Introduction

Urbanisation and dependence on fossil fuels as the main energy source, coupled with industrial development and an increased use of road transport has led to an increase in air pollution in South Africa urban areas and an increase in the number of people exposed to poor air quality. The inadequacy of the current approach to the regulation of both stationary and mobile sources of air pollution has contributed to the poor air quality. This situation emphasises the need to manage air quality in urban areas, or rather to manage the activities in urban areas that contribute to a degradation of air quality.

The Dynamic Air Pollution Prediction System (DAPPS) is a research project that proposes to develop a system to assist stakeholders in managing air quality on an urban scale. The 3-year project involves a consortium of four groups – the CSIR (the lead partner), South African Weather Service, Peninsula Technikon and SRK Consulting, and is funded by the Department of Arts, Culture, Science and Technology via the National Research Foundation’s Innovation Fund. The project start date was July 2002.

General description of the DAPPS System

The system will involve the following elements:

- Downscaling the current numerical weather prediction model resolution to an appropriate Local-scale for utilisation by the air dispersion model. More specifically, the NWP model data output (which is at a 48 km resolution and every 3-hours) will be downsampled to a finer spatial (5km) and temporal (1 hour) resolution suitable for air pollution modelling on a metropolitan-scale.
The development of a comprehensive air pollutant emission inventory, including industrial, commercial, mobile (vehicular) and domestic sources.

The enhanced meteorological data and the emission inventory data will be used as basic inputs into a well-established photochemical dispersion model, the Comprehensive Air Quality Model with Extensions (CAMx) to produce air pollution forecast fields, forecast up to 48 hours in advance.

The intention is to communicate the system outputs in a simplified, but meaningful way. The potential health and environmental impacts of the predicted air pollution fields will be translated into an Air Pollution Index (API) based on local demographic characteristics, including a consideration of sensitive groups within the exposed population. At the same time, layers of more detailed information will be made available, including pollutant concentration fields.

Developing and implementing a suitable communication plan to allow sustainable, real time display of the predicted pollution fields and API on the World Wide Web and through other media.

Who is the system intended for?

The system will be developed using the Cape Town Metropolitan Area as a pilot site. The system is being developed as a key tool for air quality management at the urban (city) level. We therefore expect that the system would be of interest to both the various levels of government and the general public concerned with air pollution impacts and air quality management.

We anticipate that the main users of the system will be:

- City of Cape Town (Air Pollution Control section)
- Department of Environment and Tourism (W Cape)
- Department of Environment, Culture and Sport (W Cape)
- The general public concerned environmental and air pollution matters
- Environmental Non-Governmental Organisations and Community Based Organisations
- Industries
- Students at school level or tertiary level
- Health officials at various levels of government
- The tourism industry
- The Department of Minerals and Energy

What will the system be able to do?

The system will estimate and predict air pollution fields (concentrations associated with specific regions) throughout the study area, for averaging times of 1 hour or longer. These air pollution fields will be translated into an Air Pollution Index in the form of a numerical scale (1=low, 10= very high) and a colour
coding system, accessible via a colour-coded map. The API will be based on literature data on the relationship between exposure to air pollution and health effects. During the first year of the project, the possibility of developing a Visibility or Haze Index will be investigated.

We anticipate that the system will enable the identification of major pollutant sources or groups of sources as contributors to poor air quality.

**What will the system not be able to do?**

The quality of dispersion modelling is critically dependent on the quality of input data. In addition, the accuracy and resolution (the length and time scale) of the model outputs is limited by the accuracy and resolution of meteorological data, the limited ability to characterise local terrain effects and to predict atmospheric chemical reactions. The system is therefore unlikely to be able to predict very local variations in concentrations, or short time period variations - of less than one hour.

Abnormal or accidental releases of pollutants can clearly not be predicted, although retrospective analysis of the impacts of these releases should be possible provided that a realistic release scenario is available.

We believe that a fully functioning DAPPS will be an essential aspect of a fully functional Air Quality Management System, but the full implementation of an Air Quality Management System is beyond the scope of this project.

**What will the output (the results) look like?**

A number of countries and cities have developed, and are continuing to develop, similar systems. The following example illustrates a typical output.
How will the predicted results be verified and validated?

The major input components of the system – the meteorological prediction and the emission inventory – will be assessed against measured data (whenever possible) using accepted statistical techniques. The predicted concentrations will be evaluated against the available ambient monitoring data.

A detailed protocol for the verification and validation of the model performance will be developed during the early phases of the project. There is also provision for peer review of the system.

How will the results be made available to the public?

A principle objective of the project is the communication of results and to make this information accessible to as wide an audience as possible and to as many potential users as possible. The principle means for disseminating the information generated by DAPPS will be the Internet. Current and background information will be made available on the CSIR and Weather Bureau web sites. In addition, summary data will be disseminated via the conventional media through established Weather Bureau networks of newspapers, radio and television.

During the execution of the project, contact and formal liaison will be established with a wide range of interested parties in the pilot area. Through periodic formal contact with a reference group drawn from the interested parties, and periodic open workshops, the system will be designed to be as user-friendly as possible. As far as possible, we will attempt to meet the expectations of the target user group, subject to the limitations of input data availability, the underlying science, and the budgetary and time constraints of the project team.

How is the project being managed, and how long will the development of the system take?

This is a 3-year project, with each of the consortium partners responsible for different elements of the development of the system. The project is managed by a steering committee consisting of representatives of each of the consortium members. The project is scheduled for completion in June 2005.

The program for the first year includes the identification and selection of the pilot site, establishing communications with stakeholders and interested parties, the identification and selection of the pollutants to be included in the design and piloting of the system, developing a preliminary emission inventory for the pilot site and procedures for updating and refining the emission inventory, downscaling of the meteorological model, developing familiarity with the capabilities and requirements of the dispersion models, the development of a pilot Air Pollution Index (API) and Information System and the setting up the
Information Technology platform for the system under development. At the end of the first year, the overall objective is to have a rough prototype of the system.

Activities during the second year of the project will include the testing of the API and Pollution Information interface and the design of the associated software interface, the refinement and development of all the software interfaces, the refinement of the emission inventory, establishing the web based communications interface and the initial validation of the dispersion model outputs. The overall objective of year two is to have a fully functional system populated with (using) actual pilot area data.

During the final year of the project the focus will be on testing, calibration and validation of the system, implementation of a communication strategy and running of the demonstration system in the pilot area.

**What are the potential benefits and applications of the system?**

The DAPPS design will integrate meteorology and data on all sources of the most common urban pollutants to estimate the impacts of these pollutants on human health and the environment.

Some of the potential benefits of such an information system are:

- To serve as a common platform for an understanding of poor air quality, and the root of Air Quality Management problems.
- To provide a decision support tool for integrated planning and sustainable growth and development. For example, the impact of continued traffic growth or new industrial developments could be assessed in an integrated manner using DAPPS.
- To assist local, provincial and national government to make informed decisions on development options, with due consideration of human health and environmental impact implications.
- To provide industries and other source contributors with a tool to evaluate source reduction mitigatory options.
- To provide an educational tool and a means of raising understanding and awareness of air quality issues.
- To provide an information system to environmental non-governmental organisations and community groups concerned about air quality.
- To provide supporting information for air-quality related health risk assessments and epidemiological studies.
What happens beyond after the three-year research, design and development phase?

The DAPPS project entails the development of the system, based on the chosen pilot site, Cape Town. However, all the major urban and industrial sites in South Africa suffer similar air pollution problems. The intention is therefore to offer the system as a product to all major urban centres in South Africa. In the case of the pilot site, the system would be fully functional, but would require ongoing management and maintenance. The experience of piloting the system in one area will enable a full specification of the data input requirements for a typical South African urban area, and will facilitate the application of the system in other areas.

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When can I get more information?

For more information, and to keep up to date with project developments, please consult our project website:

http://dbn.csir.co.za/dapps/