detailed Description
Air quality monitoring stations	Y	S-42, JTSK, WGS84
Meteorological monitoring stations	Y	S-42, JTSK, WGS84
Data Source:	Czech Hydrometeorological Institute (Cesky hydrometeorologicky ustav) Address: Na Sabatce 17, 143 06 Praha 4, Czech Rep.	

D. **Existence of an emission inventory** in standard GIS *raster* format for the respective chemicals listed in 3A above:

Emission Inventory Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd) regarding the chemicals listed in A.	Y	a) The most recent data available is from 2005 (annual average emissions). b) The emission values are expressed in tonnes per year. c) Big polluters have to report their emissions, though emissions from small sources (local heating units) and transport are estimated according to model calculations. Emissions from local heating units are based on the general population census, with the model relying on updated data on climatic conditions, figures on household heating requirements and on consumption of particular fuel types. Calculation of transport emissions is processed by the Transport Research Centre (CDV) in Brno based on an updated method.
Data Source:	Czech Hydrometeorological Institute (Cesky hydrometeorologicky ustav) Address: Na Sabatce 17, 143 06 Praha 4, Czech Rep.	

For each of the hotspots described above, the following key ancillary data is available:

E. **Road network** data:

Road Network Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y	The most recent data available: 2005
Data Source:	Czech Office for Surveying, Mapping and Cadastre (Zememericsky urad) Address: Pod sidlistem 9/1800, 182 11 Praha 8, Czech Rep.	

F. **Population density** data in standard GIS *raster* format:

Population Density Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y	a) data is available for the entire region (apropos the Czech Republic) b) spatial resolution includes "urban district" scale c) most recent data (the last census): 2001 d) the data is differentiated by gender and age
Data Source:	Czech Statistical Office (Cesky statisticky urad) Address: Na padesatem 81, 100 82 Praha 10 – Strasnice, Czech Rep.	

G. **Epidemiological data:**

Epidemiological Data	Availability [Y/N]	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases	Y	Monthly data is available
Data Source:	National Institute of Public Health (Statni zdravotni ustav) Address: Srobarova 48, 100 42 Praha 10, Czech Rep.	

H. **Administrative boundaries** in standard GIS *raster* format:

Administrative Boundary Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y	For the whole of Czech Republic
Data Source:	Czech Office for Surveying, Mapping and Cadastre (Zememericsky urad) Address: Pod sidlistem 9/1800, 182 11 Praha 8, Czech Rep.	

I. **Digital elevation model (DEM)** in standard GIS *raster* format:

Digital Elevation Model Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y	
Data Source:	Czech Office for Surveying, Mapping and Cadastre (Zememericsky urad) Address: Pod sidlistem 9/1800, 182 11 Praha 8, Czech Rep.	

J. **Land use/land cover** in standard GIS *raster* format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	(Y)	Only Image 2000 and CLC2000 (CORINE LandCover) at 1:100 000 scale is available for the whole territory of the Czech Republic. In addition, different layers of sometimes complex land cover data are available from different institutions – e.g. protected areas land cover and Natura 2000 regions, agricultural land (LPIS system), spatial planning data (within municipalities). However, there is no complex land cover data for the whole territory.
Data Source:	Nature protection data: Agency for Nature Conservation and Landscape Protection of the Czech Republic (AOPK CR), Address: Nuselska 39, 140 00 Praha 4, Czech Rep. Agricultural data: Ministry of Agriculture, Address: Tesnov 17, 117 05 Praha 1, Czech Rep.	

K. **Hydrology data** (lakes, rivers, etc.) in Shapefile GIS format.

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y	
Data Source:	T. G. Masaryk Water Research Institute (Vyzkumny ustav vodohospodarsky T.G.Masaryka), Address: Podbabská 2582/30, 160 00 Praha 6, Czech Rep.	

L. **Biodiversity (ecosystem) indicators** in standard GIS *raster* format:

Biodiversity Indicators	Availability [Y/N]	Detailed Description
Fragmented data	Y	Rather than raster grid GIS format, only fragmented data is available for certain protected areas. There is no systemic database for the whole of Czech Republic.
Data Source:	Agency for Nature Conservation and Landscape Protection of the Czech Republic (AOPK CR), Address: Nuselska 39, 140 00 Praha 4, Czech Rep.	

4. Current status of environmental (air quality) information systems

Air quality data collection and management

The Czech Hydrometeorological Institute (CHMI) is responsible for the main emissions monitoring system in the Czech Republic, on behalf of the Ministry of Environment. Other relevant monitoring networks are managed by a network of health institutes which span the country, local authorities (in Pilsen, Trinec, Pardubice, Sumperk, Olomouc, Zlin, Brno and Valaske Mezirici) and private enterprises such as Ceska rafinerska a.s., Litvinov, CEZ a.s., Frantschach Pulp and Paper Czech a. s. All these entities submit their data to the Air Quality Information System (ISKO) database, operated by CHMI. Polluters are obliged to submit emissions data to either the Czech Environmental Inspection Office or those authorities responsible for the respective administrative unit with extended competencies (depending on the polluter's categorisation). These bodies verify the data and forward for entry in the Register of Emissions and Air Pollution Sources (REZZO), which is operated by CHMI (REZZO is part of the ISKO system).

All monitoring measurements (received from automated stations and manually) are verified then saved in the ISKO database. The database resides on an ORACLE platform, whose features allow communication with the data collection points and several ways to present various layers of data. Data can also be processed using ArcGIS. CHMI has long experience in preparing pollutant maps and merging measurement data with dispersion models, meteorological data, etc. While methods for map configuration are being constantly developed, satellite data has not been used to date.

All the substances listed in 3A are monitored according to EU directives and Czech legislation. The legal basis for air quality is the Clean Air Act No. 86/2002 Coll. (as amended), and details are specified in the Government Order No. 597/2006 Coll. on air quality monitoring and assessment.
Regarding the INSPIRE directive, an inter-departmental working group has been established by the Czech Environmental Information Agency (www.cenia.cz), an external institution of the Ministry of Environment. CENIA is preparing a corresponding law and waiting for implementation rules. An Internet presentation is available regarding INSPIRE and its status in the Czech Republic. Meanwhile all the state and regional authorities have been informed that it will soon come into force.

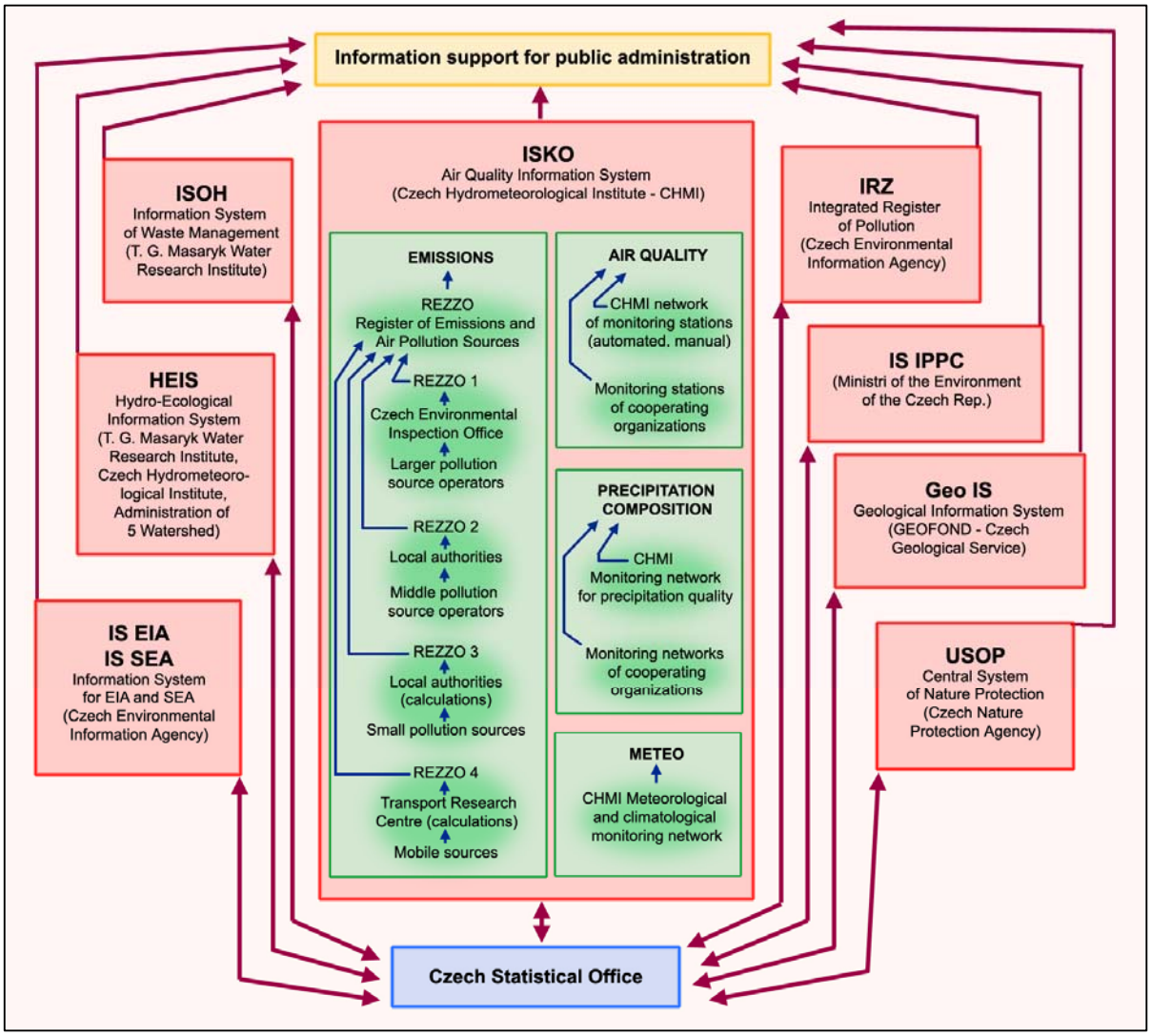
Inter-agency cooperation

Inter-agency cooperation in monitoring, assessing and public reporting is well developed, with no gaps or problems between them. The Czech Hydrometeorological Institute manages almost all air quality data, including its publication. The institute has five branches (in Usti nad Labem, Ostrava, Hradec Kralove, Brno and Plzen), all with on-line access to the ISKO databases. State and regional authorities co-operate with CHMI and its branches and acquire air quality data from CHMI, especially during unfavourable dispersion conditions when smog can form or when there are high levels of ground-level ozone.

Public accessibility

The Czech Hydrometeorological Institute publishes detailed annual reports entitled Air Pollution in the Czech Republic and Air Pollution and Atmospheric Deposition Data. The same data is made available online via the Internet at: http://www.chmi.cz/uoco. Data on current air quality conditions is also published here. Every year, the institute produces other forms of statistical data, graphical summaries and further missives for the benefit of state authorities, international obligations and the public. Two laws regulate free access to information in the Czech Republic: Act No. 123/1998 Coll., on the Right to Information about the Environment, and Act No. 106/1999 Coll., on Free Access to Information.

Schematic diagrams of the EIS, including air quality data management components



5. Obstacles and challenges for SMAQ technology transfer

Given the well-developed methodology for air quality monitoring, assessment and reporting, either SMAQ scenario has sound potential to be implemented within the Czech Republic. Nevertheless, there are a number of challenges, including:

- relative inexperience with the use of satellite data from either Ikonos, IRS, Meteosat, SPOT, Landsat or MODIS, besides concern over the price; and
- the cost of SMAQ as a new system, especially considering that the existing system of air quality monitoring is well-established and functioning well.

6. Future domestic priorities and opportunities for EIS development

The environmental information and air quality information system is constantly being developed, although there are no significant changes planned in the next two years. All information systems are operated by state authorities and any major developmental shifts will be contingent on the rules and requirements for INSPIRE directive implementation as well as the new development guidelines regarding the European Environment Agency's Shared Environmental Information System (SEIS).

7. Recommendations

SMAQ implementation in the Czech Republic should only be undertaken following detailed negotiations with the Czech Hydrometeorological Institute. Further familiarisation would be necessary for the institute to determine whether SMAQ could be useful and cost-effective and under what conditions implementation could succeed (vis-à-vis the usage of satellite data).

List of Contributors

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SMAQ COUNTRY REPORT: ESTONIA

Tallinn, Estonia's capital, with 401,000 residents and an area of 158 km^2. Urban transport produces 90 percent of the city's air pollution through emissions of CO, NO_X and PM10s. Industry is also a contributor, making the capital's air the worst in Estonia. Average daily concentrations of PM10s exceed limits more than 35 days/year with occasional exceedances of O_3.

Kohtla-Järve, with 50,000 residents, is a key industrial centre with high pollution driven by oil-shale mining and treatment, chemicals production, power generation and wastewater treatment plants. Thus H_2S and SO_2 are key determinants of air quality. Nevertheless, pollutant concentrations do not exceed limit values except in the case of PM10s.

Keila, a town of 9,500 inhabitants 25 km west of Tallinn, is semi-urbanised with industrial parks in the town's hinterland and the rest half-covered by forest, hayfields and bogs. It has not exceeded any limit values, with only dust registered at the city's crossroads.

Tartu, Estonia's second largest city with 101,000 residents, occupies an area of some 40 km^2 and is the centre of southern Estonia. Traffic and district heating plants are the main sources of air pollution, with particulate dust, including nickel, exceeded limit values fewer than 10 days/year.

1. Key findings

- Estonia is fortunate enough not to experience any air quality "hotspots" vis-à-vis SO_2, NO_X, O_3, PM10s or PM2.5s. Levels of these pollutants don't critically exceed threshold values identified in EU or national legislation.

- The Estonian air quality information system was established in 2002 upon a sound legal basis, and those responsible for data management are no strangers to the use of satellite data for verification of ground-based measurements of air quality.

- Despite the fact there is no evident need for a tool to support health-risk and exposure assessment, Estonian authorities (Ministry of Environment and the Estonian Environmental Research Center) would appreciate further information and an introduction to SMAQ.

2. The environment

The reason Estonia has relatively clean air is that since independence in 1991, much of its heavy industry and other branches of the economy responsible for air pollution have closed. From an urban environment perspective, fuel quality improvements have also had an impact on air quality, although in some cases PM10 emissions have increased along with O_3 levels.

Administratively speaking[5], Estonia is divided into two urban areas (conurbations) and two regions: the urbanised areas of Tallinn and Kohtla-Järve and the regions of North Estonia and South Estonia. In all these areas, SO_2, NO_x, O_3, PM10s and PM2.5s are measured along with NO_2 and CO. Furthermore, heavy metals, including arsenic, cadmium, nickel, and lead as well as benzo(e)pyrene (BaP) are measured as fractions of PM10s (BaP is also measured in PM2.5 fractions).

The data for these four regions are described below, based on the annual „ „Assessment of Air Quality in Designated Regions in Estonia,[6]" which is compiled and presented by the Estonian Environmental Research Centre.

3. Current status of environmental (air quality) information

Existing air quality and ancillary data

A. Time series of **air quality** data from the monitoring network for the following parameters:

Data Type	Availability [Y/N]	Detailed Description
PM10 ambient air concentrations (ug/m^3).	Y	The chemical composition of PM is measured by the content of BaP, Cd, As, Ni, Hg and PAH (excluding BaP) in all locations except Kohtla-Järve City where it additionally includes H_2S, C_6H_5OH and HCHO. Time resolution: Hourly average Data period: last 3 years Data format: not specified
PM2.5 ambient air concentrations (ug/m^3).	Y	Time resolution: Hourly average in all locations except Kohtla-Järve City where this will be available from 2008. Data period: last 1 year Data format: not specified
PM1 ambient air concentrations (ug/m^3).	N	
SO_2 ambient air concentrations (ug/m^3).	Y	Time resolution: Hourly average Data period: last 3 years Data format: not specified
NO_x ambient air concentrations (ug/m^3).	Y	Time resolution: Hourly average Data period: last 3 years Data format: not specified
NO_2 ambient air concentrations (ug/m^3).	Y	Time resolution: Hourly average Data period: last 3 years Data format: not specified
O_3 ambient air concentrations (ug/m^3).	Y	Time resolution: Hourly average Data period: last 3 years Data format: not specified

[5] Ministerial Decree No. 128 on the Distribution of the Territory of the State according to the Content of Different Pollutants in Ambient Air, of 19 Oct. 2004

[6] Online: www.envir.ee/orb.aw/class=file/action=preview/id=785408/PreAssessment_2006%5B2004-107-EC%5DEstonia.pdf

NH_3 ambient air concentrations (ug/m^3).	N	
Data Source:	www.klab.ee	

B. Time series of **meteorological** data from the monitoring network for at least for the following parameters:

Data Type	Availability [Y/N]	Detailed Description
Relative humidity (RH)	Y	Time resolution: Hourly average Data period: last 3 years (6 years in Tallinn) Data format: mainly Excel but also available as ASCII
Wind speed (m/s)	Y	Time resolution: Hourly average Data period: last 3 years (6 years in Tallinn) Data format: mainly Excel but also available as ASCII
Wind direction (degrees)	Y	Time resolution: Hourly average Data period: last 3 years (6 years in Tallinn) Data format: mainly Excel but also available as ASCII
Temperature (Celsius)	Y	Time resolution: Hourly average Data period: last 3 years (except 6 years in Tallinn) Data format: mainly Excel but also available as ASCII
Mixing layer height (m)	Only Tallinn	Time resolution: Daily averages Data period: more than 6 years Data format: mainly Excel but also available as ASCII
Data Source:	www.emhi.ee	

C. **Exact coordinates** of all the monitoring stations (both air quality and meteorological) supplying the above data (3A and 3B):

Coordinates	Availability [Y/N]	Detailed Description
Air quality monitoring stations	Y	Type and name of the coordinates system used, e.g. WGS84 or UTM34N not indicated for any location
Meteorological monitoring stations	Y	Type and name of the coordinates system used, e.g. WGS84 or UTM34N not indicated for any location
Data Source:	www.emhi.ee , www.klab.ee	

D. **Existence of an emission inventory** for the chemicals listed in 3A above:

Emission Inventory Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd) regarding chemicals listed in A.	Y	Yearly average emissions in tons in all locations
Data Source:	www.keskkonnainfo.ee	

For the regions described above, the following key ancillary data is available:

E. **Road network** data:

Road Network Data	Availability [Y/N]	Detailed Description
Shapefile GIS Format (.shp)	Y	Data available in all locations although most recent data available is not indicated.
Data Source:	www.eomap.ee, www.regio.ee	

F. **Population density** data:

Population Density Data	Availability [Y/N]	Detailed Description
Raster Grid GIS Format (.grd)	Y	In all locations the population information is available at urban district level for the latest population census and is differentiated by gender and age (for North and South Estonia it's also available in Excel).
Data Source:	www.stat.ee	

G. **Epidemiological data**:

Epidemiological Data	Availability [Y/N]	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases	Y	Data is available on a yearly basis for all locations.
Data Source:	www.stat.ee	

H. **Administrative boundaries**:

Administrative Boundary Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y	In all locations
Data Source:	www.eomap.ee, www.regio.ee	

I. **Digital elevation model (DEM)**:

Digital Elevation Model Data	Availability [Y/N]	Detailed Description
Raster Grid GIS Format (.grd)	N/A	Not available for any locations
Data Source:	-	

J. **Land use/land cover**:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y	For all locations
Data Source:	www.eomap.ee, www.regio.ee, www.stat.ee	

K. **Hydrology data** (lakes, rivers, etc.):

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y	For all locations
Data Source:	www.eomap.ee, www.regio.ee	

L. **Biodiversity (ecosystem) indicators**:

Biodiversity Indicators	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y	Type of indicator and their respective spatial resolution not indicated
Data Source:	www.eelis.ee	

4. Current status of environmental (air quality) information systems

Air quality data collection and management

The Ministry of Environment broadly co-ordinates environmental monitoring including the National Environmental Monitoring Programme and its sub-programmes. A monitoring council is headed by the environment minister and comprises representatives of government agencies and other experts and, if necessary, representatives of national local government associations. Meanwhile the Estonian Environmental Research Centre (EERC), specialised in chemical analyses and with branches all over Estonia, monitors SO_2, NO_x, O_3, PM10s and PM2.5s according to procedures established by environment ministry regulation[7]. Private industry monitors its own emissions pursuant to the environmental permit it has been issued according to the act on the environmental register[8]. This is obligatory for factories with large incinerators, power plants and oil terminals. Their assessment entails monitoring the area affected by their activities. Their data is stored in Estonia's environmental pollutant register.

The institutional use of GIS to store data is well established in Estonia, with the EERC using satellite data (specific instruments/companies not indicated) on air quality for verifying ground-based data. Regarding the EC's INSPIRE Directive the Estonian Land Board (online at: www.maaamet.ee) has recently begun introducing the main principles of the directive.

Inter-agency cooperation

The exchange of data procured through state and local government monitoring is defined within the act on the environmental register. However, it not limited to what is required by rules and procedures, as such exchange occurs, for example, in working groups within specific projects). Any problems with exchanging information usually occur as a result of non-integrated databases.

Public accessibility

According to the Ambient Air Protection Act,[9] the authorities in change of continuous monitoring of ambient air pollution levels at the state, local government or enterprise level shall consolidate the monitoring results pursuant to the procedure provided by the environmental monitoring act and notify the public of the presence of pollutants in the ambient air by means of radio, television, newspapers, electronic information board or the Internet. The act also sets down rules regarding the frequency of updates, the content of information, and the information to be communicated in the event of pollutant or ozone levels rising above alert thresholds.

[7] No. 76, 13.12.2006
[8] RT I 2002, 58, 361; 2004, 30, 209; 84, 572
[9] RTI, 19.05.2004, 43, 298

Those authorities and institutions responsible for ensuring public access include the Ministry of the Environment, which carries out this task through the Estonian Environment Information Centre. The information centre collects, analyses and publishes environmental data; compiles and issues environmental reviews (both electronically and in hard-copy as well as online at: www.keskkonnainfo.ee). The Estonian Environmental Research Centre provides online information about the state of air quality at: www.klab.ee

The legal basis for public access is provided by the Ambient Air Protection Act, the Public Information Act[10], the Act on Administrative Procedure[11], as well as the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, ratified by the Estonian Government in 2001.

Schematic diagrams of the EIS, including air quality data management components

The Estonian Air Quality Management System was developed in 2002 as part of a Phare project, Development of the Estonian Air Quality Management System[12] .

[10] RT I 2000, 92, 597
[11] RT I 2001, 58, 354
[12] http://mail.klab.ee/seire/airviro/

5. Obstacles and challenges for SMAQ technology transfer

SMAQ is not well understood but its value in combining different data sets and running health risk assessment is appreciated. However, perceived high investment costs and an uncertainty about the availability of “after-sales” support were listed as the key obstacles for successful technology transfer. An introduction to SMAQ would help assuage these concerns.

6. Future domestic priorities and opportunities for EIS development

No details were provided here although the country’s national information and environment strategies were indicated.

7. Recommendations

None given

List of Contributors

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SMAQ COUNTRY REPORT: HUNGARY

The Budapest agglomeration is increasingly suffering from exceedances of air pollution limit thresholds for NO_X and PM10s, besides high levels of O_3 during summertime, mainly caused by transport.

1. Key Findings

- The main hotspot region singled out by this survey is the Budapest agglomeration, home to more than 2 million, a fifth of the country's population. However, other regions also experience poor air quality owing to industrial sources of pollution. A key driving force in Budapest is transport.

- The National Environment Protection and Information System (OKIR) is managed by the Ministry of Environment and Waters and supported by VITUKI, a subordinate body that monitors PM10s, PM2.5s, SO_2 and NO_X countrywide. Auxiliary data (meteorological, epidemiological, and population) is also widely available.

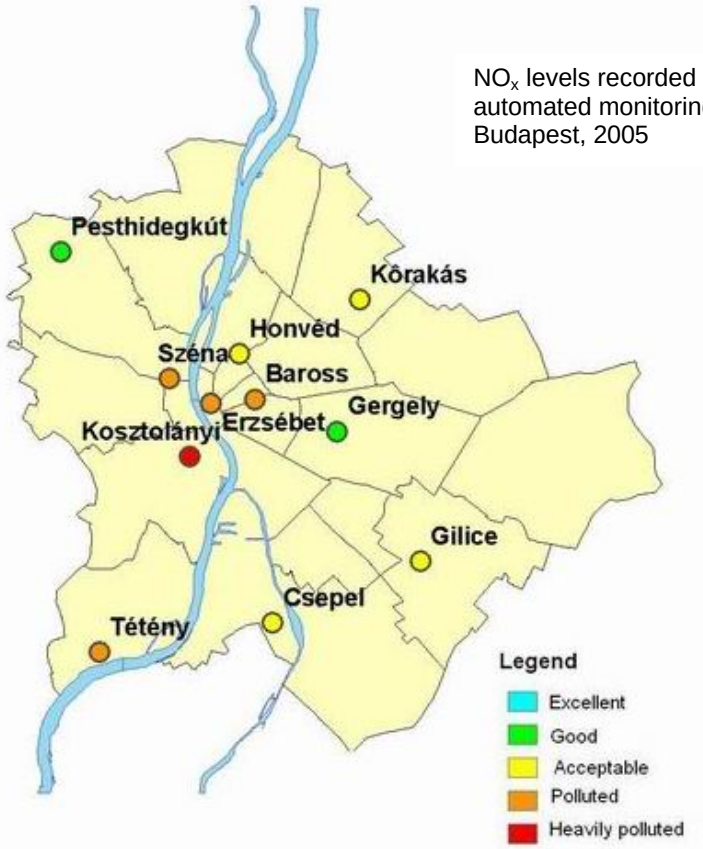
- A particular opportunity for SMAQ implementation lies within the established *Budapest Agglomeration Development Council*, which in 2006 adopted a preferential development programme regarding the environment. The initiative's first priority is the development of an integrated environmental monitoring system. EC funding programmes would appear to put this within reach, although gaining the support and collaboration of all 23 of Budapest's districts and 81 settlements could be the major challenge.

- Further introductions to SMAQ should be made. Despite the apparently limited use of satellite data from either commercial or public sources, GIS-based tools are being increasingly appreciated and utilised. An interministerial committee was established at the end of 2007 to examine the steps required to comply with the INSPIRE directive. SMAQ could be implemented as part of this effort.

2. The environment

Hungary's capital city Budapest and its agglomeration (defined by law) has the attributes of a regional hotspot measuring 80 km by 80 km. The two main pollutants that frequently exceed legal limit values are NO_X and PM10s (the former is shown in the graphic below). During summertime O_3 is also high, a result of the high levels of NO_X, with annual thresholds breached at Gilice ter in the southeast and Korakas park in the northeast. The main source of this pollution is transport. Industrial pollution has been declining since 1990.

NO_x levels recorded by automated monitoring stations, Budapest, 2005



Source: OLM-VITUKI

The table overleaf shows the total number of exceedances of limit values that occurred during 2006 on a range of scales (hourly, daily, yearly) for all pollutants of interest to SMAQ. One can see that annual limits were exceeded in five central Budapest locations for PM10, in seven locations for NO_X and in four locations for NO_2. Emissions of SO_2 are well controlled. Allowable levels of annual O_3 concentrations were exceeded in two Budapest locations as well as in Szazhalombatta and Vac, which lie outside the city limits but within the 80 by 80 km zone.

Exceedances of ambient air limit values in 2006 (#/occasions)

Station[1]	PM10		NO_X			NO_2			O_3	SO_2		
	Daily average	Yearly average	Hourly average	Daily average	Yearly average	Hourly average	Daily average	Yearly average	8 hrs daily max.	Hourly average	Daily average	Yearly average
Budapest, Baross ter	91		1,126	76		97	19		0	0	0	0
Budapest, Csepel	-	-	548	34		146	15	0	13	0	0	0
Budapest, Erzsebet ter	157		1,058	78		308	54		-	0	0	0
Budapest, Gergely utca	77	0	243	9	0	33	1	0	4	0	0	0
Budapest, Gilice ter	69	0	307	15	0	156	12	0	39	0	0	0
Budapest, Honved utca	162		602	37		240	17	0	-	0	0	0
Budapest, Kosztolanyi ter	153		1,368	88		298	31		5	0	0	0
Budapest, Korakas park	161		368	18	0	7	0	0	25	0	0	0
Budapest, Pesthidegkut	45	0	195	6	0	31	3	0	15	0	0	0
Budapest, Szena ter	27	0	955	56		188	20		2	0	0	0
Budapest, Teteny	-	-	629	30		9	1	0	0	0	0	0
Szazhalombatta[2], 1	40	0	6	0	0	0	0	0	34	0	0	0
Szazhalombatta[2], 2	29	0	59	2	0	0	0	0	-	0	0	0
Szazhalombatta[2], 3	32	0	17	0	0	0	0	0	41	0	0	0
Vac[1]	65		5	0	0	6	0	0	8	0	0	0
Dorog[3]	94		8	0	0	0	0	0	21	0	0	0
Szigetujfalu[3]	37	0	33	0	0	6	0	0	27	0	0	0

Indicates those locations where yearly averages were breached

[1] Budapest is served by 11 automatic monitoring stations with four more outside the city boundaries (one in Vac, three in Szazhalombatta). Furthermore, there are 27 stations belonging to the manual air quality monitoring network and four more beyond the city boundaries

[2] Szazhalombatta lies to the southwest of Budapest, Vac lies to the north

[3] Dorog and Szigetujfalu are not strictlypart of the Budapest agglomeration, but are within an 80 km by 80 km region.

3. Current status of environmental (air quality) information

Existing air quality and ancillary data

A. Time series of **air quality** data from the monitoring network:

Data Type	Availability [Y/N]	Detailed Description
PM10s ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: from January 1, 2004 (from automatic monitoring stations) Data format: html, pdf, csv, xls Chemical composition of PM is not available, although the instruments are able to measure them. No long-term series data is available
PM2.5 ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period; from January 1, 2005 (from automatic monitoring stations) Data format: html, pdf, csv, xls Chemical composition of PM is not available, although the instruments are able to measure them. No long-term series data is available
PM1 ambient air concentrations (ug/m^3).	N	Not measured, neither planned
SO_2 ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: from January 1, 2004 (from automatic monitoring stations) Data format: html, pdf, csv, xls
NO_x ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: from January 1, 2004 (from automatic monitoring stations) Data format: html, pdf, csv, xls
NO_2 ambient air concentrations (ug/m^3).	Y	Time resolution available: h ourly averages The available data period: from January 1, 2004 (from automatic monitoring stations) Data format: html, pdf, csv, xls
O_3 ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: from January 1, 2004 (from automatic monitoring stations) Data format: html, pdf, csv, excel
NH_3 ambient air concentrations (ug/m^3).	N	Not measured, neither planned
Data Source:	Hungarian Air Quality Monitoring System of the Ministry of Envrionment and Water http://www.kvvm.hu/olm/ (in English also) Budapest H-1011, Fo utca 44-50.	

B. Time series of **meteorological** data from the monitoring network:

Data Type	Availability [Y/N]	Detailed Description
Relative humidity (RH)	Y	Time resolution: hourly. Data period available: varies according to location KMI and Lorinc: 1998; Ujpest: 2001 (Q2); Lagymanyos: 1999 (Q4) Data format: ASCII text (.txt)
Wind speed (m/s)	Y	Time resolution: hourly. Data period available: varies according to location: KMI and Lorinc: 1998; Ujpest: 2001 (Q2); Lagymanyos: 1999 (Q4) Data format: ASCII text (.txt)
Wind direction (degrees)	Y	Time resolution: hourly. Data period available: varies according to location: KMI and Lorinc: 1998; Ujpest: 2001 (Q2); Lagymanyos: 1999 (Q4) Data format: ASCII text (.txt)
Temperature (Celsius)	Y	Time resolution: hourly. Data period available: varies according to location: KMI and Lorinc: 1998; Ujpest: 2001 (Q2); Lagymanyos: 1999 (Q4) Data format: ASCII text (.txt)
Mixing layer height (m)	Y	No measurements are available but from 2004 this parameter can be derived from models
Data Source:	National Meterological Institute (www.met.hu) Budapest, H-1024 Kitaibel P. utca 1.	

C. **Exact coordinates** of all the monitoring stations (both air quality and meteorological) supplying the above data (3A and 3B):

Coordinates	Availability [Y/N]	Detailed Description
Air quality monitoring stations	Y	WGS84 coordinates system is used
Meteorological monitoring stations	Y	KMI: φ (Latitude): 47,51 λ (Longitude): 19,03 Ujpest: φ (Latitude): 47,57 λ (Longitude): 19,08 Lagymanyos: φ (Latitude): 47,47 λ (Longitude): 19,06 Lorinc: φ (Latitude): 47,43 λ (Longitude): 19,18
Data Source:	VITUKI (www.vituki.hu) Budapest, H-1095 Kvassay J. ut 1. National Meterological Institute (www.met.hu) Budapest, H-1024 Kitaibel P. utca 1.	

D. **Existence of an emission inventory** in standard GIS *raster* format and the respective chemicals listed in 3A above:

Emission Inventory Data	Availability [Y/N]	Detailed Description
If not raster grid GIS format, please indicate the data format available		a) The most recent annual average emissions data is from 2005. b) The emission values (national sums) are expressed in k-tons (or gigagrams) per year. c) Two emission inventories exist in Hungary, reflecting two international agreements in the field of air quality (the LRTAP Convention*[13] and the Kyoto Protocol). The former incorporates assessment of PM10s, PM2.5s, SO_2, and NO_X. NO_2 and O_3 are not recorded in either. Polluters will have to report their emissions, according to a recent 2007 government decree, complete with their geographic coordinates. Calculation of mobile sources of emissions is processed by the Institute for Transport Sciences: www.kti.hu. Its most recent inventory was compiled in 2004.
Data Source:	Ministry of Environment and Waters: http://www.kvvm.hu/ Budapest H-1011, Fo utca 44-50.	

For each of the hotspots described above, the following key ancillary data is available:

E. **Road network** data:

Road Network Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y	The most recent data available: 2008 The most reliable official source (Magyar Kozut Kht) encompasses all national roads (those inside and outside settlements) in GIS format. Less reliable data is available for roads under the jurisdiction of local authorities (there is no obligation to maintain digitally, neither to update). Market-based firms (e.g. www.geox.hu/english.asp) naturally offer updated maps for all roads, typically used to source car navigation systems.
Data Source:	Magyar Kozut Kht. (Hungarian Road Management Company) Budapest, H-1024 Fenyes Elek utca 7-13.	

F. **Population density** data in standard GIS *raster* format:

Population Density Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y	a) data is available for the entire region (apropos Hungary) b) spatial resolution includes "urban district" scale for Budapest, and for its agglomeration, at settlement level c) the last census was 2001, the most recent dataset produced is 2005 d) data is differentiated by gender and age in both T-STAR and Bp-STAR The Hungarian Central Statistical Office, responsible for census implementation and data collection, manages two population databases. "T-STAR" covers Hungary and "BP-STAR," Budapest (district level). Two corresponding GIS tools have been developed around these datasets: MATERIA, based on T-STAR and BUTERIA, based on BP-STAR.
Data Source:	Hungarian Central Statistical Office. Budapest, H-1024 Keleti K. utca 5-7: portal.ksh.hu/pls/portal/url/page/kshportaleng/hcso_website	

[13] LRTAP: Convention on Long-range Transboundary Air Pollution

G. **Epidemiological data**:

Epidemiological Data	Availability [Y/N]	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases	Y	Monthly data is available which can be differentiated by gender and age. It can be searched by a patient's postcode as well as the ICD code of the disease (as the main diagnosis).
Data Source:	National Centre for Healthcare Audit and Inspection http://www.oszmk.hu Budapest, H-1097 Gyali ut 2-6.	

H. **Administrative boundaries** in standard GIS *raster* format:

Administrative Boundary Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y	Administrative boundary coordinates on country, county and settlement levels are available which correspond to the legally registered data stored at land offices. A broad range of enquiries of the data can be made with an accuracy to centimetres, metres, and tens and hundreds of metres.
Data Source:	Institute of Geodesy, Cartography and Remote Sensing: www.fomi.hu/honlap/angol Budapest, H-1149 Bosnyak ter 5. Contact: Tibor Meszaros, Department of Land Information Developments	

I. **Digital elevation model (DEM)** in standard GIS *raster* format:

Digital Elevation Model Data	Availability [Y/N]	Detailed Description
Raster Grid GIS Format (.grd)	Y	The Digital Elevation Model database of Hungary (DDM-100) contains DEM files in TIN and GRID formats derived from vector relief files at a scale of 1:100 000 within the digital topographical map database. The size of the GRID is: 100x100m. There is a fee for usage: 10 HUF/km^2 or appx. Eur 1/25km2. It is also available online.
Data Source:	Institute of Geodesy, Cartography and Remote Sensing www.fomi.hu/honlap/angol Budapest, H-1149 Bosnysk trr 5. Contact: Gyula Ivan, FOMI Department of Geoinformation Developments	

J. **Land use/land cover** in standard GIS *raster* format::

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Raster Grid GIS Format (.grd)	Y	The institute below mentioned can generate land use/land cover maps (the same institute is responsible for CORINE LandCover in Hungary).
Data Source:	Institute of Geodesy, Cartography and Remote Sensing www.fomi.hu/honlap/angol Budapest, H-1149 Bosnyak ter 5.	

K. **Hydrology data** (lakes, rivers, etc.) in Shapefile GIS format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y	The map's development was in its final phase at the time of writing (Oct. 07), It should now be available in ESRI ArcView format.
Data Source:	KDV-KOVIZIG Budapest, H-1088 Rakoczi ut 41.	

L. **Biodiversity (ecosystem) indicators** in standard GIS *raster* format:

Biodiversity Indicators	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y (Partly)	Based on a strategy adopted April 2006, an information system for nature protection is being developed as part of the National Environmental Information System. Currently a so-called landscape ecological vegetation map is available for Hungary. This systematically surveys, via hexagon grids of 35 hectares, habitats with more than 25 percent cover of natural and semi-natural vegetation, according to the National Habitat Classification System. The GIS environment is further supplemented by 17 attributes on the actual state of the vegetation. To handle this diverse data, a well-structured SQL database has been created with capacity to store and handle more than 1 million data records. The data can be viewed with ArcView. Further info: novenyzetiterkep.hu/meta/en/index.shtml#details
Data Source:	Ministry of Envrionment and Water http://www.kvvm.hu Budapest H-1011, Fo utca 44-50.	

4. Current status of environmental (air quality) information systems

Air quality data collection and management

The monitoring of PM10s, PM2.5s, SO_2 and NO_x countrywide is coordinated by VITUKI, a subordinate body of the Ministry of Environment and Water, within the framework of the Hungarian Air Quality Network. VITUKI also handles data processing, calibration, and evaluation (long-term time-series data and yearly analysis), and posts it online at: kvvm.hu/olm. Regional environmental authorities are responsible for the operation of the 54 automatic monitoring stations and manual measurement stations across the country. Pollution data is typically stored in .csv and .xls formats (see 3A above), but the national environmental information system incorporates GIS functionality. Industrial self-assessment is regulated by government decree 21/2001 and emission data supplied in electronic format is fed into the national environmental information system, which is the responsibility of the Ministry of Environment and Waters (see 3D). According to a recent government decree (78/2007), all polluters will possess an identification code which indicates their geographic coordinates, thereby facilitating their registration and submission of pollution data to the system. Use of satellite data from the Ikonos/IRS/Meteosat/SPOT satellites for air quality assessment appears limited.

PM1 ambient air concentrations (ug/m^3) and NH_3 ambient air concentrations (ug/m^3) are not monitored and there are no plans to do so. The official environment ministry explanation being: there is no corresponding EU obligation. The current legal basis for monitoring, control and evaluation of air quality is Decree 17/2001, last modified in 2004 in order to conform to EU standards.

Regarding the INSPIRE directive, the environment ministry is responsible for its implementation in an environment context, and in October 2007, an interministerial committee was being established to examine the steps required to achieve compliance. Other involved ministries include Economy and Transport, Agriculture and Rural Development, Health, Defense, and Local Government and Regional Development.

Inter-agency cooperation

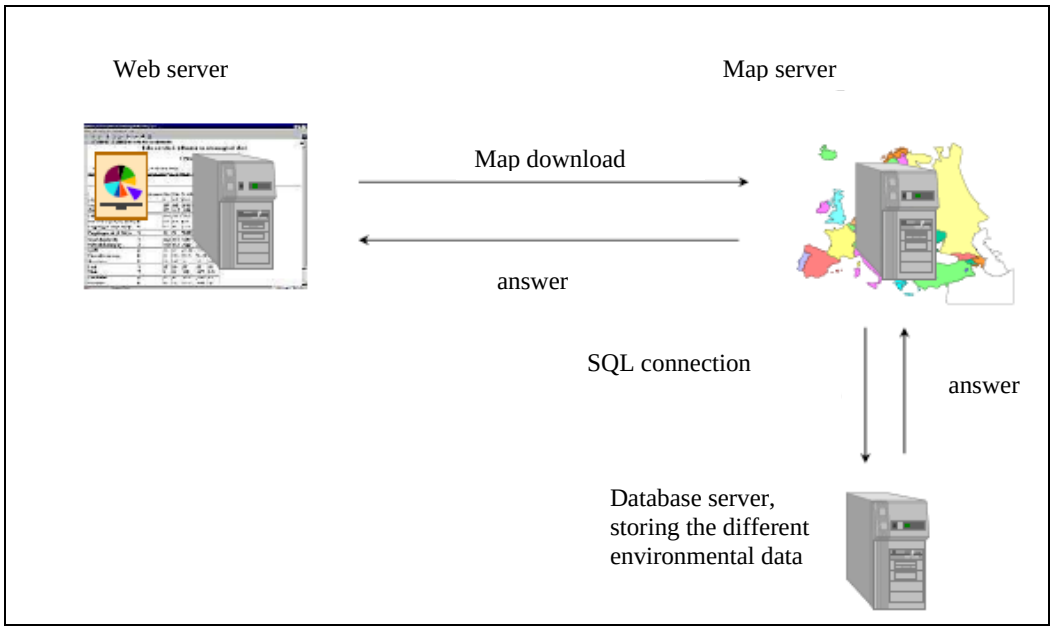
Because air quality monitoring and public reporting/accessibility are all generally supervised by the environment ministry, there are no major problems with respect to information exchange. Other agencies and institutes (e.g. the statistical office) are able to freely access this data, as per the respective legislation on the right to access data (although prior to 2004 the situation was less clear).

Public accessibility

Data for PM10s, PM2.5s, SO_2 and NO_x are easily accessible via the Internet webpage of the Hungarian Air Quality Network: kvvm.hu/olm, including real-time information direct from the automated stations. Public access to the pollution data collected through industrial self-monitoring is possible only upon written request to the environment ministry. However, an Internet front-end for this data is being developed through the national environmental information system: OKIR, see details below. This webpage will be available from September 1, 2008. The legal basis for public access are the laws CXL/2004 and CXXVII/2005, which assure that environmental data is of general public interest, irrespective of who possesses it.

Schematic diagrams of the EIS, including air quality data management components

The environmental information system (the Hungarian acronym is OKIR, short for the National Environment Protection and Information System) is based on a suite of data (emissions of noise and emissions into surface water, underground water, air and soil) collected by regional and national environmental authorities. All databases correspond to the same structure and therefore can be integrated into OKIR, which is primarily intended to aid the work of the authorities. However, it is also a sound basis for publicly available information. The system is essentially SQL-based with some Java elements. The mapping module relies on Mapviewer. The Ministry of Environment and Waters is responsible for the system, shown below.



5. Obstacles and challenges for SMAQ technology transfer

The *Budapest Agglomeration Development Council* is responsible for the entire hotspot region. This body could take on a significant coordinating role in implementing SMAQ since it has plans to develop the environment monitoring system (detailed below). In the council's view, the obstacles to implementing SMAQ would be:

- local authority collaboration (Budapest has 23 districts and 81 settlements);
- poorly understood investment outlay; and
- weak air quality monitoring infrastructure at some points within the agglomeration.

6. Future domestic priorities and opportunities for EIS development

At the national level no major developments are foreseen within the next 12 months (till mid-2009) regarding the air quality monitoring network or the emissions inventory. The priorities within Hungary's environmental information system are the integration of different environmental data collection and evaluation mechanisms and the development of data accessibility. This is in no small way also connected to the implementation of the INSPIRE directive. It is also worth noting that GIS-based tools are being used more widely and winning more support.

Among the opportunities to be considered, the EC's Structural Funds (Environment and Energy Operational Programme) offers financial support for "developments targeting e-environmental protection," both at the national and local/regional level. Nationally this funding can be used for:

- EIONET (European Environment Information and Observation Network) development (Hungary's data exchange point with the European Environment Agency, including, for instance, the pollution emissions register or EPER);
- further development of OKIR (the National Environment Protection and Information System); and
- promoting accessibility through online publishing of the most important electronic environmental data and information of public interest

Locally and regionally level this funding can be used for information technology support for rural and regional co-operation.

Acquisition of such funding could conceivably be leveraged for SMAQ transfer.

7. Recommendations

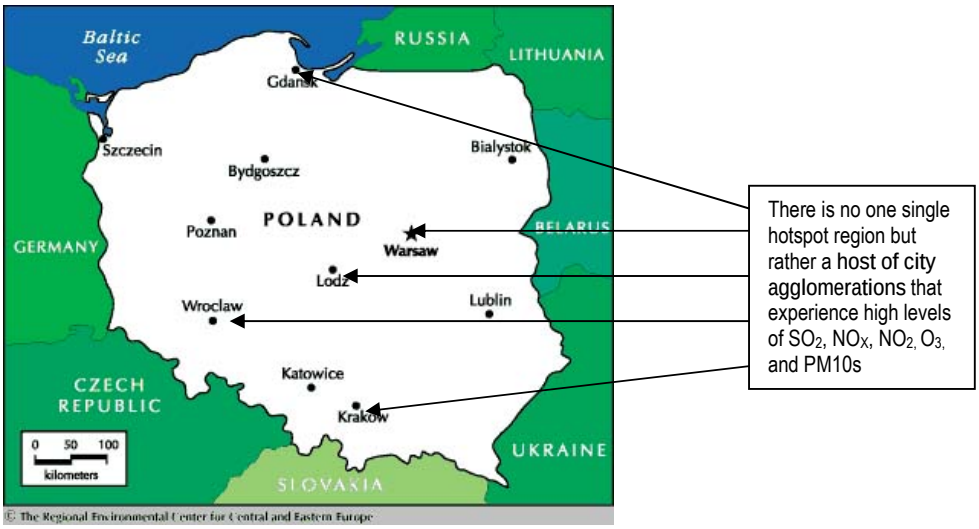
According to the 1996/XXI law on regional development (modified by 2004/LXXV), the Budapest Agglomeration Development Council or BAFT (online at: www.baft.hu) undertakes the responsibility to coordinate development policies and the efforts of the government and the local authorities within its territory. In 2006, the council adopted a preferential development programme regarding the environment, whose first priority is the development of an integrated "Environmental Monitoring System." This aims to integrate existing and develop new databases within a GIS-based application. Worth noting is the importance also attached to air quality and health information. As of late Oct. 2007, the council was in the process of applying for seed funding under the Structural Funds' Environment and Energy Operational Programme (see above). A more formal introduction to SMAQ should occur, to capitalise upon this opportunity.

Beyond Budapest, settlements that suffer poor air quality include Miskolc, Dunaujvaros and Szeged, all of which could benefit from SMAQ. It's worth noting that the availability of data under point 3 is generally the same across the country. The differences with respect to the above data would be isolated perhaps to section 5: Obstacles and Challenges for SMAQ Technology Transfer.

List of Contributors

Peter Szuppinger, project manager, REC Country Office Hungary

SMAQ COUNTRY REPORT: POLAND



1. Key findings

- Six urban agglomerations have been highlighted by this survey due to concentrations of SO_2, NO_X, NO_2, O_3, and PM10s that tend to be high and occasionally exceed legal limits.

- The State Environmental Monitoring (SEM) system, under the supervision of the State Inspectorate Of Environment Protection assures that emissions data for all but PM1 and NH_3 is monitored and reported across the country, according to EU standards. PM2.5s are generally monitored but not in the northern agglomeration around Gdansk and Wroclaw. Auxiliary data (meteorological, epidemiological, and population) is also widely available.

- There would appear to be more challenges for SMAQ implementation than opportunities: little practical use is made of satellite data, INSPIRE directive implementation does not appear to be widely addressed, information exchange among state and local institutions can still be troublesome and GIS application tends to be disparate and according to an institution's own wishes.

- Nevertheless, the restructuring of the State Inspectorate for Environment Protection and its transformation into the Polish Environment Agency, along with the increasing funds available at the local level and the development of the national emissions inventory, would appear to be opportunities worth exploring. Such investigations should be combined with the spread of practical information on GIS technology and a demonstration of the tangible benefits to be had from SMAQ.

2. The environment

There has been a decline in the quantity of pollutants emitted in Poland since the political changes of almost 20 years ago. This has resulted in a general improvement of air quality such that measurements stay well below legal limit values.

Exceptions, however, are particular matter and ozone. High concentrations of PM10s are observed in all regions, especially in Poland's larger agglomerations, six of which are featured in this report:

- Gornoslaska, an industrial region of 14 cities in Silesia, southern Poland;
- Warszawa, the country's capital at the centre of Poland;
- Lodz, one of the biggest industrial cities in central Poland;
- Trojmiasto (Gdansk, Sopot and Gdynia), three northern Polish cities;
- Krakow, a famous city in southern Poland (close to Silesia); and
- Wroclaw, one of the largest cities in western Poland.

Combined, these account for more than seven million residents. Here concentrations of primary pollutants (SO_2, NO_X, and NO_2) are typically higher than in other regions and areas of Poland. In the case of O_3, limit values are sometimes exceeded (e.g. during the summer), although very high concentrations are not detected.

Numerous small municipal facilities, as well as households, play an important role in shaping city air quality. Traffic-related pollution is another problem in densely populated areas.

3. Current status of environmental (air quality) information

Existing air quality and ancillary data

A. Time series of **air quality** data from the monitoring network for the following parametres for all six regions listed above (unless otherwise indicated):

Data Type	Availability [Y/N]	Detailed Description
PM10 ambient air concentrations (ug/m^3).	Y (including heavy metals)	Time resolution: hourly and daily average Data period: several years Data format: data base, ASCII and Excel Chemical composition: not indicated
PM2.5 ambient air concentrations (ug/m^3).	Y (except Trojmiasto and Wroclaw)	Time resolution: daily average Data period: several years Data format: data base, ASCII and Excel Chemical composition: not indicated
PM1 ambient air concentrations (ug/m^3).	N	
SO_2 ambient air concentrations (ug/m^3).	Y	Time resolution: hourly and daily average Data period: several years Data format: data base, ASCII and Excel
NO_x ambient air concentrations (ug/m^3).	Y	Time resolution: hourly average Data period: several years Data format: data base, ASCII and Excel
NO_2 ambient air concentrations (ug/m^3).	Y	Time resolution: hourly and daily average Data period: several years Data format: data base, ASCII and Excel

O_3 ambient air concentrations (ug/m^3).	Y	Time resolution: hourly average Data period: several years Data format: data base, ASCII and Excel
NH_3 ambient air concentrations (ug/m^3).	N	
Data Sources:	State (and local) inspectorates of environment protection (SIEP): www.gios.gov.pl 52/54 Wawelska Str., 00-922 Warsaw Chief Sanitary Inspectorate (CSI) and local Inspectorates: www.gis.gov.pl 38/40 Długa Str., 00-238 Warsaw National Institute of Hygiene: www.pzh.gov.pl 24 Chocimska Str., 00-791 Warsaw	

B. Time series of **meteorological** data from the monitoring network for all six regions described above:

Data Type	Availability [Y/N]	Detailed Description
Relative humidity (RH)	Y	Time resolution: hourly Data period available: several years Data format: ASCII text (.txt) and Excel format
Wind speed (m/s)	Y	Time resolution: hourly from automated monitoring stations Data period available: several years Data format: ASCII text (.txt) and Excel format
Wind direction (degrees)	Y	Time resolution: hourly from automated monitoring stations Data period available: several years Data format: ASCII text (.txt) and Excel format
Temperature (Celsius)	Y	Time resolution: hourly from automated monitoring stations Data period available: several years Data format: ASCII text (.txt) and Excel format
Mixing Layer Height (m)	Y	Data period available: several years
Data Sources:	IMWM - Institute of Meteorology and Water Management (www.imgw.pl) 61 Podlesna Str., 01-673 Warsaw The various local inspectorates of environment protection (www.gios.gov.pl) also collect and store data for the first four categories above from automated monitoring stations.	

C. **Exact coordinates** of all monitoring stations (both air quality and meteorological) supplying the above data (3A and 3B) for all six regions described above

Coordinates	Availability [Y/N]	Detailed Description
Air quality monitoring stations	Y	WGS84 coordinates system is used
Meteorological monitoring stations	Y	WGS84 coordinates system is used
Data Source:	See 3A and 3B above, as well as NIH - National Institute of Hygiene (www.pzh.gov.pl) 24 Chocimska Str., 00-791 Warsaw	

D. **Existence of an emission inventory** in standard GIS *raster* format and the respective chemicals listed in 3A above, for all six regions described above

Emission Inventory Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd) regarding chemicals listed in A.	N	Under development
If not faster grid GIS format, please indicate the data format available	Y	a) Annual average emissions data is available for all locations. b) The emission values (national sums) are expressed in tonnes per year. c) All necessary information concerning the methodology used for the emissions inventory development and estimation of local emission factors is available from the National Administration for the Emissions Trading Scheme. Data format: ASCII text (.txt) and Excel formats
Data Sources:	The National Administration for the Emissions Trading Scheme (NAETS)/ National Emission Centre (NEC) (www.kashue.pl / emisje.ios.edu.pl) 4 Kolektorska Str., 01-692 Warsaw Other institutions collecting similar data include: Central Statistical Office (www.stat.gov.pl) 208 Niepodległości Av, 00-925 Warsaw Motor Transport Institute (www.its.home.pl/nsite) 80 Jagiellońska Str., 03-301 Warsaw	

For each of the hotspots described above, the following key ancillary data is available

E. **Road network** data:

Road Network Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y (partially)	The Central Institute for Geodesy and Cartography (GUGiK) maintains GIS-based data
If not Shapefile GIS format, please indicate the format available	Y	The General Directorate for National Road and Motorways is responsible for all information concerning the Polish road network, although its information is typically available in ASCII text (.txt) and Excel formats. Further information concerning transport and road monitoring is elaborated by the Motor Transport Institute on behalf of various government bodies in a variety of formats at a variety of scales.
Data Sources:	GUGiK - Glowny Urzad Geodezji i Kartografii (www.gugik.gov.pl) 2 Wspolna Str., 00-926 Warsaw GDNRM - General Directorate for National Road and Motorways (www.gddkia.gov.pl) 59 Zelazna Str., 00-848 Warsaw Motor Transport Institute (www.its.home.pl/nsite) 80 Jagiellonska Str., 03-301 Warsaw	

F. **Population density** data in standard GIS *raster* format:

Population Density Data	Availability [Y/N]	Detailed Description
Raster Grid GIS Format (.grd)	Y (partially)	A GIS system is under development, therefore only limited data is available.
If not Raster Grid GIS Format, please indicate the format available	Y	a) Data is available for all regions/agglomerations (apropos Poland). b) Spatial resolution includes "urban district" scale (from local voivode statistical offices. c) Data from the last census, in 2002, is available. d) Data is differentiated by gender and age. Data concerning population density is gathered in central and local databases as per the administrative level, mostly on the "NUTS4" level (so-called gmina level in Poland).
Data Source:	Central Statistical Office (www.stat.gov.pl) 208 Niepodległości Av, 00-925 Warsaw	

G. **Epidemiological data**:

Epidemiological Data	Availability [Y/N]	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases	Y	This data (temporal scale not defined) is gathered in a central (national) database maintained by the National Institute of Hygiene (NIH). The Nofer Institute of Occupation Medicine (NIOM) is a secondary data source
Data Sources:	NIH - National Institute of Hygiene: www.pzh.gov.pl 24 Chocimska Str., 00-791 Warsaw NIOM - Nofer Institute of Occupation Medicine (www.imp.lodz.pl) 8 Św. Teresy, Str., 91-348 Lodz	

H. **Administrative boundaries** in standard GIS *raster* format:

Administrative Boundary Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y	Data is available for the entire country
Data Sources:	CODGiK - Centralny Osrodek Dokumentacji Geodezyjnej i Kartograficznej (codgik.gov.pl) 94 Jana Olbrachta Str., 01-102 Warsaw GUGiK - Glowny Urząd Geodezji i Kartografii (www.gugik.gov.pl) 2 Wspolna Str., 00-926 Warsaw	

I. **Digital elevation model (DEM)** in standard GIS *raster* format:

Digital Elevation Model Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y	Data is available for almost all of the country.
If not raster grid GIS format, please indicate the format available	Y	Data is available for almost all of the country in ASCII, TIN, and TTN formats.
Data Source:	CODGiK - Centralny Osrodek Dokumentacji Geodezyjnej i Kartograficznej (codgik.gov.pl) 94 Jana Olbrachta Str., 01-102 Warsaw	

J. **Land use/land cover** in standard GIS *raster* format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)	Y (partially)	This dataset is under development by the Central Institute for Geodesy and Cartography (GUGiK), therefore only limited data is available.
If not raster grid GIS format, please indicate the format available	Y	Some data (often aggregated) is available at the Central Statistical Office in ASCII and Excel formats.
Data Sources:	GUGiK - Glowny Urzad Geodezji i Kartografii (www.gugik.gov.pl) 2 Wspólna Str., 00-926 Warsaw Central Statistical Office (www.stat.gov.pl) 208 Niepodleglosci Av, 00-925 Warsaw	

K. **Hydrology data** (lakes, rivers, etc.) in Shapefile GIS format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Shapefile GIS Format (.shp)	Y	Data is available for the entire country
Data Source:	GUGiK - Glowny Urzad Geodezji i Kartografii (www.gugik.gov.pl) 2 Wspólna Str., 00-926 Warsaw CODGiK - Centralny Osrodek Dokumentacji Geodezyjnej i Kartograficznej (codgik.gov.pl) 94 Jana Olbrachta Str., 01-102 Warsaw	

L. **Biodiversity (ecosystem) indicators** in standard GIS *raster* format:

Biodiversity Indicators	Availability [Y/N]	Detailed Description
Raster Grid GIS Format (.grd)	Y (Although raster GIS is much less popular than vector GIS)	Various institutions collect a variety of data, among them: - The Nature Protection Institute for Corine LandCover Data, Natura 2000 data, and general nature protection data - The Institute of Environment Protection for data concerning nature and the environment - The Chief Inspectorate for Environment Protection

Data Source:	SIEP - State Inspectorate of Environment Protection: www.gios.gov.pl 52/54 Wawelska Str., 00-922 Warsaw NPI - Nature Protection Institute (www.iop.krakow.pl) al. A. Mickiewicza 33, 31-120 Kraków, IEP - Institute of Environment Protection (www.ios.edu.pl) 5/11d Krucza Str., 00-548 Warsaw

4. Current status of environmental (air quality) information systems

Air quality data collection and management

The State Environmental Monitoring (SEM) system (regulated in accordance with the statute on state inspectorate of environment protection) ensures the provision of data on air quality for analysis and assessment according to the EU's legal standards; for tracking trends and evaluating the efficiency of pollution abatement programmes; and for regional environmental and economic policy development (where air quality standards are being exceeded). Within this framework, the State Inspectorate of Environment Protection (SIEP) determines the location (and where necessary relocation) of sites for monitoring the substances listed in 3A and the respective sampling and analysis. Because of Poland's size, monitoring is devolved mainly to local (or "voivode") environmental (VIEP) and sanitary (VSI) inspectorates, whose monitoring activities are in turn coordinated by relevant research institutes (the Institute for Environment Protection or IEP and National Institute of Hygiene or NIH). These latter bodies oversee the local data collection and storage, assessment and reporting. On the basis of these results, annual reports on air quality and management are elaborated, very often using GIS software and modelling.

Industrial installations with their own monitoring practices are integrated into the State Environmental Monitoring (SEM) system when certain criteria have been satisfied (since they tend to measure specific parameters and substances, as determined by the emissions permit under which they operate). However, it is chiefly the National Administration for the Emissions Trading Scheme (NAETS)/National Emission Centre (in accordance with the statute on state statistics monitoring and international agreements and conventions) that tracks air emissions (based on a locally administered annual questionnaire) within a national inventory (under the auspices of a national statistical system for atmospheric emissions supervised by the Central Statistical Office). Smaller emission (including mobile) sources' data are based on emission factors, fuel consumption and other relevant information depending on the pollutant and source. PM1 and NH_3 are generally not monitored owing to the absence of a legal basis.

The above institutions' experience in using and processing meteorological and air quality satellite data derived from either of the Ikonos, IRS, Meteosat, SPOT, Landsat or MODIS satellites is not well documented. It is understood that the same institutions are aware of the EC's INSPIRE Directive and steps are afoot to prepare for its implementation, though details are not known.

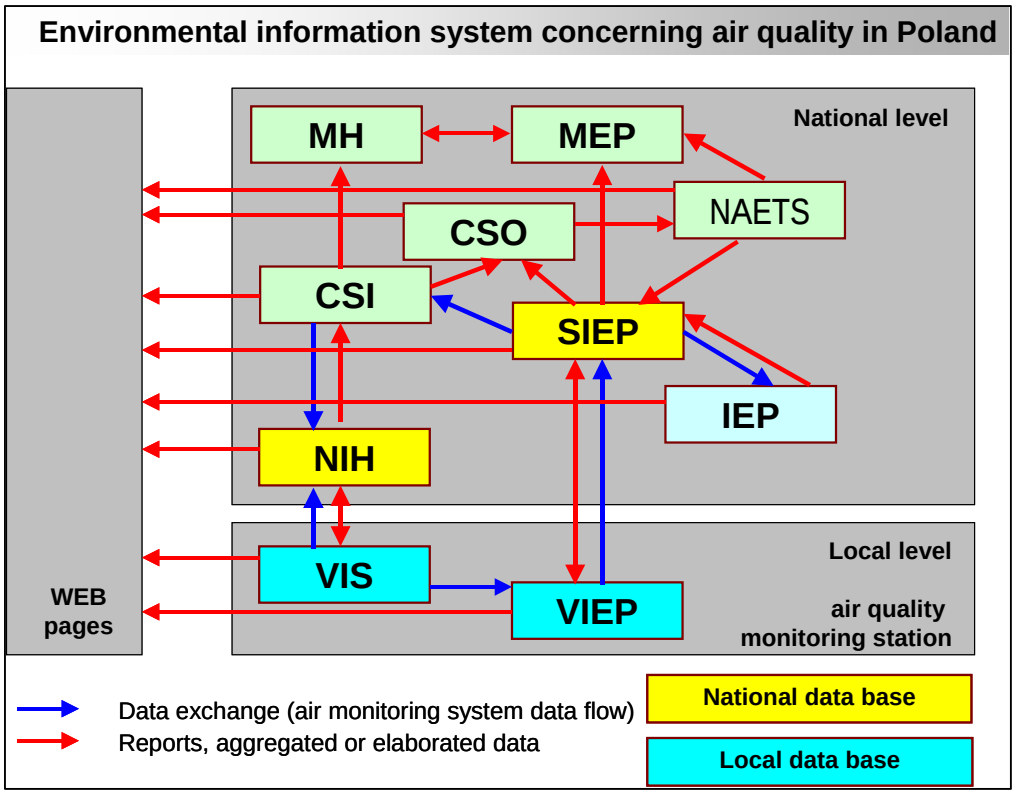
Inter-agency cooperation

Several different national and local authorities, institutes, inspectorates and organisations are involved in air quality monitoring, and they have many different objectives in this work. Therefore, software, hardware, and database problems have been known to arise with information exchange. However, there are no legal obstacles to the exchange of information among institutions belonging to the State Environmental Monitoring system.

Public accessibility

All air quality monitoring reports are made available on the web pages of the national institutions described previously: the State Inspectorate for Environment Protection, the Chief Sanitary Inspectorate, the Institute for Environment Protection, the National Institute of Hygiene) and local-level voivode environmental (VIEP) and sanitary (VSI) inspectorates. Certain raw air quality monitoring data is also available on-line on local VIEP and VSI web pages. The legal basis for public access accords to related EU standards.

Schematic diagrams of the EIS, including air quality data management components



Legend:

Environment Bodies

MEP – Ministry of Environmental Protection
IEP – Institute of Environmental Protection
VIEP – Voivodship (provincial) Inspectorate for Environment Protection
SIEP - State Inspectorate for Environment Protection
NAETS - National Administration for the Emissions Trading Scheme

Other Bodies

MH – Ministry of Health
CSO – Central Statistical Office
NIH – National Institute of Hygiene
CSI – Chief Sanitary Inspectorate
VIS - Voivodship (provincial) Sanitary Inspectorate

5. Obstacles and challenges for SMAQ technology transfer

The main key challenges for SMAQ's implementation in Poland are:

- Weak (or even a lack of) coordination between key institutions concerned. Those institutes and organisations responsible for air quality and health impact assessment work within the remits of different ministries (environmental protection and health) who have different aims and responsibilities, for instance environmental monitoring and reporting as per state environment inspectorate standards that do not necessarily account for health problems.
- The national emissions inventory is based on an annual questionnaire survey and consequent reports concern the national, as opposed to agglomeration, level. The National Administration for the Emissions Trading Scheme was established in 2005, and as the main institution responsible for Poland's emissions inventory, it is still overseeing its development (vis-a-vis its database, formats, reports, etc.).
- The plethora of institutes and organisations involved in air quality monitoring in Poland (described above) each have tended to develop their own GIS data systems based on diverse software, with little consideration for inter-operability and functionality.
- Satellite data use and image processing still tends to remain with universities and research institutes, with cooperation occasionally extended to the environment and agriculture ministries and local authorities for research purposes than for practice decision-making purposes. To the author's knowledge, there have been no projects where satellite images have been utilised for air quality or health impact management.

6. Future domestic priorities and opportunities for EIS development

Among the developments over the coming two years (to mid-2009) that may provide opportunity for the implementation of the SMAQ toolkit in the hotspot regions are the:

- availability of financial assistance, especially at the local level;
- restructuring of the State Inspectorate for Environment Protection and its transformation into the Polish Environment Agency;
- emergence of the National Administration for the Emissions Trading Scheme and the development of its emissions inventory; and
- the development of GIS systems, especially within the Ministry of Health.

7. Recommendations

The author suggests the following activities to foster SMAQ toolkit transfer:

- Deliver practical information on GIS technology through the presentation of good practical examples regarding the application of SMAQ within a pilot area where air quality and epidemiological data, information sourced from emissions inventories, and population data are gathered from the databases of various institutions (at both national and local level) within one system. Sharing the legal solutions adopted to achieve implementation and explaining the coordination processes can be very helpful.
- The tangible benefits of SMAQ for an existing hotspot should be clearly described along with the necessary annual operating expenses for local authorities.
- Understanding of the cost-benefits of satellite data/imagery and its availability needs to be improved among all concerned institutions.

List of Contributors

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SMAQ COUNTRY REPORT: ROMANIA

1. Key findings

- Urban centres served by municipal heating plants burning traditional fuels combined with generous grace periods on EU Directives mean the exceedance of daily, monthly and annual average concentrations is commonplace in many parts of Romania. The exceedances are exacerbated by a range of industrial activities, traffic and energy production.

- The National Integrated Monitoring System incorporates a national network for air quality monitoring and the national air pollutant emissions inventory and is overseen by the National Environment Protection Agency. All key air quality data required for SMAQ is collected regularly via the network. The availability of auxiliary (meteorological, epidemiological and population) data is patchy.

- The development of and investment into a national integrated environmental informational system, in part to satisfy INSPIRE demands, combined with the ongoing acquistion of satellite imagery, would appear to be opportunities to market and pilot SMAQ (Bucharest and Iasi were singled out). A constraint would appear to be the limited availability and degree of know-how with respect to GIS software.

- Further data about SMAQ (including a personalised letter of interest from its project managers) could help in gauging whether the system's data requirements could be met, and at the same time would help to convince air quality managers of its benefits.

2. The environment

Despite significant improvements to air quality since 1990, when economic decline resulted in the closure of major polluters' operations, the emission of harmful compounds into the air (SO_2, NO_2, NO_x, CO and PM10s) remains a key challenge in Romania. Reducing this pollution is an important part of national environmental policy.

In many urban agglomerations, municipal heating plants are major sources of pollution, due to old technologies and long-term under-investment. Romania still depends on traditional fuels such as coal and fuel oil for 46 percent of its heating and hot water services in large agglomerations, with natural gas accounting for another 39 percent. Although emissions from these fuels represent a threat to residents' health, the country enjoys transition periods ranging from 2013 to 2017 for SO_2, NO_x and particulates and for certain installations under the Large Combustion Directive.

Some of the urban areas suffering from exceedances of daily, monthly and annual average concentrations include:

County	Source	Pollutants
Iasi *(NE Romania)*	Metallurgy, chemical production, pharmaceuticals	SO_2, NO_2, CO, PM10s
Onesti *(Central Romania)*	Petrochemical industry, refining, chemical production	SO_2, NO_2, CO, PM10s, CO_2, dust, NO_X, COV, CH4
Constanta *(SE Romania)*	Energy production, refining and petrochemical activity	SO_2, NO_2, CO, PM10, CO2,
Galati *(E Romania)*	Non-ferrous industry	SO_2, CO, CO_2, NO_X, CH4
Rovinari *(W Romania)*	Energy production, mining	Particulates
Bucharest	Energy production, traffic, industrial activities	NO_2, SO_2, PM10s, PM2.5s

Source: 2006 Environmental State Report

SO_2 emissions arise from the fossil fuel combustion and the processing industries (contributing approx. 75 percent of the country's total in 2003).

NO_X emissions continuously declined between 1990-2000, but have recorded a significant increase since, reaching 326,000 tonnes in 2004. The main sources are the combustion of energy and the processing industry (approximately 39 percent of the country's total), road service (approximately 31 percent) and manufacturing (about 11 percent).

Particulate matter significantly exceeds the maximum admissible concentration (MAC). The sources are diverse and include thermal power plants using solid fuels, the metallurgical and steel industries, cement manufacturing, road transport and waste dumps and deposits.

3. Current status of environmental (air quality) information

Existing air quality and ancillary data

A. Time series of **air quality** data from the monitoring network for the following parameters:

Data Type	Availability [Y/N]	Detailed Description
PM10s ambient air concentrations (ug/m^3).	Y	Time resolution: hourly averages Data period: 1-2 years Data format: not indicated Chemical composition: metals only
PM2.5s ambient air concentrations (ug/m^3).	Y (partially)	Time resolution: Hourly averages Data period: 1-2 years Data format: not indicated Chemical composition: metals only
PM1s ambient air concentrations (ug/m^3).	N	
SO_2 ambient air concentrations (ug/m^3).	Y	Time resolution: Hourly averages Data period: 1-2 years Data format: not indicated
NO_x ambient air concentrations (ug/m^3).	Y	Time resolution: hourly averages Data period: 1-2 years Data format: not indicated
NO_2 ambient air concentrations (ug/m^3).	Y	Time resolution: hourly averages Data period: 1-2 years Data format: not indicated
O_3 ambient air concentrations (ug/m^3).	Y	Time resolution: hourly averages Data period: 1-2 years Data format: not indicated
NH_3 ambient air concentrations (ug/m^3).	Y	Time resolution: hourly averages Data period: 1-2 years Data format: not indicated
Data Source:	National Environmental Protection Agency and their local (county) representatives Splaiul Independentei, no.294, Sector 6, Bucharest, Cod 060031; www.anpm.ro/ E-mail: office@anpm.ro; Tel: +40 (21) 207-1101/1102; Fax: +40 (21) 207-1103	

B. Time series of **meteorological** data from the monitoring network:

Data Type	Availability [Y/N]	Detailed Description
Relative humidity (RH)	Y	Time resolution: every six hours (1, 7, 13, 19 hrs local average solar time) Data period available: not indicated Data format: not indicated
Wind speed (m/s)	Y	Time resolution: every six hours (1, 7, 13, 19 hrs local average solar time) Data period available: not indicated Data format: not indicated
Wind direction (degrees)	Y	Time resolution: every six hours (1, 7, 13, 19 hrs local average solar time) Data period available: not indicated Data format: not indicated
Temperature (Celsius)	Y	Time resolution: every six hours (1, 7, 13, 19 hrs local average solar time) Data period available: not indicated Data format: not indicated
Mixing layer height (m)	N	
Data Source:	National Meteorological Administration: Sos. Bucuresti-Ploiesti No. 97; Code: 013686 www.meteoromania.ro/ Tel: +40 (21) 318-3240; Fax: +40 (21) 316-3143	

C. **Exact coordinates** of all the monitoring stations (both air quality and meteorological) supplying the above data (3A and 3B):

Coordinates	Availability [Y/N]	Detailed Description
Air quality monitoring stations	Y	Coordinates system *(e.g. WGS84 or UTM34N)*: not indicated
Meteorological monitoring stations	Y	Data format *(e.g. WGS84 or UTM34N)*: not indicated
Data Sources:	National Environmental Protection Agency and their local (county) representatives www.anpm.ro/ National Meteorological Administration: Sos. Bucuresti-Ploiesti No. 97; Code: 013686 www.meteoromania.ro/ Tel: +40 (21) 318-3240; Fax: +40 (21) 316-3143	

D. **Existence of an emission inventory** in standard GIS *raster* format and the respective chemicals listed in 3A above:

Emission Inventory Data	Availability [Y/N]	Detailed Description
If not Raster Grid GIS Format, please indicate the data format available	Y	a) Emissions data is available as an annual average b) The format of emission data c) Information concerning the methodology used for the emissions inventory development and estimation of local emission factors would appear to be defined by Government Order No. 592/2002 on limit values, thresholds, criteria and methods Data format: not indicated
Data Source:	Local (county) environmental protection agencies, identifiable via www.anpm.ro/	

For each of the hotspots described above, the following key ancillary data is available:

E. **Road network** data (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available).

Road Network Data	Availability [Y/N]	Detailed Description
If not Shapefile GIS format, please indicate the format available	Y	Geographical maps (the most recent data available is not defined)
Data Source:	Not known	

F. **Population density** data in standard GIS *raster* format:

Population Density Data	Availability [Y/N]	Detailed Description
If not raster grid GIS format, please indicate the format available	Y	a) Data is available for all regions/agglomerations b) Spatial resolution includes urban scale c) Most recent census: not indicated d) Data differentiated by gender and age: not indicated
Data Source:	Mayor's offices within the respective towns	

G. **Epidemiological data**:

Epidemiological Data	Availability [Y/N]	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases	Y	Temporal resolution: not indicated
Data Source:	Institute of Public Health: Str. Dr. Leonte nr. 1-3, Sector 5, 050463 Bucuresti Centrala: +40 (21) 318-3620/3621; Fax: +40 (21) 312-3426; www.ispb.ro/	

H. **Administrative boundaries** in standard GIS *raster* format:

Administrative Boundary Data	Availability [Y/N]	Detailed Description
If not raster grid GIS format, please indicate the format available	Y	Geographical maps
Data Source:	Relevant institutional address: not indicated	

I. **Digital elevation model (DEM)** in standard GIS *raster* format:

Digital Elevation Model Data	Availability [Y/N]	Detailed Description
	N	Neither raster grid GIS format (.grd) nor any other format appears to be available
Data Source:		

J. **Land use/land cover** in standard GIS *raster* format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
	Y	The CORINE LandCover has yielded land use/land cover maps, however, the GIS format is not indicated. Furthermore soil, geological, and risk maps have been prepared for the implementation of the Nitrates Directive (format not indicated).
Data Source:	Not indicated	

K. **Hydrology data** (lakes, rivers, etc.) in Shapefile GIS format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
	Y (partially)	Neither Shapefile GIS format (.shp) nor any other format appears to be available, although measurement and maps of water coordinates for the hydrogeographical system and territorial infrastructure system appear to be available (format not indicated).
Data Source:	National Administration of Romanian Waters www.rowater.ro/	

L. **Biodiversity (ecosystem) indicators** in standard GIS *raster* format:

Biodiversity Indicators	Availability [Y/N]	Detailed Description
	Y	A GIS map for the Natura 2000 network has been developed. It is not indicated whether this is raster or vector GIS. Maps of virgin forests, protected areas, species' distribution are also available (format also not known)
Data Source:	Relevant institutional address: not indicated	

4. Current status of environmental (air quality) information systems

Air quality data collection and management

The National Integrated Monitoring System incorporates a national network for air quality monitoring and the national air pollutant emissions inventory. The system is based on Government Decree No. 586/2004 and coordinated by the National Environment Protection Agency (NEPA), which is subordinate to the Ministry of Environment and Sustainable Development (MESD). Manual and automated monitoring stations are operated, with the latter being functional since 2006 and incorporating monitoring of the urban agglomerations of Bucharest, Iasi, Craiova and Cluj. By 2009, it is expected that a total of 94 stations will operate in Romania. Pollutant data (including the results of industrial self-monitoring, mandatory under the EU's IPPC Directive and Romania's laws) is collected by the local (county) environmental protection agencies, in accordance with Government Order No. 592/2002 on limit values, thresholds, criteria and methods for SO_2, NO_X, O_3,, PM10s and PM2.5 in the air. Their individual reports are subsequently ranked on an annual basis. The National Meteorological Administration oversees the accumulation and transmission of observation data from the ground, radar and upper-air monitoring stations network.

GIS is utilised in Romania in the fields of nature and atmospheric protection, hydrometeorogical forecasting, water resource management, infrastructure and risk management and agriculture. High resolution optical teledetection applications, GIS and LCCS (Land Cover Classification System) methodologies were used to prepare the maps and inventories listed in the tables above (3J, 3K and 3L) regarding land use/land cover, hydrology and biodiversity). Further maps will be generated for the basis of environmental protection based on a Phare 2005 project supporting the aquisition of satellite images. However, the above institutions' experience in using/processing meteorological and air quality satellite data derived from the Ikonos, IRS, Meteosat, SPOT, Landsat and MODIS satellites is not indicated. The same institutions' level of understanding of the EC's INSPIRE Directive (to make interoperable spatial information readily available to the public and in support of both national and Community policy) is weak, and steps being undertaken to prepare for its implementation are few. On a positive note, Decree No. 572/2006 green lights the development of a national integrated environmental informational system which is intended as a response to INSPIRE requirements.

Regarding gaps in the monitoring of the pollutants of concern to SMAQ, PM1 and PM2.5 are not continuously measured owing to the lack of widespread availability of this technology for measurement (and it would appear, legal basis).

Inter-agency cooperation

The environment ministry and the National Environment Protection Agency are bound by official agreements to cooperate and exchange data among themselves and with all relevant institutions (for instance, the National Institute for Research and Development for Environment Protection, local environmental protection agencies, the National Statistical Institute and the Institute of Public Health, etc.) As a founding member of the World Meteorological Organisation (WMO), Romania also enjoys international data exchange in the meteorological field.

Public accessibility

Government Decree No. 586/2004 regarding the National Integrated Monitoring System also ensures that the public is informed in due time regarding air quality. To this end, electronic boards in the centres of large towns relay this type of data, while it is also available upon request from local authorities and environmental protection agencies. In addition, Romania's ratification of the "Aarhus" Convention (Law No. 86/2000) ensures the legal basis for making official requests and accessing air quality and pollution data in urban areas from annual state of environment reports.

Schematic diagrams of the EIS, including air quality data management components

Governmental Decree No. 572/2006 gave the green light for the development and investment into a national integrated environmental informational system managed by, and for the benefit of, the National Environmental Protection Agency and environment ministry. The system will link all information sub-systems and unify environmental information in a standardised format, according to EU requirements under INSPIRE and the European Environment Agency (EEA). A schematic diagram does not appear to be available, however.

5. Obstacles and challenges for SMAQ technology transfer

The main key challenges for SMAQ's implementation in Romania are:

- inadequate air quality monitoring infrastructure (vis-à-vis all the requested parameters), incomplete national coverage and the lack of high precision data, besides inadequate GIS map processing know-how and equipment;
- the lack of a solid base for SMAQ, given the ongoing development of the national environmental informational system and limited technical support.

6. Future domestic priorities and opportunities for EIS development

Some of the above challenges are conversely opportunities, with the national environmental informational system's development ongoing with current investments occurring in infrastructure. Furthermore, the aquisition of satellite images for GIS map preparation could enable the implementation of SMAQ according to the first scenario described above (offline exposure assessment).

7. Recommendations

The cities of Bucharest and Iasi can be considered potential locations suitable for the application of SMAQ. National Environment Protection Agency representatives believe such a system could be useful, but fear that the availability of national data is insufficient.

Further data about SMAQ (including a personalised letter of interest from its project managers) could help in gauging whether the system's data requirements could be met, and at the same time would help to persuade air quality managers of its benefits.

List of contributors

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SMAQ COUNTRY REPORT: SLOVAKIA

US Steel, lying in the Kosice agglomeration in eastern Slovakia, contributes significant quantities to annual emission totals of SO_2, NO_2, PM10s and CO. It makes a fairly obvious choice for scoping the potential application of SMAQ.

1. Key Findings

- All pollutants of interest to SMAQ (SO_2, NO_X, NO_2, O_3, and to an extent PM2.5s) are monitored and their concentrations in the air are found to be below legal limits. However, high levels of PM10s are a problem, and U.S. Steel in the eastern part of the country makes a significant contribution to the country's annual emission totals.

- The National Air Quality Monitoring Network managed by the Slovak Hydro-meteorological Institute (SHMU) regularly collects emissions and meteorological data and reports this online. Auxiliary (epidemiological, population, road and biodiversity) data is also widely available.

- GIS practice is advanced within SHMU as is modeling and the use of Meteosat satellite data. The institute's grasp of the INSPIRE Directive and the steps being undertaken for its implementation are not well documented.

- Owing to their high degree of involvement in international projects, SHMU must be persuaded of that investments in SMAQ will be worthwhile. The system's innovative value is poorly understood. The Kosice agglomeration, under the influence of U.S. Steel, could make an interesting local pilot, possibly as a public-private partnership.

2. The environment

Slovakia, administratively divided into eight zones and two agglomerations, experiences ambient air quality levels well in line with current legislation[14]. Limit values are adequately respected for all pollutants of interest to SMAQ (SO_2, NO_X, NO_2, O_3 and PM2.5s). However, a problem is the high levels of PM10s.

Taking into account these pollutants, the variations in air quality contamination experienced from region to region, and industrial zones with power plants burning brown coal and other solid fuels, the report authors have opted to concentrate on the agglomeration of Kosice in the eastern part of the country. It is here that the steel industry is located, with the main source of air pollution being the U.S. Steel company. Its contribution to the country's annual emissions are as follows: SO_2 (10 percent), NO_2 (18.5 percent), CO (70 percent, in combination with SLOVALCO), and PM10s (31 percent).

3. Current status of environmental (air quality) information

Existing air quality and ancillary data

A. Time series of **air quality** data from the monitoring network for the Kosice agglomeration:

Data Type	Availability [Y/N]	Detailed Description
PM10 ambient air concentrations (ug/m^3).	Y	Time resolution available; hourly averages The available data period: not indicated Data format: html (online at: www.shmu.sk), and Excel Chemical composition of PM: not indicated
PM2.5 ambient air concentrations (ug/m^3).	N	
PM1 ambient air concentrations (ug/m^3).	N	
SO_2 ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: not indicated Data format: html (online at: www.shmu.sk), and Excel
NO_X ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: not indicated Data format: html (online at: www.shmu.sk), and Excel
NO_2 ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: not indicated Data format: html (online at: www.shmu.sk), and Excel
O_3 ambient air concentrations (ug/m^3).	Y	Time resolution available: hourly averages The available data period: not indicated Data format: html (online at: www.shmu.sk), and Excel
NH_3 ambient air concentrations (ug/m^3).	N	
Data Source:	SHMU – Slovak Hydro-meteorological Institute Jesénova 17, 833 15, Bratislava: www.shmu.sk	

[14] Air Pollution Assessment in the Slovak Republic – 2005, SHMU publisher, Bratislava. Pp 72

B. Time series of **meteorological** data from the monitoring network:

Data Type	Availability [Y/N]	Detailed Description
Relative humidity (RH)	Y	Time resolution: hourly Data period available: not indicated Data format: html (online at: www.shmu.sk), and Excel
Wind speed (m/s)	Y	Time resolution: hourly Data period available: not indicated Data format: Excel, html (online in 6-hourly intervals at: www.shmu.sk for the purpose of the weather forecasting)
Wind direction (degrees)	Y	Time resolution: hourly Data period available: not indicated Data format: Excel, html (online in 6-hourly intervals at: www.shmu.sk for the purpose of the weather forecasting)
Temperature (Celsius)	Y	Time resolution: hourly Data period available: not indicated Data format: Excel, html (online in 6-hourly intervals at: www.shmu.sk for the purpose of the weather forecasting)
Mixing layer height (m)	Y	The method used is upon case-by-case basis within the individual meteorological stations
Data Source:	SHMU – Slovak Hydro-meteorological Institute Jesénova 17, 833 15, Bratislava: www.shmu.sk	

C. **Exact coordinates** of all the monitoring stations (both air quality and meteorological) supplying the above data (3A and 3B):

Coordinates	Availability [Y/N]	Detailed Description
Air quality monitoring stations	Y	φ (Latitude):48°43'02" λ (Longitude): 21°15'39" Elevation: 199m
Meteorological monitoring stations	Y	φ (Latitude): 48°43'02" λ (Longitude): 21°15'39" Elevation: 199m
Data Source:	SHMU – Slovak Hydro-meteorological Institute Jesénova 17, 833 15, Bratislava: www.shmu.sk	

D. **Existence of an emission inventory** in standard GIS *raster* format and the respective chemicals listed in 3A above:

Emission Inventory Data	Availability [Y/N]	Detailed Description
If not raster grid GIS format, please indicate the data format available	Y (.shp)	a) Daily average emissions data is available online at SHMU; b) The emission values (national sums) are expressed in tonnes per year. c) Information regarding instrumentation and analytical methods used to derive the values provided and is available at the SHMU website. The methodology used for emissions inventory development and estimation of local emission factors are in the line with the standards used in EU member states. An air quality emission inventory is availabile in the Slovak State of the Environment report published annually by the environment ministry. Usually the text and charts are accompanied by maps and other graphics created in GIS. The same approach is adopted within an elaborated emission report published annually by SHMU (based on a modeling system called CEMOD adjusted to Slovak conditions) along with *Air Pollution Assessment in the Slovak Republic 2005.* Data is contributed to

		this inventory by industrial self-monitoring practices that feed the National Emission Information System (described in Section 4 below).
Data Source:	SHMU – Slovak Hydro-meteorological Institute Jesséniova 17, 833 15, Bratislava: www.shmu.sk	

For the Kosice agglomeration, the following key ancillary data is available:

E. **Road network** data:

Road Network Data	Availability [Y/N]	Detailed Description
Shapefile GIS Format (.shp)	Y	The most recent data available: not indicated The whole territory of Slovakia is available in shape files, divided based on theme. There are seven thematic maps available at two scales: SVM50 (1:50000) and SVM500 (1:500000). The data owner is ARCGEO, although state institutions (e.g. SHMU) have acquired and utilise the thematic GIS maps.
Data Source:	ARCGEO ltd; Nevadzova 5, 821 01 Bratislava, E-mail: www.arcgeo.sk	

F. **Population density** data in standard GIS *raster* format:

Population Density Data	Availability [Y/N]	Detailed Description
Not raster grid GIS format (.grd) but Shapefile GIS format (.shp)	Y	a) data is available for the entire region b) spatial resolution includes adequate for analysis of the Kosice agglomeration c) the last census; not indicated d) data is differentiated by gender and age
Data Source:	Not indicated	

G. **Epidemiological data:**

Epidemiological Data	Availability [Y/N]	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases	?	Temporal resolution not indicated
Data Source:	Not indicated	

H. **Administrative boundaries** in standard GIS *raster* format:

Administrative Boundary Data	Availability [Y/N]	Detailed Description
Not raster grid GIS format (.grd) but Shapefile GIS format (.shp)	Y (.shp)	The whole territory of Slovakia is available in shape files, divided based on theme. There are seven thematic maps available at two scales: SVM50 (1:50000) and SVM500 (1:500000). The data owner is ARCGEO, although state institutions (e.g. SHMU) have acquired and utilise the thematic GIS maps.
Data Source:	ARCGEO ltd; Nevadzova 5, 821 01 Bratislava, EMail: www.arcgeo.sk	

I. **Digital elevation model (DEM)** in standard GIS *raster* format:

Digital Elevation Model Data	Availability [Y/N]	Detailed Description
Not raster grid GIS format (.grd) but Shapefile GIS format (.shp)	Y (.shp)	The whole territory of Slovakia is available in shape files, divided based on theme. There are 7 thematic maps available at two scales: SVM50 (1:50000) and SVM500 (1:500000). The data owner is ARCGEO, although state institutions (e.g. SHMU) have acquired and utilise the thematic GIS maps.
Data Source:	ARCGEO ltd; Nevadzova 5, 821 01 Bratislava, EMail: www.arcgeo.sk	

J. **Land use/land cover** in standard GIS *raster* format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Not raster grid GIS format (.grd) but Shapefile GIS format (.shp)	Y (.shp)	The whole territory of Slovakia is available in shape files, divided based on theme. There are 7 thematic maps available at two scales: SVM50 (1:50000) and SVM500 (1:500000). The data owner is ARCGEO, although state institutions (e.g. SHMU) have acquired and utilise the thematic GIS maps.
Data Source:	ARCGEO ltd; Nevadzova 5, 821 01 Bratislava, EMail: www.arcgeo.sk	

K. **Hydrology data** (lakes, rivers, etc.) in Shapefile GIS format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Shapefile GIS format (.shp)	Y	The whole territory of Slovakia is available in shape files, divided based on theme. There are 7 thematic maps available at two scales: SVM50 (1:50000) and SVM500 (1:500000). The data owner is ARCGEO, although state institutions (e.g. SHMU) have acquired and utilise the thematic GIS maps.
Data Source:	ARCGEO ltd; Nevadzova 5, 821 01 Bratislava, EMail: www.arcgeo.sk	

L. **Biodiversity (ecosystem) indicators** in standard GIS *raster* format:

Biodiversity Indicators	Availability [Y/N]	Detailed Description
Not raster grid GIS format (.grd) but Shapefile GIS format (.shp)	.shp	The whole territory of Slovakia is available in shape files, divided based on theme. There are 7 thematic maps available at two scales: SVM50 (1:50000) and SVM500 (1:500000). The data owner is ARCGEO, although state institutions (e.g. SHMU) have acquired and utilise the thematic GIS maps.
Data Source:	ARCGEO ltd; Nevadzova 5, 821 01 Bratislava, EMail: www.arcgeo.sk	

4. Current status of environmental (air quality) information systems

Air quality data collection and management

The Slovak Hydro-meteorological Institute (SHMU), subordinate to the Ministry of Environment, is responsible for all air quality monitoring according to the requirements of EU air quality directives, which is adequately reflected in Slovak legislation[15], sometimes even more stringently. Thirty-nine stations constitute the National Air Quality Monitoring Network (NMSKO) and measure the concentration of 12 pollutants, alongside their spatial distribution. A further 18 stations under the responsibility of industry monitor pollutants. For instance, the Slovnaft refinery in Bratislava has two monitoring stations, while a paper mill in the north of the country has four (rather related to malodorous emissions). Emissions data is fed into the National Emission Information System via regional environmental authorities who oversee pollution data collection.

Regarding GIS practice, a specialised department was setup within the institute responsible for the integration of the data collected into maps. Air quality data management in GIS formats is commonplace and at a high level, for instance several modeling systems were adjusted (e.g. CEMOD, IDWA) or have been developed to support the National Emission Information System. Mapping systems rely on a standard called S-JTSK Krovak (which translates to Unified Regional Trigonometric Network).

Meteosat satellite data has been regularly received and processed by the Slovak Hydro-meteorological Institute since 1983 (albeit with changes since then in processing software, archive formats, hardware and media). Since November 1998, their PDUS processing station (based on an Alfa workstation and their own software written in C language under the Unix operating system) receives Meteosat data. Their satellite image databank includes a short-term (two-week) local archive and a "floating" archive with data periodically stored on 4mm DL 90m magnetic tapes. TAR files are generated with about 25-30 Mbytes of compressed data daily.

Slovak institutions' understanding of the EC's INSPIRE Directive (which aims to make interoperable spatial information readily available to the public and in support of both national and Community policy) and steps being undertaken for its implementation are not well documented.

Inter-agency cooperation

Besides the Slovak Hydro-Meteorological Institute's regular cooperation with the European Environment Agency (EEA) and international panels and agreements (UNECE, UNFCCC), collaboration at the national level is generally smooth despite the existence of additional national bodies involved in environmental assessment which interact with bodies such as the EEA and the Slovak Environment Agency. The latter reports information collected from expert institutions such as SHMU. The existence of an "extra link" in the chain can sometimes appear ineffective and may hinder information exchange.

[15] For instance Act 203/2007, amending Act 478/2002 about the protection of air (which amended Act 401/1998 about pollution fees), and MoE Order 351/2007, amending Order 705/2002 about air quality.

Public accessibility

The availability and accessibility of air quality monitoring data is at a high level. The Slovak Hydro-Meteorological Institute's website offers free access to information for general public consumption, combined with comprehensive scientific descriptions. Annual reports on the other hand sometimes lack sufficient explanation of charts, although they may be self-explanatory enough for experts. Maps with pictograms enable the digestion of complex data and moreover makes the information more understandable by non-Slovak speakers. The Act on Free Access to Information No. 211/2000 is the legal cornerstone for public access.

Schematic diagrams of the EIS, including air quality data management components

The Slovak environmental information system integrates information from monitoring activity, assessment and spatial analysis. The resulting information supports the work of the environment authorities and those responsible for enforcing legislation, including the environment ministry and its affiliated organisations, as well as other ministry bodies. The environment ministry serves as the central gateway to all related information, via ENVIROPORTAL online at: www.enviroportal.sk. All organisations involved in the environmental information system, alongside their responsibilities are indicated in the table below.

PMS	Guarantor	Center	Monitored subsystems	
Air quality	MoE SR	SHMU	Level of pollution, ground atmospheric level	
Meteorological and climatological conditions	MoE SR	SHMU	Network of ground synoptic and air stations; network of meteorological radars; meteorological satellite measurements; network of stations with climatologic observation program; network of precipitation monitoring system; network of monitoring system of solar radiation and total atmospheric ozone	Network of phonological stations; network of measuring soil temperature and soil humidity; network of monitoring in the ground atmospheric level; aerologic station; storm detection station network
Water	MoE SR	SHMU	Surface water quantitative indicators; groundwater water quantitative indicators; surface water quality; groundwater water quality	Thermal and mineral water; irrigation water, recreational water bodies
Radioactivity	MoE SR	SHMU	Environmental radioactivity – ground atmospheric level at monitoring sites.	
Waste	MoE SR	SAZP	Waste generation and disposal in SR; waste reclamation facilities.	Waste reclamation facilities; interstate transport of hazardous waste
Biota	MoE SR	State Nature Protection	Fauna and Flora	
Geological factors	MoE SR	State Geological Institute	Landslides and other slope deformations; erosion processes; monitoring of erosion process; soils of unstable volumes; effect of mineral exploitation on environment; change to anthropogenic sediments	Anthropogenic sediments buried; tectonic seismic activity of territory; monitoring of snowcap chemical composition; monitoring of seismic activity; active alluvial sediments; volume of radon activity in geological layers
Soils	Ministry of Agriculture (MoA)	Soil Science and Conservation	Basic network; key sites; special network of sites	Spatial monitoring of agricultural land; forest and monitoring
Forests	MoA	National Forest Center	Extensive periodical monitoring – 112 permanent monitoring areas; Intensive periodical and continuous monitoring – 7 permanent monitoring areas.	
Xenobiotic substances	MoA	Research Institute of Food	Coordinated focal monitoring; consumption pool monitoring.	Monitoring of game and fish

Environmental monitoring practices
(From: State of the Environment in the Slovak Republic, 2005: Ministry of Environment)

5. Obstacles and challenges for SMAQ technology transfer

From discussion with air quality specialists at the Slovak Hydro-Meteorological Institute, three challenges were identified:

- Investment cost (an approximate estimate should be given as this is unclear);
- Project or application benefits (the institute already runs a high volume of projects and the innovative value of SMAQ has to be "sold"); and
- Uncertainty about the availability of "after-sales" SMAQ service.

6. Future domestic priorities and opportunities for EIS development

Few tangible opportunities can be related, although three may be proposed. First, having been eligible for pre-accession assistance and a beneficiary of various financial instruments, Slovakia's institutions should be well-prepared and able to take advantage of future financing programmes. Second, based on policy cycles, the transition of the energy supply system driven by climate policy may yield opportunity. Third, support to adopt innovations in monitoring equipment and use high-tech systems (e.g. more precise forecasting and adoption of the precautionary principle) would be welcome. This could build upon SHMU's past involvement in collaborative initiatives with the EEA vis-à-vis environmental reporting.

7. Recommendations

In the authors' opinion, SMAQ does not appear to provide a completely new approach, innovation or technology. The Hydro-meteorological Institute is already involved in many international projects, although their work must be raised to international standards. Their experience with modeling is at a high level, based on many years' experience. Conversely, if SMAQ heralds innovation, it may best be applied at local level, in cooperation with industry as a possible public-private partnership. The Kosice agglomeration, under the influence of U.S. Steel could make an interesting pilot, although they do not appear to practice any form of self-monitoring (REC would be ready to facilitate this partnership and air quality monitoring/reporting). The energy sector could be a viable secondary target.

List of contributors

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SMAQ COUNTRY REPORT: SLOVENIA

Zasavje region: Its predominanty coal-based industrial base, including the Trbovlje Power Plant, contributes to exceedances of permissible levels of PM10s and ozone, exacerbated by unfavourable meteorological conditions.

Veliki vrh.: Due to the operation of the Sostanj Power Plant, limits of SO_2, O_3, and PM10s continue to be exceeded.

1. Key findings

- The Annual Air Quality Report of 2006 shows the main problems concerning air quality are PM10s, ozone and, to a lesser extent, SO_2. Notable hotspots are Veliki vrh and the Zasavje region (where the coal-based Sostanj and Trbovlje power plants are located).

- All key pollutants of interest to SMAQ (PM10s, SO_2, NO_2, O_3) are monitored and regularly reported upon online and in hardcopy by the Slovenian Environmental Agency. PM1s are not monitored and PM2.5s and NH_3 are measured at selected locations only). All key ancillary data is available in GIS format.

- Slovenia is very familiar with the INSPIRE Directive having prepared a comprehensive list of implementation measures in 2007. GIS itself is already widely used by those institutions concerned with environmental management, including local authorities in the hotspot regions. Less can be said about institutions' usage of meteorological and air quality satellite data.

- Few challenges would appear to exist related to the possible implementation of SMAQ although capacities at the local authority level and division of responsibilities should be taken into account. There should also be awareness raising measures to convince stakeholders of SMAQ's benefits. Significant synergy could be achieved with the roll-out of the annual national programme on ambient air quality monitoring during 2008.

2. The environment

Ambient air quality in Slovenia has markedly improved in recent years. The Annual Air Quality Report of 2006[16] shows the main outstanding problems to be PM10s, O_3 and to a lesser extent, SO_2. Pollution from NO_2 and benzene are generally found to be below the limit values, although occasional exceedances were measured at Maribor's traffic hotspots.

The highest levels of PM10s are typically experienced in urban locations (for instance, the eastern Slovenian city of Maribor) and are a result of traffic. Exceedances within the cities of the Zasavje region (located within a narrow valley of the Sava river in central Slovenia), are typically driven by local industry (namely the Trbovlje Power Plant, shown right, and the Lafarge cement company). Much of Zasavje's coal-based industry also contributes to exceedances of permissible O_3 levels, exacerbated by unfavourable meteorological conditions. In fact permissible concentrations of O_3 were found to be exceeded in almost all monitored locations in Slovenia, except at traffic hubs such as Maribor and Zagorje. The highest concentrations, however, continue to be experienced on the coast and within the Primorska region.

SO_2 emissions have been steadily declining across the country. Exceedance of limit values around Zasavje's Trbovlje Power Plant have ceased thanks to the installation of desulphurising devices, while the closure of the Krsko paper mill in southeast Slovenia in 2006 saw concentrations decrease to the lowest levels seen. At Veliki vrh, the mountainous region around the Sostanj Power Plant in north Slovenia (shown left), emissions have also fallen thanks to the increased capacity of the desulphurising devices there. Yet despite this, limit values continue to be exceeded for SO_2, along with PM10s and O_3.

Notable Slovenian hotspots can then be summarised as Veliki vrh (Sostanj) and the Zasavje region (Trbovlje), as shown opposite:

[16] Kakovost Zraka V Sloveniji V Letu 2006, ARSO – Slovenian Environmental Agency, LJUBLJANA, junij 2007, p. 3, online at: www.arso.gov.si/zrak/kakovost%20zraka/poro%c4%8dila%20in%20publikacije/LETNO2006.pdf

3. Current status of environmental (air quality) information

Existing air quality and ancillary data

A. Time series of **air quality** data from the monitoring network for the following parametres for the two regions described above:

Data Type	Availability [Y/N]	Detailed Description
PM10 ambient air concentrations (ug/m^3).	Y	Time resolution: half-hourly Data period: more than 4 years Data format: *.dbf databases (Excel compatible) Chemical composition/distribution size: not available
PM2.5 ambient air concentrations (ug/m^3).	N	
PM1 ambient air concentrations (ug/m^3).	N	
SO_2 ambient air concentrations (ug/m^3).	Y	Time resolution: half-hourly Data period: more than 4 years Data format: *.dbf databases (Excel compatible)
NO_X ambient air concentrations (ug/m^3).	Y	Time resolution: half-hourly Data period: more than 4 years Data format: *.dbf databases (Excel compatible)
NO_2 ambient air concentrations (ug/m^3).	Y	Time resolution: half-hourly Data period: more than 4 years Data format: *.dbf databases (Excel compatible)
O_3 ambient air concentrations (ug/m^3).	Y	Time resolution: half-hourly Data period: more than 4 years Data format: *.dbf databases (Excel compatible)
NH_3 ambient air concentrations (ug/m^3).	N	
Data Sources:	VONCINA R., et al, Results of the measurement and monitoring of emissions at the ancillary network stations of Sostanj (TES) and Trbovlje (TET). Porocilo st.: EKO 3173 and EKO 3210 (respectively), Ljubljana, 2007 okolje.info/ and envir.eimv.si/TET.HTM (resp.) Roman Kocuvan, EIMV - Electric Power Research Institute: www.eimv.si/eng (personal correspondance)	

B. Time series of **meteorological** data from the monitoring network for the following parametres for the two regions described above:

Data Type	Availability [Y/N]	Detailed Description
Relative humidity (RH)	Y	Time resolution: half-hourly Data period: more than 4 years Data format: *.dbf databases (EXCEL compatible)
Wind speed (m/s)	Y	As above
Wind direction (degrees)	Y	As above
Temperature (Celsius)	Y	As above
Mixing Layer Height (m)	N	
Data Source:	ARSO – Slovenian Environmental Agency: arso.gov.si Roman Kocuvan, EIMV - Electric Power Research Institute: www.eimv.si/eng (personal correspondance)	

C. **Exact coordinates** of all monitoring stations (both air quality and meteorological) supplying the above data (3A and 3B) for the two regions described above:

Coordinates	Availability [Y/N]	Detailed Description
Air quality monitoring stations	Y	GK coordinates system (see accompanying table below)
Meteorological monitoring stations	Y	GK coordinates system (see accompanying table below)
Data Source:	Annual Air Quality Report of 2006, ARSO – Slovenian Environmental Agency. Ljubljana, June 2007: arso.gov.si	

Kraj	NV	Geog. dolž	Geog. šir.	GKKy	GKKx	Začetek meritev	Tip m. mesta	Tip območja	Značil-nost območja	Geog. opis
DMKZ:										
EIS-TEŠ										
Šoštanj	360	15°3'31"	46°22'38"	5504508	5136982		I	S	I	2
Topolšica	390	15°1'29"	46°24'12"	5501901	5139882		B	S	IC	2
Veliki vrh	550	15°2'44"	46°21'8"	5503506	5134203		I	R(REG)	A	32
Zavodnje	770	15°0'12"	46°25'43"	5500256	5142691		I	R(REG)	A	32
Velenje	390	15°7'1"	46°21'43"	5508998	5135289		B	U	RCI	2
Graška gora	774	15°7'43"	46°24'54"	5509886	5141187		I	R(REG)	A	32
Pesje	394	15°5'5"	46°22'0"	5506524	5135804		B	S	IR	32
Škale	410	15°6'38"	46°22'42"	5508504	5137110		B	S	IR	32
EIS-TET										
Dobovec	700	15°4'35"	46°6'21"	5505905	5106823		I	R(REG)	A	32
Kovk	600	15°6'50"	46°7'43"	5508800	5109358		I	R(REG)	A	32
Ravenska vas	580	15°1'24"	46°7'29"	5501803	5108919		I	R(REG)	A	32
Kum	1210	15°4'39"	46°5'18"	5505993	5104878		B	R(REG)	I	1
Prapretno	480	15°4'54"	46°8'12"	5506116	5110250		I	R(REG)	A	32

Legenda:

NV:	nadmorska višina (m)	**Značilnost območja:**	R – stanovanjsko
Tip m. mesta:	B – ozadje		C- poslovno
	T – promet		I - industrijsko
	I - industrijsko		A - kmetijsko
Tip območja:	U – mestno		N - naravno
	S – predmestno	**Geografska značilnost:**	1 – gorsko
	R - podeželsko		2 - dolina
	NC - obmestno		4 – obala
	REG - regionalno		16 – ravnina
			32 – razgibano

D. **Existence of an emission inventory** in standard GIS *raster* format and the respective chemicals listed in 3A above, for the two described regions:

Emission Inventory Data	Availability [Y/N]	Detailed Description
If not raster grid GIS format, please indicate the data format available	Y	a) Annual average emissions data is available for all locations (monthly for Sostanj) at the Slovenian Environmental Agency's website: arso.gov.si b) The emission values are expressed in kilograms per year. c) All necessary information concerning the methodology used for the emissions inventory management is prescribed in the decree on the emission of substances into the atmosphere from stationary sources of pollution (Ur.l. RS, st. 31/2007). Data format: Excel format, but not inclusive of data on the precise location of the emission source. However, the Slovenian Environmental Agency does have Gauss-Kruegger coordinates, since the annual reporting template requires this information.
Data Source:	Ministry of Environment & Spatial Planning, Slovenian Environmental Agency: arso.gov.si Vojkova 1b, SI-1000 Ljubljana	

For each of the hotspots described above, the following key ancillary data is available:

E. **Road network** data:

Road Network Data	Availability [Y/N]	Detailed Description
Shapefile GIS Format (.shp)	Y	Available for Slovenia, vectored from the "infrastructure" layer of the national topographic map at a scale of 1: 25 000. It describes the basic characteristics of the roads. Dates for the most recent data available not indicated. Besides Shapefile GIS the following formats are also available: E00, ASCII, DXF
Data Sources:	Ministry of Transport, Slovenian Roads Agency: www.dc.gov.si/si/informacije_javnega_znacaja/evidenca_javnih_cest/ Ministry for Environment and Spatial Planning, Surveying and Mapping Authority: www.gu.gov.si/si/delovnapodrocja_gu/podatki_gu/vticnik/seznam_vzorcev	

F. **Population density** data in standard GIS *raster* format:

Population Density Data	Availability [Y/N]	Detailed Description
Raster grid GIS format (.grd)		a) Data is available for all settlements in Slovenia down to the scale of individual houses (though such specific information won't be disclosed under personal data laws). b) Spatial resolution includes the level of spatial units for settlements and municipalities, respectively, in hierarchical grid with the smallest cell of 125m x 125m (250m x 250m, 500m x 500m…). c) The last census was 2002, although more recent data is available from June, 2007 (regular annual research). d) Data is differentiated by gender and age. Besides raster grid GIS format data is also available in .tab or .shp formats.
Data Source:	SORS - Statistical Office of the Republic of Slovenia: www.stat.si/eng/index.asp	

G. **Epidemiological data**:

Epidemiological Data	Availability [Y/N]	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases	Y	The data is available on an annual basis, with basic information available per statistical regions. Cumulative data on health issues is also published on the Internet. More detailed data may also be requested.
Data Source:	Institute for Health Care: www.ivz.si/index.php?akcija=podkategorija&p=46	

H. **Administrative boundaries** in standard GIS *raster* format:

Administrative Boundary Data	Availability [Y/N]	Detailed Description
Not raster grid but .shp file format	Y (.shp)	The data is available in .shp format along with the attributes of 210 municipalities and 68 administrative units in xls format.
Data Source:	Ministry for Environment and Spatial Planning, Surveying and Mapping Authority: www.gu.gov.si/si/delovnapodrocja_gu/podatki_gu/vticnik/seznam_vzorcev and www.prostor.gov.si/iokno/iokno.jsp	

I. **Digital elevation model (DEM)** in standard GIS *raster* format:

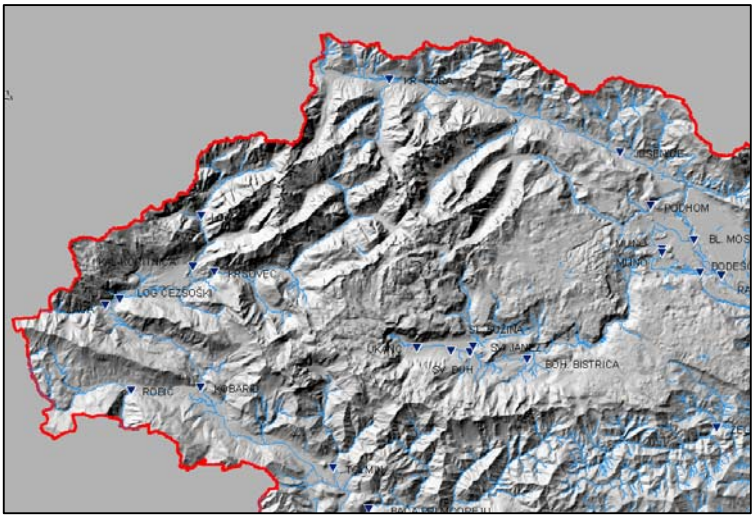
Digital Elevation Model Data	Availability [Y/N]	Detailed Description
Raster Grid GIS Format (.grd)	Y	Available grids include: 5x5m, 12.5x12x5m, 25x25m, 100x100m
Data Source:	Ministry for Environment and Spatial Planning, Surveying and Mapping Authority: www.gu.gov.si/si/delovnapodrocja_gu/podatki_gu/vticnik/seznam_vzorcev	

J. **Land use/land cover** in standard GIS *raster* format:

Land Use/Land Cover Data	Availability [Y/N]	Detailed Description
Raster Grid GIS Format (.grd)	Y	The Corine LandCover 2000 (CLC2000) project represents land cover data for the year 2000. It is the result of the visual interpretation of satellite images from 1999/2000 and auxiliary data. CLC2000 is a combination of the revised 1995 (90) database and the changes database. In Slovenia 36 classes (of land cover) are recognised out of a total of 44 witihn CORINE. The most common type are forests, which cover more than 50 percent of the surface. The data is part of the vectored spatial database, while the map represents the reality as observed by satellite. CLC2000 is useful as a basis for identifying various indicators and for landscape, sustainable management, environmental influences etc. CLC95 data on land cover is and will continue to be used: • for reporting to the European Environmental Agency (EEA) on water, land development and land permeability and the sea and shore situation; • for reporting to the European Commission; • as a basis in the Nopol project; • as basic thematic data for the Inspire initiative; • for proposal preparation regarding the underground water quality monitoring network; and • as environmental indicators for 2003. The basic data source was ortho-rectified Landsat 7 TM satellite images from 1999/2000 whose mean positional error is 100m or less and encompasses the full territory of Slovenia. The data format is ArcView.shp, and E00. There is no direct online access.
Data Source:	ARSO – Slovenian Environmental Agency (as owner and producer): arso.gov.si Contact person for ordering data: Aleš Veršič, E-mail: aversic@gov.si Ministry for Environment and Spatial Planning, Surveying and Mapping Authority: www.gu.gov.si/si/delovnapodrocja_gu/podatki_gu/vticnik/seznam_vzorcev Contact person for ordering data: Marjana Duhovnik, E-mail: marjana.duhovnik@gov.si	

K. **Hydrology data** (lakes, rivers, etc.) in Shapefile GIS format:

Hydrology Data	Availability [Y/N]	Detailed Description
Shapefile GIS Format (.shp)	Y	Data is available on national rivers (waters) as well as the water monitoring network (for river flows and water heights). Data is available in GML format.
Data Source:	ARSO – Slovenian Environmental Agency (as owner and producer): gis.arso.gov.si/	



Picture: Peter Frantar, GIS na hidrologiji, ARSO Urad za monitoring

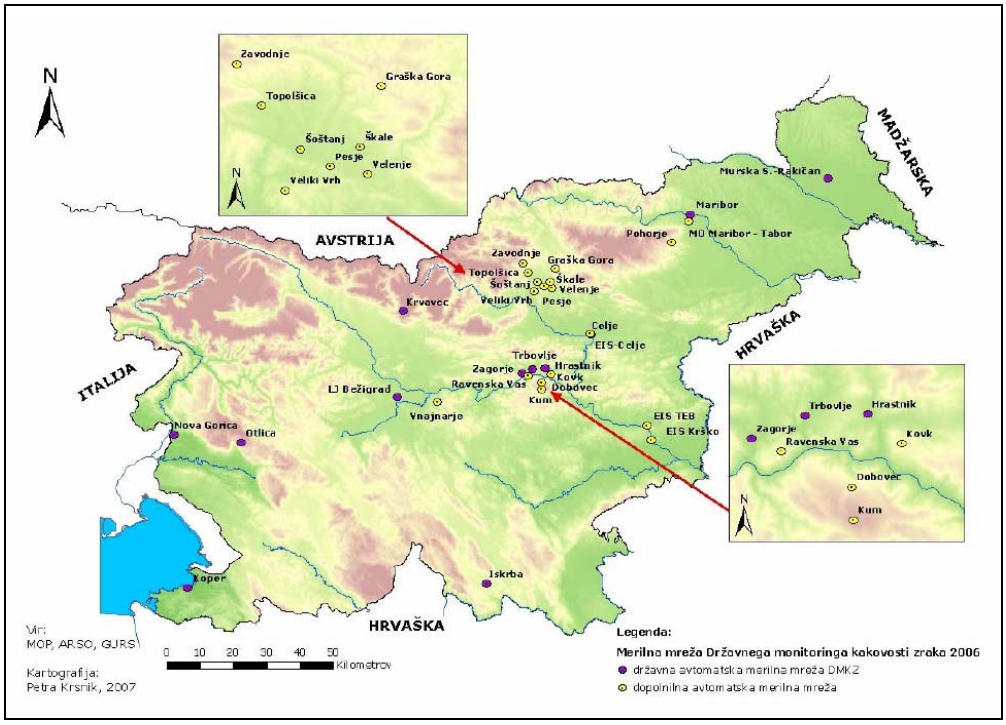
L. **Biodiversity (ecosystem) indicators** in standard GIS *raster* format:

Biodiversity Indicators	Availability [Y/N]	Detailed Description
Protected areas (.shp, .gml)	Y	The three datasets (polygons, points, zonation) represent areas protected by nature protection regulations. Datasets contain areas protected at state level as well as those protected by local communities. According to the Nature Conservation Act, six categories of protected areas exist (national, regional, landscape park, natural monument, strict natural reserve and natural reserve). The database is not yet complete. The data is captured at different scales, not less than 1: 50 000.
NATURA 2000 (.shp, .gml)	Y	The dataset contains Natura 2000 areas designated by the 2004 Regulation on NATURA 2000 areas as part of Habitat Directive implementation (92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora). The database is complete but some changes are expected in the first half of 2008 due to the EC's acceptance of Slovenian Natura 2000 network proposals. The data is captured is at different scales, not less than 1: 50 000.
Ecologically important areas (.shp, .gml)	Y	The two datasets (polygons, points) represent the areas designated by the 2004 Regulation on Ecologically Important Areas. According to the Nature Conservation Act, an ecologically important area is a habitat part of a larger ecosystem contributing significantly to the conservation of biological diversity. The database is complete but some changes are expected in the first half of 2008 due to the Slovenian Natura 2000 network proposals which should include ecologically important areas. The data is captured at different scales, not less than 1: 50 000.
Data Source:	Ministry of Environment & Spatial Planning, Slovenian Environmental Agency: arso.gov.si Vojkova 1b, SI-1000 Ljubljana	

4. Current status of environmental (air quality) information systems

Air quality data collection and management

The Slovenian Environmental Agency (ARSO) is responsible for monitoring (through measurement networks) and inventorying emissions into the atmosphere of SO_2, NO_X, NMVOC, CH_4, NH_3, N_2O, CO and CO_2 (in accordance with the methodology prescribed by the Convention on Long-Range Transboundary Air Pollution) and performing analysis, research, and forecasting according to Article 94 of the Environmental Protection Act and rules on the setting up of ambient air quality monitoring and methods for its implementation, No. 127/03. PM1s are not monitored, while PM2.5s are monitored in three locations (Ljubljana and Maribor, Iskrba as a reference point). NH_3 is monitored, however no limit values are set. The graphic below shows the automatic measurement network (both national – *purple* – and ancillary stations – *yellow*)



Regarding Veliki vrh (Sostanj) in the north and the central Zasavje region (Trbovlje), two automatic monitoring stations (TES and TET respectively), part of the ancillary network, are operated by the respective power plant operators and maintained by the environmental protection department of the electric power research institute (EIMV). Here the continuous measurement of emission concentrations of the substances listed in section 3A (SO_2, NO_X and common dust) are measured along with CO and CO_2. Concentrations of other elements are also periodically monitored within the flue gas. Their emissions data, besides that collected via the national monitoring network, is submitted to the Slovenian Environmental Agency, which maintains emission inventories for the substances in line with data quality assurance and control guidelines.

Regarding institutions' air quality data management practices and use of GIS, the tables above indicate many government institutions are very experienced in the use and application of GIS. However, their experience in using and processing meteorological and air quality satellite data derived from the Ikonos, IRS, Meteosat, SPOT, Landsat and/or MODIS satellites has not been intensive in recent years, which is not to say they have no familiarity at all.

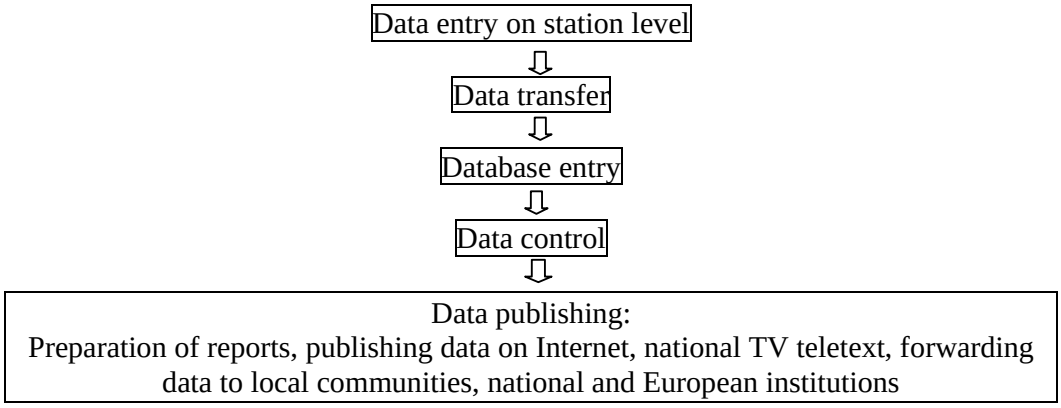
Slovenia began familiarising itself with teh INSPIRE Directive in 2003 when the first project group was created by its environment ministry.[17] A corresponding website was prepared and the ministry has been part of the process, as is evidenced at www.inspire.mop.gov.si. Following the adoption of the INSPIRE Directive, the Surveying and Mapping Authority prepared a comprehensive list of implementation measures.[18] Their inventory of Slovenian digital spatial data is available at: www.geodetska-uprava.si/gu_eng/applic/cepp/cepp.asp

Inter-agency cooperation

There are no significant challenges to agency cooperation, partly because there is no regional administrative level to be dealt with vis-à-vis monitoring. Personal interviews affirmed that cooperation between the monitoring authorities and companies reporting emissions is also satisfactory. However, there is room for improvement in cross-sectoral (i.e. health, agriculture) data availability and usability.

Public accessibility

The use of web applications by the Slovenian Environmental Agency to provide daily real-time information, along with daily, monthly and annual average concentrations of pollutants, to the public, is well advanced. A monthly bulletin is also produced and raw data is available to the public upon request. For both listed hotspots, real time data on air quality is published online (see links above), archived since 2002 for Sostanj and for the last 10 days for Trbovlje. The legal basis for public access has been the Aarhus Convention's ratification, the new act on access to information of public character and the new environmental protection act. Information flow from automatic monitoring stations to the public can be summarised as follows:



[17] Tomaž Petek, Elektronsko poslovanje s prostorskimi podatki in direktiva INSPIRE, Statistical Days 2005
[18] Božena Lipej, Možnosti implementacije direktive INSPIRE v Sloveniji, Geodetski vestnik 51/2007 – 3, str. 632ff

Schematic diagrams of the EIS, including air quality data management components

According to the Environmental Protection Act of 2004, the environment ministry is solely responsible for the management and maintenance of the national environmental information system. Emission data and its sources are specifically listed as data that shall be part of the system.

5. Obstacles and challenges for SMAQ technology transfer

The main key challenges for SMAQ's implementation in Veliki vrh (Sostanj) in the north and the central Zasavje region (Trbovlje), could be described as follows:

- limited human resources and, in this context, limited knowledge and experience to establish, implement and maintain such a concept;
- the unclear distribution of responsibilities across sectors (especially where health data is concerned) within local authorities; and
- the scope of the project, which may be too demanding for local authorities (thus the Slovenian Environmental Agency may be the more viable partner).

6. Future domestic priorities and opportunities for EIS development

The annual national programme on ambient air quality monitoring, prepared by the environment minister, emphasises the following priorities for 2008 and 2009:

- monitoring of trace metals within ambient air from 2008 as per Decree 56/06;
- monitoring in the vicinity of stationary pollution sources from 2008, in accordance with the rules on the setting up of ambient air quality monitoring and methods for its implementation No. 127/03;
- forecasting of ozone from 2008;
- Continuous monitoring of PM10s to create a firm basis for the further preparation of plans and programmes;
- establishing the statistical anlysis of particulates to specify potential measurement sites; and the
- modelling of ambient air quality.

The realisation of a number of these action items would certainly facilitate the application and practical demonstratation of the benefits of SMAQ. Furthermore, it's worth noting that the authorities of both Sostanj and Trbovlje are involved in initiatives to collaborate on administrative issues, assess the state of the environment, share environment and spatial planning responsibilities and utilise GIS applications to these ends (supported by a private company called Realis: www.geoprostor.net). Both sets of authorities are also accustomed to dealing with and publishing air quality data on city web pages direct from the monitoring networks.

7. Recommendations

Following discussions with the national experts on air quality monitoring, the following recommendations are made:

- Prepare a SMAQ presentation (summarising the approach) for local/regional stakeholders, including the public.
- Further educate air quality data managers on the possibilities for interlinking diverse data sets within GIS systems.
- Share existing experiences with meta-data web applications (available on the Internet) from other sectors (health, agriculture).

List of Contributors

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- Tanja Bolte, ARSO, interview
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- Katja Kalin, Statistical Office, Demography Statistic Department
- Igor Kuzma, Statistical Office, Regional Statistic Department
- Ursa Mezan, ARSO (data on biodiversity indicators)
- Bojana Kelbel, Surveying and Mapping Authority (land cover data)
- Roman Kocuvan, EIMV (data on substances and monitoring)

Conclusions and recommendations

Conclusions

This section digests the key country findings in the form of tables. It does this across four categories that broadly correspond to sections 2 through to 6 of the country reports, namely;

1) Air quality (reflecting section *2: The Environment*, including known air quality hotspots);

2) Monitoring practice and data availability - from the pollution and meteorological monitoring networks, pollutant inventories, and ancillary data (reflecting section *3: Current status of environmental (air quality) information)*;

3) GIS application, satellite data use and INSPIRE implementation (reflecting section *4: Current Status of environmental (air quality) information systems*); and

4) Opportunities and threats (reflecting section *5: Obstacles and challenges for (SMAQ) technology transfer* and section *6: Future domestic priorities and opportunities for EIS development*).

A non-scientific assessment of each country's relevance for SMAQ for each of these categories is also made via a simple scoring system. The scores for each category are then averaged to give an overall SMAQ suitability ranking. The editor then draws his own conclusions.

AIR QUALITY

This sub-section reflects on the environment and known air quality hotspots and their suitability for SMAQ.

COUNTRY	BG	CZ	EE	HU	PL	RO	SL	SK
KEY FINDINGS	Three hotspots with pollution caused by thermal power plants (Pernik and Dimitrovgrad) and metallurgical plants/heavy traffic (Sofia)	Ostravsko-Karvinsko suffers exceed-ances of air quality limit values owing to metal-lurgical and fuel processing industries, heavy traffic and from Katowice, Poland	No locations critically exceed threshold values identified in EU or national legislation	The Budapest agglomeration, home to more than 2 million inhabitants, has heavy traffic, causing exceedances of legal limit values for NO_x and PM10	Six urban agglom-erations are highlighted where pollutant concen-trations are high and occasionally exceed legal limits	Many urban centres have municipal heating plants that burn traditional fuels, a problem exacerbated by a range of industrial activities, traffic and energy production. Generous grace periods on EU directives also contribute to the frequent exceedances of legal limits	Notable hotspots are Veliki vrh and the Zasavje region where the coal-based Sostanj and Trbovlje power plants are located, contributing to exceedance s of PM10s, ozone and to an extent, SO_2	U.S. Steel in the eastern part of the country makes a significant contribution to the country's annual emissions totals contributing inter alia to high levels of PM10s
SUITABILITY SCORE*	8	8	-	8	8	8	8	7

*A score of eight or higher is given where limit values are exceeded

MONITORING PRACTICE AND DATA AVAILABILITY

This sub-section reflects on the current status of environmental (air quality) information.

COUNTRY	BG	CZ	EE	HU	PL	RO	SL	SK
KEY FINDINGS	The air quality information system is well established and the essential data required for SMAQ operation (including private sector reporting plus ancillary data) is regularly collected	The Czech air quality information system is well-established and accustomed to monitoring SMAQ pollutants (incl. PM2.5s) in line with EU standards. Auxiliary data is also widely available.	The Estonian air quality information system was firmly established in 2002 upon a sound legal basis and monitoring of SMAQ pollutants is in line with EU standards	The National Environment Protection and Information System monitors PM10s, PM2.5s, SO_2 and NO_X cross-country.	The State Environmental Monitoring system assures that emissions data for all but PM1s and NH_3 is monitored and reported across the country according to EU standards. Auxiliary data is also widely available.	The National Integrated Monitoring System regularly collects all key air quality data required for SMAQ. The availability of auxiliary (meteorological, epidemiological, and population) data appears to be patchy*	All key pollutants of interest to SMAQ (PM10s, SO_2, NO_2, O_3) are monitored and regularly reported online by the Slovenian Environmental Agency, with the exception of PM1s (PM2.5s and NH_3 in selected locations only). All key ancillary data is also available in GIS format.	All pollutants of interest to SMAQ (including to an extent PM2.5s) are monitored and reported online by the National Air Quality Monitoring Network and auxiliary data is also widely available.
SUITABILITY SCORE	8	8	8	8	8	7	8	8

*Romania fails to reach an 8 only because the availability of auxiliary data is patchy

GIS APPLICATION, SATELLITE DATA USE AND INSPIRE IMPLEMENTATION

This sub-section reflects on the current status of environmental (air quality) information systems.

COUNTRY	BG	CZ	EE	HU	PL	RO	SL	SK
KEY FINDINGS	The formatting and processing of monitoring data in appropriate formats for GIS usage occurs. It has not been deemed effective to compile information derived from ground based monitoring stations and satellites. It is not clear what steps have been taken to implement the INSPIRE Directive.	Data processing is performed using ArcGIS, while pollutant map preparation, merging measurement data with dispersion models and meteorological data, etc. is typical. There is limited use of satellite data, although regarding the INSPIRE Directive, an inter-departmental working group has been established and is preparing a corresponding law.	The use of satellite data for verification of ground-based measure-ments of air quality is not unusual, while the Estonian Land Board has begun introducing the main principles of the INSPIRE Directive.	Despite the limited use of satellite data by both commercial or public sources, GIS-based tools are more and more appreciated and utilized. An inter-ministerial committee, established at the end of 2007 examines the required steps to comply with the INSPIRE Directive.	Little practical use is made of satellite data and INSPIRE Directive implem-entation does not appear to be widely addressed. GIS application tends to be disparate and according to each institution's own wishes	The development of and investment into a national integrated environ-mental informational system is intended in part to satisfy INSPIRE Demands. The ongoing acquisition of satellite imagery is financed by Phare. The degree of know-how with respect to GIS software is limited.	Slovenia is quite familiar with the INSPIRE Directive, having shortlisted its implementation measures in 2007, while GIS itself is already widely utilised by institutions concerned with environmental management, including local authorities within the hotspot regions. Less can be said about institutions' use of meteorological and air quality satellite data.	GIS practice is advanced, as are modeling and the use of Meteosat satellite data. It is not well documented whether the INSPIRE Directive is appreciated or what steps have been taken to prepare for its implemen-tation.
SUITABILITY SCORE	5	6	7	6	5	6	8	6

OPPORTUNITIES AND THREATS

This sub-section reflects on the obstacles and challenges for (SMAQ) Technology transfer and future domestic priorities and opportunities for EIS development.

COUNTRY	BG	CZ	EE	HU	PL	RO	SL	SK
KEY FINDINGS	A real challenge for implementing SMAQ offline is acquiring the necessary data sets from the various players and finding the necessary technical know-how to integrate them for the target area. The INSPIRE Directive may present opportunity to acquire some funds to implement SMAQ.	Upcoming rules and requirements for INSPIRE implement-ation and development guidelines regarding Europe's Shared Environ-mental Information System are opportunities upon which to "piggy-back" potential SMAQ transfer.	Despite no real evident need for a tool to support health-risk and exposure assess-ment, there is interest in further inform-ation and an introd-uction to SMAQ.	The newly established *Budapest Agglomeration Development Council* adopted a preferential development programme regarding the environment in 2006. A first priority is the development of an integrated environmental monitoring system. EC funding programmes would appear to put this within reach. Gaining the support and collaboration of all 23 of Budapest's districts could be the biggest challenge.	Despite some threats and the restructuring of the Polish Environment Agency, increasing funds at the local level and the development of the national emissions inventory are SMAQ opportunities worth exploring	Development of a national integrated environmental informational system to satisfy INSPIRE demands is an opportunity, although limited experience in satellite image use is a threat. The degree of know-how with respect to GIS software is limited.	Capacities among local authorities may be a constraint, otherwise few challenges appear to exist. Significant synergy could be achieved with the roll-out of the annual national programme on ambient air quality monitoring during 2008.	The Kosice agglomeration, under the influence of U.S. Steel, could make an interesting local pilot, possibly as a public-private partnership. But the high degree of Slovak Hydro-meteorological Institute involvement in international projects means they need to be convinced of the benefits of SMAQ and required investments
SUITABILITY SCORE*	6	6	4	7	6	6	8	6

*High scores represent high opportunty, low scores represent a higher proportion of challenges

SMAQ SUITABILITY RANKING: TECHNOLOGY TRANSFER POTENTIAL

COUNTRY	BG	CZ	EE	HU	PL	RO	SL	SK
AIR QUALITY	8	8	-	8	8	8	8	7
MONITORING PRACTICE AND DATA AVAILABILITY	8	8	8	8	8	7	8	8
GIS APPLICATION, SATELLITE DATA USE AND INSPIRE IMPLEMENTATION	5	6	7	6	5	6	8	6
OPPORTUNITIES AND THREATS	6	6	4	7	6	6	8	6
AVERAGE SCORE	6.75	7	4.75	7.25	6.75	6.75	8	6.75

Based on a non-scientific assessment of country's relevance for SMAQ and the scores for each of the categories above, results are summed and averaged to give an overall SMAQ suitability ranking. The conclusions are perhaps not surprising, with the more economically developed and technically advanced countries (i.e. Slovenia, Hungary and the Czech Republic) emerging as favourites. However, it should not be overlooked that scoring is also based on hotspot eligibility and despite major air quality improvements over the last two decades, there is still room to diminish the impact on citizens everywhere. Budapest appears to be a prime test site for SMAQ, given its population of over two million. In any case, more should be learned about the incidence of hospital admissions for respiratory infections and other pulmonary diseases, since it is perhaps this statistic more than any other that might tip the balance in favour of SMAQ implementation over improvements to ground-based monitoring networks and harmonisation of reporting in line with EU policy targets.

Recommendations

This section reflects on country report authors' recommendations, and makes some overall suggestions in light of these for promoting SMAQ take-up.

Broadly speaking, all country report authors suggest similar actions: awareness raising to convince the relevant authorities (environment ministries, health ministries, environmental agencies, regional inspectorates, etc.) of the benefits of SMAQ. The more detailed suggestions are to:

- Ensure that the *educational and practical aspects* of SMAQ and GIS technology are well-explained so that senior experts appreciate the skills required to effectively implement the system in conjunction with the monitoring network and stations (Bulgaria, Poland), to link diverse datasets via GIS (Slovenia), and to demonstrate how the system's data requirements can be fulfilled (Romania).

- Clearly demonstrate the *tangible benefits* and *cost effectiveness* of SMAQ while also making clear the required *investments and annual operating expenses* for authorities. It is important that authorities understand the *conditions* under which implementation could be successful vis-à-vis the usage of (expensive) satellite data (Czech Republic, Poland, Slovakia), vis-à-vis hotspots (Poland). The countries should see how decision-making processes have improved and it is important to persuade local/regional stakeholders, including the public, of the system's benefits (Slovenia).

- *Make formal introductions*, write *personalised letters* of interest from SMAQ's project managers, and follow up with *detailed negotiations* with key players (among those listed were the Czech Hydrometeorological Institute, the Budapest Agglomeration Development Council, the Romanian National Environment Protection Agency, the Romanian cities of Bucharest and Iasi, the Slovak Hydro-meteorological Institute and US Steel in the Kosice agglomeration). These efforts could help to persuade stakeholders that such a system could be useful, especcially against the background of insufficient data availability (Romania) and many other international commitments (Slovakia).

In some cases it was felt SMAQ does not appear to provide a completely new approach, innovation or technology. An interesting suggestion is exploring the possibility of "public-private partnerships" with industry, and targeting the energy sector directly.

These recommendations and in certain cases observations, require that an effective presentation on SMAQ should be prepared (or the communications tools which have been prepared are adequately utilised and disseminated). The country report author for Poland made a number of suggestions in regard to their content:

- Present good practical examples regarding the application of SMAQ within a pilot area where air quality and epidemiological data, information sourced from emissions inventories and census records are gathered from different databases supervised by different institutions (at both national and local level) within one system. Do this to deliver practical information on GIS technology and demonstrate how legal solutions can be adapted to achieve implementation, and explain the coordination process.

A second suggestion came from the Slovenian country report author:

- Share existing experiences with meta-data web applications (available on the Internet) from other sectors (health, agriculture).

A final suggestion from the Hungary country report author is to:

- Explore the potential of seed funding under the Structural Funds' Environment and Energy Operational Programme.

Although this report has surveyed eight new member states, a separate survey performed by REC during 2008 has shown there may be opportunities elsewhere within eastern Europe to pilot SMAQ. Short assessments of the urban environments of the west Balkan countries online at www.rec.org/sector/assistance/masterclass.html show that most suffer from poor air quality including high levels of particulate matter including PM2.5s, SO_2 and O_3. In a number of locations this is caused by heavy industry and/or growing levels of traffic, exacerbated by low-quality fuel (lead has yet to be phased out) and an aging vehicle fleet. Examples of the former include Elbasan and Fushe Kruje (Albania); Bitola (former Yugoslav Republic of Macedonia); Kostolac, Obrenovac (thermal power plants), Pancevo, Novi Sad, Sabac (the oil and chemical industry) and the very polluted mining areas of Bor and Majdanpek (Serbia). Mitrovica in northern Kosovo hosts two large thermal power plants, one of which emits about 25 tonnes of dust and ash per hour, 74 times in excess of European standards, besides SO_2 and NO_X. This leads to high risks of diseases, infections and allergic reactions in residents' upper and lower respiratory tracts.

Regarding traffic pollution, hotspots include Tirana (Albania); Skopje, Bitola, Veles and Ohrid (former Yugoslav Republic of Macedonia) and Banja Luka, Sarajevo and Tuzla (Bosnia-Herzegovina). Other industrial hotspots in the former Yugoslav Republic of Macedonia include Jegunovce (home to a metallurgical plant), Veles (lead smelting facilities), Probistip (lead and zinc mines), and Skopje (in the vicinity of the OHIS-Skopje chemical complex). Studies have shown that children in Skopje and Veles suffer from respiratory diseases associated with air pollution.

While these countries struggle to meet rising energy demands, they continue to rely on fossil fuels. From this perspective, their conditions would appear to be ideal for piloting SMAQ. However, as in all transition countries, environment is typically low on the policy priority agenda, and other challenges may arise, such as the adequacy of the air quality monitoring and reporting network, or GIS know-how (a recent survey is online at:

www.rec.org/REC/Programs/REReP/InformationSystems/PDF/Snapshot-EIS.PDF). Nevertheless, it could be interesting to explore the potential for technology transfer here, where funding also might more easily be available through pre-accession assistance.

At the same time, scoping the response toward SMAQ from more developed European Union member states might show conversely a higher level of interest. Where air quality is better, technical know-how about the use of satellite data may also be better, and therefore elements of SMAQ could be integrated more easily into decision support systems.

Two suggestions may be made in this context. The first is to extend this same survey to the West Balkan countries, and several EU countries struggling with poor air quality. Second, invite representatives of these countries to the SMAQ workshop series, scheduled for autumn 2008 and spring 2009.

These recommendations, as well as the above conclusions will be considered as the SMAQ project team prepares for the accompanying workshops scheduled for Prague (February 2009) and Venice (March 2009) regarding monitoring network design and SMAQ applicability, and which in themselves serve as opportunities to disseminate the project's results and informally get underway consultations with the above listed agencies and institutions. The Budapest-based training (Spring 2009) meanwhile is an opportunity to explain the *educational and practical aspects* of SMAQ and GIS technology.

Annex I: List of Contributors

Bulgaria

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Albin Keuc, project manager, REC Slovenia, with contributions from:

- Tanja Bolte, ARSO, interview
- Ales Versic, ARSO, interview
- Peter Prešeren, Surveying and Mapping Authority (data on DEM)
- Katja Kalin, Statistical Office, Demography Statistic Department
- Igor Kuzma, Statistical Office, Regional Statistic Department
- Ursa Mežan, ARSO (data on biodiversity indicators)
- Bojana Kelbel, Surveying and Mapping Authority (LandCover data)
- Roman Kocuvan, EIMV (data on substances and monitoring)

Annex II: Country Report Template

SMAQ COUNTRY REPORT: NAME OF COUNTRY *(max. length: 8pgs)*

Note: Country maps are available online at: https://intranet.rec.org/ under the Communication Tools link/Logo Standards and Image Bank/REC Maps

1. Key findings *(no more than 0.5pg)*

Three or four bullet points to be completed by Jerome at the end

2. The environment *(no more than 0.5pg).*

Please describe air quality "hotspots" that exist within your country (please use a separate paragraph for each). To qualify as a hotspot, they should have ambient air levels of SO_2, NO_X, PM10s and/or PM2.5s or ozone higher than the annual average values identified in EU or national air pollution legislation[19]. In your description, please *summarise* the main levels and causes of contamination. There is no particular limitation regarding size of the hotspot area, but we are interested particularly in regions of around 80 km * 80 km.

3. Current status of environmental (air quality) information
(appx. 4 pgs)

Existing air quality and ancillary data

For each of the hotspots described above please tell us about the existence of the following air quality monitoring data

A. Time series of **air quality** data from the monitoring network for the following parameters (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available):

Data Type	Availability (y/n)	Detailed Description *(Please indicate for all categories what time-resolution is available? (generally hourly averages are available or bi-hourly if hourly averages are not). What is the data period available (min: 1-2 years, but ideally 2-4)? What is the data format: ASCII text (.TXT) or Excel (*.xls)?*
PM10 ambient air concentrations (ug/m^3).		Please also indicate whether the chemical composition of PM (in terms of "organic and inorganic fraction" is available). And also the distribution size of PM (if available)
PM2.5 ambient air concentrations (ug/m^3).		Please also indicate whether the chemical composition of PM (in terms of "organic and inorganic fraction" is available). And also the distribution size of PM (if available)
PM1 ambient air concentrations (ug/m^3).		Please also indicate whether the chemical composition of PM (in terms of "organic and inorganic fraction" is available). And also the distribution size of PM (if available)
SO_2 ambient air concentrations (ug/m^3).		
NO_x ambient air concentrations (ug/m^3).		
NO_2 ambient air concentrations (ug/m^3).		
O_3 ambient air concentrations (ug/m^3)		

[19] Relevant EU legislation (online at: www.smaq-life.org/index.php?page=links) includes:
- COM(2005) 446 final: Thematic Strategy on Air Pollution Brussels, 21.9.2005
- DIRECTIVE 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air of 16 November 2000
- COUNCIL DIRECTIVE 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air of 22 April 1999
- DIRECTIVE 2002/3/EC of 12 February 2002 relating to ozone in ambient air

NH_3 ambient air concentrations (ug/m^3).		
Data Source:	Insert the relevant institutional address(es)	

B. Time series of **meteorological** data from the monitoring network for at least for the following parameters (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available):

Data Type	Availability (y/n)	Detailed Description *(Please indicate for all categories what time-resolution is available? (generally hourly averages are available or bi-hourly if hourly averages are not). What is the data period available (min: 1-2 years, but ideally 2-4)? What is the data format: ASCII text (.TXT) or EXCEL (*.xls)?*
Relative humidity (RH)		
Wind speed (m/s)		
Wind direction (degrees)		
Temperature (Celsius)		
Mixing Layer Height (m)		*NB: This information is usually derived either by measurements using meteorological balloons and radiosondes or using meteorological models (usually available at the National Meteorological Services in all Member States)*
Data Source:	Insert the relevant institutional address(es)	

C. **Exact coordinates** of all the monitoring stations (both air quality and meteorological) supplying the above data (3A and 3B) (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available).

Coordinates	Availability (y/n)	Detailed Description *(Please indicate the type and name of the coordinates system used, e.g. WGS84 or UTM34N etc). If necessary please distinguish for the different data types indicated above.*
Air quality monitoring stations		
Meteorological monitoring stations		
Data Source:	Insert the relevant institutional address(es)	

D. **Existence of an emission inventory** in standard GIS *raster* format and the respective chemicals listed in 3A above (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available).

Emission Inventory Data	Availability (y/n)	Detailed Description
Raster Grid GIS Format (.grd) regarding chemicals listed in A.		a) Please indicate what is the most recent data available and whether it concerns: i) yearly average emissions or ii) a finer temporal scale (e.g. on seasonal base). b) Please confirm whether the emission values are expressed in units of mass of pollutant emitted (e.g. tonnes) per year.

		c) Please indicate whether related information is available, e.g. what instrumentation and analytical method was used to derive the values provided, the methodology used for emissions inventory development and estimation of local emission factors (or where this methodology can be found and referenced). This allows for reliability checking and meta-analysis.
If not raster grid GIS format, please indicate the data format available		
Data Source:	Insert the relevant institutional address(es)	

For each of the hotspots described above please tell us about the existence of the following key ancillary data:

E. **Road network** data (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available).

Road Network Data	Availability (y/n)	Detailed Description
Shapefile GIS Format (.shp)		Please indicate the most recent data available.
If not Shapefile GIS Format, please indicate the format available		
Data Source:	Insert the relevant institutional address(es)	

F. **Population density** data in standard GIS *raster* format (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available).

Population Density Data	Availability (y/n)	Detailed Description
Raster grid GIS format (.grd)		Please indicate whether the population information is: a) available not only for the main cities within the hotspot area, but the entire hotspot region. b) the spatial resolution of this data (whether it is minimally "urban district" level) c) the most recent data available (ideally the latest census). d) differentiated for gender and age (useful for epidemiological data analysis)
If not raster grid GIS format, please indicate the format available		
Data Source:	Insert the relevant institutional address(es)	

G. **Epidemiological data** (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available)

Epidemiological Data	Availability (y/n)	Detailed Description
Hospital admissions for respiratory infections and other pulmonary diseases		Please indicate whether this is available on a yearly basis (or finer temporal resolution).
Data Source:	Insert the relevant institutional address(es)	

H. **Administrative boundaries** in standard GIS *raster* format (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available)

Administrative Boundary Data	Availability (y/n)	Detailed Description
Raster grid GIS format (.grd)		
If not raster grid GIS format, please indicate the format available		
Data Source:	Insert the relevant institutional address(es)	

I. **Digital elevation model (DEM)** in standard GIS *raster* format (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available)

Digital Elevation Model Data	Availability (y/n)	Detailed Description
Raster grid GIS format (.grd)		
If not raster grid GIS format, please indicate the format available		
Data Source:	Insert the relevant institutional address(es)	

J. **Land use/land cover** in standard GIS *raster* format (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available)

Land Use/Land Cover Data	Availability (y/n)	Detailed Description
Raster grid GIS format (.grd)		
If not raster grid GIS format, please indicate the format available		
Data Source:	Insert the relevant institutional address(es)	

K. **Hydrology data** (lakes, rivers, etc.) in Shapefile GIS format (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available)

Land Use/Land Cover Data	Availability (y/n)	Detailed Description
Shapefile GIS Format (.shp)		
If not Shapefile GIS Format, please indicate the format available		
Data Source:	Insert the relevant institutional address(es)	

L. **Biodiversity (ecosystem) indicators** in standard GIS *raster* format (please duplicate the table if more than one hotspot area is being described, and at the foot indicate where/from whom this data is available)

Biodiversity Indicators	Availability (y/n)	Detailed Description
Raster grid GIS format (.grd)		Please describe the indicator data available, and their respective spatial resolution
If not raster grid GIS format, please indicate the format available		
Data Source:	Insert the relevant institutional address(es)	

4. Current status of environmental (air quality) information systems *(no more than 1.75pg)*

Air quality data collection and management (0.75 pg)

Within this sub-section, *for the indicated hotspot area(s) and the national level*, please describe briefly in words the institution(s) responsible for monitoring the substances listed in 3A. Please also describe briefly the level of industrial self-monitoring for the same substances. Reflecting on 3D, please describe the responsibilities for the maintenance of emission inventories for the substances listed in 3A and current practices. Reflecting on 3A and 3D, please describe these institutions' air quality data management practices i.e. whether GIS is used to store data and if not, what is the format in which data is stored and the typical software/hardware or paper-based forms used. Please conclude this sub-section by summarising those same institutions' experience in using/processing meteorological and air quality satellite data derived from either of the following satellites: Ikonos/IRS/Meteosat/SPOT/Landsat/MODIS.

Please also indicate whether there are any gaps in your country's monitoring of the substances in 3A, and briefly the legal basis/standards. Please also describe institutions' level of understanding of the EC's INSPIRE Directive[20] (which aims to make interoperable spatial information readily available to the public and in support of both national and Community policy), and whether steps are being undertaken to prepare for its implementation.

Inter-agency cooperation (0.5 pg)

Within this sub-section, *for the indicated hotspot area(s) and the national level*, please describe briefly in words the level (or lack of) air quality data/information exchange among those bodies and institutions responsible for air quality monitoring and public reporting and access (this may include for example national statistical institutes besides those listed in 3A, 3C and 3D).

Please indicate briefly the reasons for the lack of exchange (e.g., legal basis, inconsistent reporting standards, equipment).

Public Accessibility (0.5 pg)

Within this sub-section, *for the indicated hotspot area(s) and the national level*, please describe briefly in words the level of public accessibility (e.g. Internet webpage, upon written request, within annual state of environment reports) to the data described in 3A, 3D, the institutions' responsible for this, and describe what emphasis is placed on making it easily digestible for the end-user.

Please also indicate briefly the legal basis for public access.

Schematic diagrams of the EIS, including air quality data management components (0.5pg)

Please draw or insert a schematic diagram of your country's environmental information system, including air quality data management components.

[20] DIRECTIVE 2007/2/EC of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), Online at: www.smaq-life.org/index.php?page=links

5. Obstacles and challenges for SMAQ technology transfer *(no more than 0.75pg)*

What is SMAQ?
"SMAQ" is the acronym for a GIS-enabled environmental and health information management system that integrates ground-based air pollution measurements with readily available satellite data and forecasting models, allowing the derivation of a highly accurate and continuous picture of regional[21] and urban air quality and more importantly, exposure levels. The "SMAQ fact sheet" provides more information at: www.smaq-life.org

SMAQ implementation may proceed in one of two ways: 1) the SMAQ system, complete with a selection of satellite images, is run locally on a standard PC for a focus area, along with a range of non-real time air quality and ancillary data (population density and epidemiological data). Offline exposure assessment for exposure to air pollution and the potential health impacts is made according to an algorithm that takes into account the current weather conditions and season; 2) the SMAQ system is run locally on a standard PC connected to a ground station that receives satellite data (covering an area of 50 km radius), which together with units for interpreting current meteorological and air pollution data from ground stations and for mapping risk, perform an online exposure assessment. Coupling this information with population density and epidemiological data, the potential health impacts of air pollution in the focus area can be reckoned. In both cases, the data can be published to the web.

Survey Background: The availability of air quality and ancillary data, queried above in Section 3, provide a quantitative and objective snapshot as to how technically feasible it may be to pilot SMAQ for a hotspot in your country. A scoring system will enable SMAQs developers to derive a weighted score for regions across 10 new member states. However, it omits a more qualitative and 'human' assessment of the obstacles and challenges countries or regional administrations may face when implementing new technology. This section seeks to better understand these qualitative and human challenges.

From a discussion with *air quality managers within regional administrations of the hotspot areas' listed in Section 2*[22], please briefly describe the key (maximum; three) challenges to implementing SMAQ. Any of the following (or indeed others) may be considered:

- limited technical know-how to install and run the GIS software, enter the relevant data, handle (purchase and upload satellite data);
- unclear roles and responsibilities as to who is responsible for air quality management and (emergency) exposure assessment;
- weak coordination and cooperation between those institutions monitoring air quality, and those managing it/safeguarding citizens' health;
- weak air quality monitoring infrastructure, processing and mapping equipment;
- poor policy framework and legal basis leading to poor data collection in the first place;
- investment cost (an approximate estimate should be given); and
- uncertainty about availability of "after-sales" SMAQ service.

[21] "Regional" in this instance applies to a zone of approximately 80 km * 80 km

[22] Country report authors are encouraged to meet with air quality managers in hotspot areas to gather this information, besides mention a SMAQ demonstration/training workshop being hosted, Prague, Nov.08

6. Future domestic priorities and opportunities for EIS development *(no more than 0.5pg)*

Within this section please briefly indicate any developments or opportunities foreseen within the next two years (until mid-2009) at the national or regional level that may facilitate the implementation of the SMAQ toolkit within one or all of the hotspots mentioned. This might include for instance: financial assistance to implement a new policy programme, closer integration with EEA reporting standards, funds for technology demonstration, air quality monitoring network upgrades, subsidies for satellite data use, emission inventory upgrade, administrative reform, enhanced ancillary data access etc.

7. Recommendations *(no more than 0.33pg)*

Within this section the country report author is invited to provide his/her personal perspective on the challenges/obstacles and opportunities for SMAQ toolkit transfer, and to make two to three practical suggestions on activities that could facilitate this.

List of contributors

Please indicate the name of the author of this country report.

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The Regional Environmental Center for Central and Eastern Europe (REC) is a non-partisan, non-advocacy, not-for-profit international organisation with a mission to assist in solving environmental problems in Central and Eastern Europe (CEE). The center fulfils this mission by promoting cooperation among non-governmental organisations, governments, businesses and other environmental stakeholders, and by supporting the free exchange of information and public participation in environmental decision making.

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