

# Integrated urban environmental management and information systems (IUEMIS)

A contribution to subproject SATURN

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## **Summary**

For the year 2001 this contribution aimed at the development of Integrated Urban Environmental Management and Information System components that are flexible and modular, and also re-usable. Another target for this year was the advances in the theoretical investigation of such systems, their components and the technologies and methodologies associated with their development.

## **Aim of the research**

Main objective of this research activity was to investigate the key points in urban environment decision and policy making that interact with the environmental information produced and processes by relevant integrated environmental surveillance, information and management systems. This investigation focused on the materialisation of applications that can serve as modules of a contemporary IUEMIS, in parallel with the theoretical investigation of aspects and characteristics related to these systems and modules.

## **Activities during the year**

The main focus on 2001 year activities was:

1. To further investigate the requirements related to the system design and development in air quality related IUEMIS,
2. To develop air quality forecasting tools based on statistical methods, and
3. To develop the methodological and technical framework that will allow for a step-by-step development of IUEMIS developments.

## **Principal results**

### *a. Development of an internet-based air quality forecasting module*

This ozone forecasting module is an internet based application that is modular and can easily be applied in combination with any existing air quality management system, or as a stand-alone application. In order for this prediction to be realized, daily meteorological and air quality data are required, and the module accesses them automatically via the internet. The application's programming language is Perl

*b. Development of an SMS module*

An SMS module was developed (in C++) that utilizes the web front-end of a commercial SMS gateway (free of charge) to deliver messages on air pollution forecasts to subscribed recipients.

*c. Development of a WAP module*

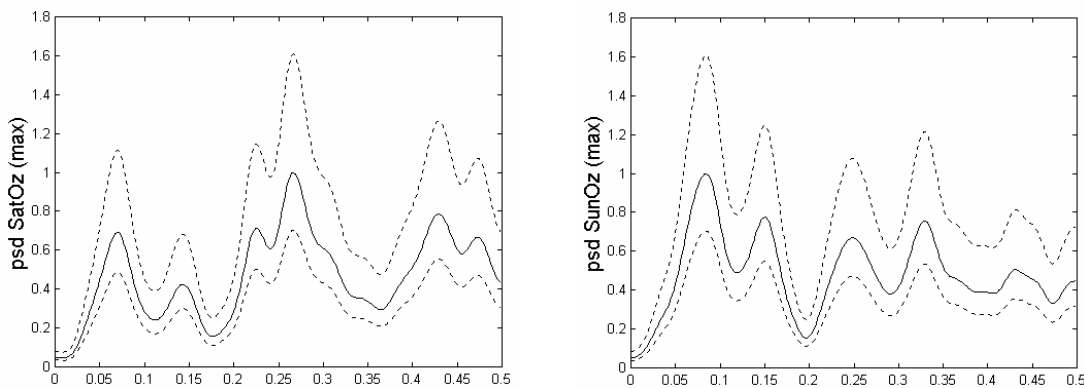
A WAP module was developed to produce pages containing dynamically updated air pollution and weather information.

*d. Development of an e-mail environmental information providing module*

An e-mail module was created for the dissemination of air quality related information to appropriate subscribed recipients, based on the org.apache.turbine.util.velocity.VelocityEmail package of the Jakarta Velocity API.

*e. Investigation of air quality data series structures*

A statistical analysis of a 10-year long record of air quality data, coming from the monitoring network operated by the Hellenic Ministry of Environment, Physical Planning and Public Works, Directorate of Air and Noise Pollution Control in Athens, Greece, has been carried out, for weekend periods and for two specific monitoring sites. The aim of the study was to analyse the temporal patterns of observations and to reveal relations and trends. Weekend periods were considered to be the "background" of traffic related emissions. In this way, it is expected that issues like the environmental consequences of various incentives aiming at the reduction of traffic related emissions, can easily be estimated. The aim of the work was also to demonstrate that the analysis of weekend air quality monitoring data records is an appropriate method for estimating the temporal variation of traffic related air pollution in urban agglomerations, based on appropriate approximations.



*Figure 1. Periodicity diagrams of maximum ozone concentration values*

*f. Statistical methods for air quality forecasting: ARIMA and Regression Analysis*

A stochastic autoregressive integrated moving average (ARIMA) model was developed for maximum ozone concentration forecasts in Athens, Greece. For this purpose, the Box-Jenkins approach was applied for the analysis of a 9-year air quality observation record. The model developed was checked against real data for one year. Results show a good index of agreement,

accompanied by a weakness in forecasting alarms. Finally, suggestions were made regarding the enrichment of the approach used, in order to improve the forecasting performance.

In addition, a model was developed capable of forecasting the maximum daily concentration of ozone as a function of meteorological and air quality variables, in the Greater Athens Area. For this reason, a number of regression models were considered, while the selection of the final model was based on extensive analysis and on literature. The final model adapted includes variables that are available on a daily basis, so as daily operational ozone forecast can be achieved.

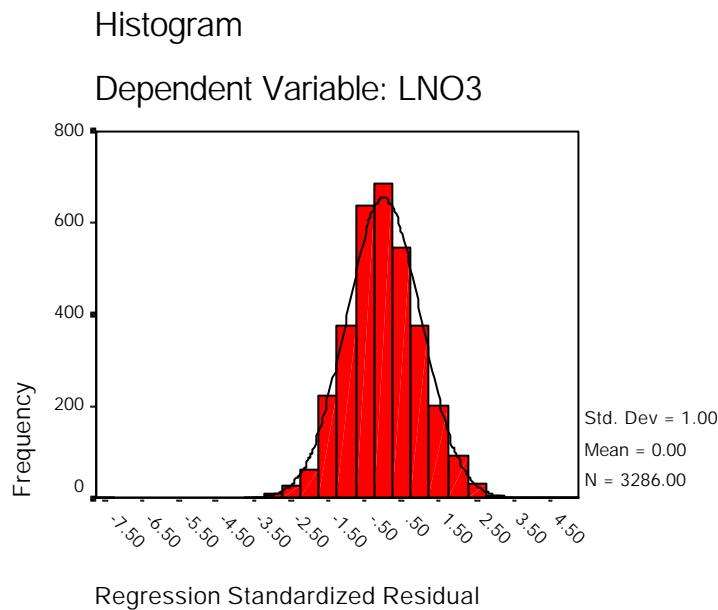


Figure 2: Normality test for the residual of  $O_3$  regression. The distribution of Standardized Residuals, indicated by bars, compared to a normal distribution.

g. *Theoretical Investigation of Urban Air Quality Management Systems Performance Towards Simplified Strategic Environmental Planning*

Urban Air Quality Management Systems are software tools that combine air quality models with various software modules like geographical information systems, databases, expert systems and statistical analysis tools. Such systems try to interpret as good as possible the complex interactions between various atmospheric, emission, land use and topographic parameters involved in the air pollution problem, in order to provide support for environmental strategic planning and decision making. As this process involves a huge set of parameters, some of which may only be roughly estimated, air quality management systems tend to aggregate parameters in order to simplify their analysis and make it more effective and operational. Yet, this aggregation may lead to deviations in the analysis results, as proved in this theoretical work, and thus influence the decision making and strategic planning process. According to the findings of this work, such a policy making process should focus primarily on short term measures when dealing with air pollution episode management.

## **Main conclusions**

They are described above as conclusions of the principal results.

## **Acknowledgements**

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## **List of publications in 2001**

- T. Bohler, K. Karatzas, G. Peinel, Th. Rose and R.S. Jose (2002), Providing multi-modal access to environmental data-customisable information services for disseminating urban air quality information in APNEE, *Computers, Environment and Urban Systems* 26(1), 39-61.
- Th. Slini, K. Karatzas and N. Moussiopoulos (2002), Statistical analysis of environmental data as the basis of forecasting: and air quality application, *The Science of the Total Environment*, accepted for publication.
- K. Karatzas (2002), Theoretical Investigation of Urban Air Quality Management Systems Performance Towards Simplified Strategic Environmental Planning, *Water Air and Soil Pollution: Focus*, Special Issue, accepted for publication.
- K. Karatzas, A. Kaprara, N. Moussiopoulos and L. Viras (2001), Statistical analysis of a 10-year long record of air quality observations in Athens, for weekend periods, accepted as an oral presentation at the Third International Conference on Urban Air Quality, 19-23 March 2001, Loutraki, Greece.
- K. Karatzas (2001), Some historical aspects of urban air quality management, accepted as a poster presentation at the Third International Conference on Urban Air Quality, 19-23 March 2001, Loutraki, Greece.
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- San José R., Stohl A., Karatzas K. Bohler T., James P. and Salas I. (2001), An extraordinary ozone episode in Madrid (April 2000) during night time: a modelling study. Proceedings of the VII International Conference on *Harmonization within Atmospheric Dispersion Modelling for Regulatory Purposes*, Beligerate (Lake Maggiore), Italy, May, 28-31, 2001, pp. 390-394.
- Johansen, P. H.; Karatzas, K.; Lindberg, J.E.; Peinel, G., Rose, Th. (2001). Citizen-centred information dissemination on multimodal information channels and GIS, *Proceedings of the "Sustainability in the Information Society"-15th International Symposium for Environmental Protection*, L. Hilty and P. Gilgen eds., Part 1: Impacts and Applications, pp. 271-278, ISBN 3-89518-370-9

## **Aims for next year (i.e. 2002) are following:**

To continue work on IUEMIS components including more technological dimensions in the investigation, and to also progress the air quality forecasting information production and management.