

Sustainability Dimensions

Annual Report of the Laboratory of Heat Transfer and Environmental Engineering - Mechanical Engineering Department, Aristotle University Thessaloniki, Greece

2014

We are approaching the end of another difficult year for Greece and its universities. Although the economic and financial recession seems gradually to be coming to an end and in spite of forecasts for GDP growth in 2015, Greek society is exhausted from the severe austerity measures and universities suffer under massive budget cuts and staff shortage, as no replacements are foreseen for those retiring.

Even under these adverse conditions, our Laboratory continued offering undergraduate courses and conducting high level research as in the years before. Our attention this year was primarily focused on the projects Urban Empathy and GREEN-AgriChains. The former aims at improving the efficiency of sustainable urban policies in Mediterranean regions, and among its main objectives is to bring solutions to decision-makers. For this purpose the Laboratory organized a High Level Seminar attracting numerous important stakeholders from various Greek regions. GREEN-AgriChains aims at tackling all aspects of Green Supply Management and Logistics, dealing among other with atmospheric composition change and waste management, i.e. major fields of our Laboratory's competence.

The emission of fine particles in residential areas resulting from intense biomass burning and the consequences regarding air quality continued being a central issue for our research. Measurements were taken at several locations in the greater Thessaloniki area and our air quality management system was applied in order to arrive at conclusions as far as the increase of PM_{2.5} and wood smoke tracers are concerned. The findings were presented in a major event organized by ECOCITY, a leading environmental Greek NGO keenly supported by our Laboratory in their endeavours (e.g. 'ecomobility', an action towards sustainable transport).

A big step forward for our Laboratory in 2014 was the appointment of Drs F. Barmpas, J. Douros, G. Perkoulidis, Th. Slini and Ch. Vlachocostas as Laboratory Teaching Personnel. Their promotion is important not only for the five senior scientists themselves, but also for the Laboratory as a whole, as now we can plan our teaching and research strategy with more confidence for the future.

Prof. Dr. Nicolas Moussiopoulos
Laboratory Director

Collaboration Highlight: We hosted the Management Committee meeting of COST Action ES1004: European framework for online integrated air quality and meteorology modelling, 20-21 October 2014.



Transport related air pollution and health impacts – Integrated methodologies for assessing particulate matter (TRANSPHORM)

TRANSPHORM aimed at improving the knowledge of transport related airborne particulate matter (PM) and its impact on human health, as well as developing and implementing assessment tools for scales ranging from city to the whole of Europe. In order to undertake this effort, TRANSPHORM brought together internationally leading air quality and health researchers and cooperated closely with other key projects, such as ESCAPE, HEIMTSA, INTARESE and MEGAPOLI. In the four years of its duration, the project has also sought to improve our understanding of transport sources of size-resolved and speciated PM and to develop and implement an integrated assessment platform covering the whole chain from emissions to disease burden.

Many epidemiological studies have identified urban air pollution and traffic emissions of PM in particular as a key ‘Priority environment and health risk’. The TRANSPHORM project applied a comprehensive health impact assessment of traffic related PM entailing:

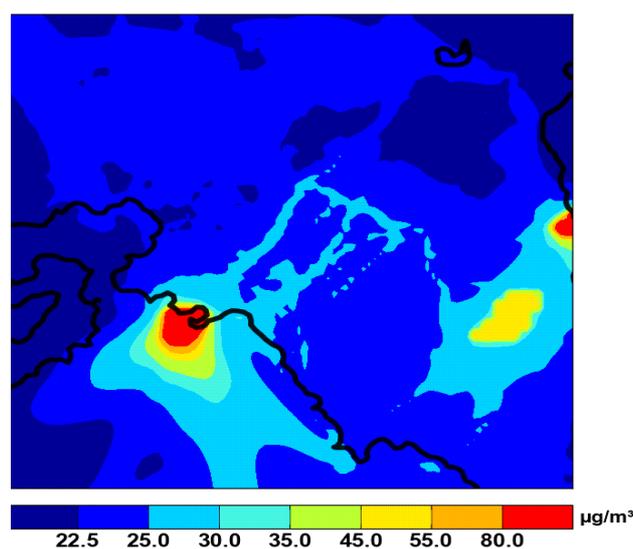
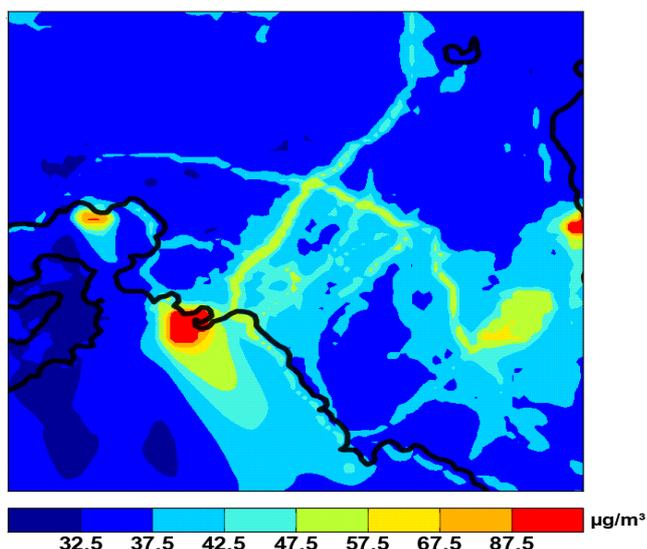
- The establishment of accurate new emission factors for size-fractionated transport related PM (including road traffic, shipping and aviation), accounting for the chemical composition and size distribution of the particles.
- Estimations of population exposure, distinguished between different population groups.
- Calculations of the subsequent levels of air pollution on local (urban) and regional scale for current and future emissions scenarios in collaboration with other projects, planning new air quality and exposure campaigns targeted at locations that reflect the dominant exposure to particulate matter pollution.

- An assessment of the health effects and development of new concentration response functions.
- Evaluation of the effectiveness of pollution mitigation and adaptation strategies for policy response.

The Laboratory was involved in several work packages of TRANSPHORM and its contribution focused on both the optimum use of existing computational tools as well as on the development and application of novel modelling methodologies to tackle the scientific issues at stake. These included:

- Further development of the MARS-aero chemical transport model to account for improved transport sector emissions and related effects (e.g. resuspension).
- Application of the advanced modelling scheme for the cases of Athens and Rotterdam and evaluation against the corresponding campaign measurements. The results from these applications demonstrated a noticeable impact of the emissions originating from road and harbour activities on the NO₂ and PM₁₀ concentration levels.
- Contribution to the development and implementation of an integrated assessment tool to investigate and analyse the whole chain of processes for selected cities and Europe as a whole.
- Further development, application and evaluation of a simplified “urban increment” methodology aiming at a fast, yet reliable estimation of the urban concentration increment on top of the regional scale background for urban areas. The methodology relies on the calculation of a functional relationship between local meteorological parameters, city characteristics urban emissions and urban concentrations, on the basis of measured increments on selected city locations

This work was funded by the EC as an FP7 Collaborative Project under topic ENV.2009.1.2.2.1 “Transport related air pollution and health impacts”.



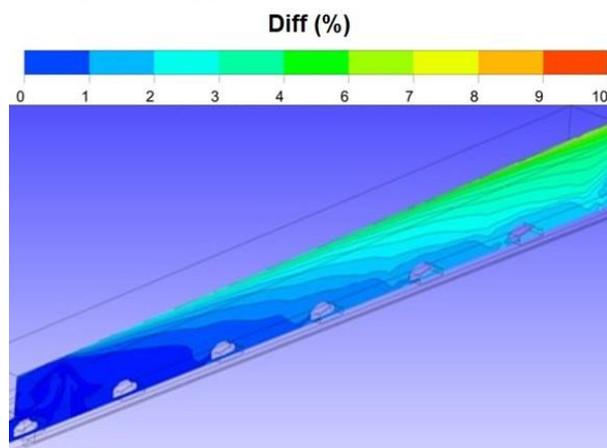
Calculated mean annual concentration fields for the Greater Athens Area as regards NO₂ (left) and PM₁₀ (right) for 2008

Demonstration of photocatalytic remediation processes on air quality (PhotoPAQ)

Clean air is essential to people's health and the environment. Since the industrial revolution, however, the quality of the air that people breathe has deteriorated considerably - mainly as a result of human activities. The need to deliver cleaner air has been recognised for several decades with actions taken at national and EU levels. The LIFE+ project PhotoPAQ aimed at providing new solutions for improving urban air quality by demonstrating the usefulness of photocatalytic materials for the abatement of air pollution in the urban environment.

In the very recent years, photo-catalytic self-cleaning and depolluting materials have been suggested as a remediation technology mainly for NO_x and aromatic VOCs. These products are based on the photo-catalytic properties of a thin layer of TiO₂ deposited at the surface of the material or embedded in paints or concrete. Assessing and demonstrating the effectiveness of these depolluting techniques have a real EU added value both in terms of policy making (and implementing the EU air quality strategy) and economics (by providing a demonstration of the actual performance of a new technique). In view of the above, the main goals of the PhotoPAQ project were the following:

- Develop a testing methodology for photocatalytic removal/production of NO_x, HONO, radicals, the majority of VOCs and particles, with all tests being performed under atmospherically relevant conditions.
- Test the photocatalytic activities of the commercially available TiO₂ based products in order to examine the pollutant removal effectiveness.
- Design better environmental indicators and methods to assess the impact of this new technology in European cities.
- Provide recommendation to the European authorities on the practical application for air treatment.



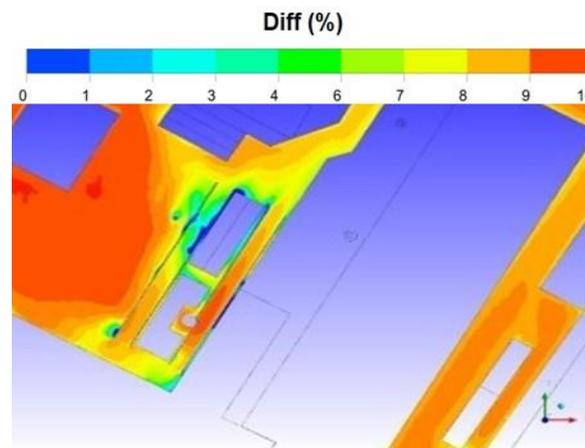
Numerically predicted mean depollution inside the Leopold II road tunnel test section under the influence of moving vehicles

The contribution of the Laboratory focused on the development and application of an integrated numerical methodology for the assessment of the expected depollution effectiveness of the suggested techniques under consideration in order to:

- Assess the air quality in the greater areas of the selected field trial locations in Bergamo, Italy and Brussels, Belgium.
- Perform urban depollution modelling for the selected field site configurations.
- Assess the measured depollution effectiveness of the selected covering materials from the field campaigns.
- Evaluate and validate the numerical modelling results.
- Perform an integrated assessment and cost benefit analysis.

While the laboratory studies clearly demonstrated the effectiveness of the tested material for the degradation of NO_x and potentially of some VOCs, the field testing revealed that the deployed conditions are critical for the expected pollution abatement. Depending on the material tested, it was observed that heavy pollution could lead to a rapid passivation of the material. In addition, high relative humidity or emission of secondary pollutants (e.g. HCHO) could alter the depollution activities. Based on the experimental and modelling results it appears that reducing air pollution by a few percent (i.e. $\leq 10\%$) is a realistic target in typical urban environments which is limited – at least in part – by pollutant transport to the active surfaces. In this context, however, it is important to note that just a few percent reduction of the NO_x concentration is in range which can be expected from any applicable after emission air quality improvement technology. Such abatements can however only be achieved with well formulated materials, exhibiting high depollution efficiencies and low passivation properties.

This work was funded by the EC, under the LIFE+ (2007-2013) programme.



Numerically predicted mean depollution at the Italcementi Group industrial site in Bergamo, Italy

Further development of software tools for simulating air quality in Cyprus

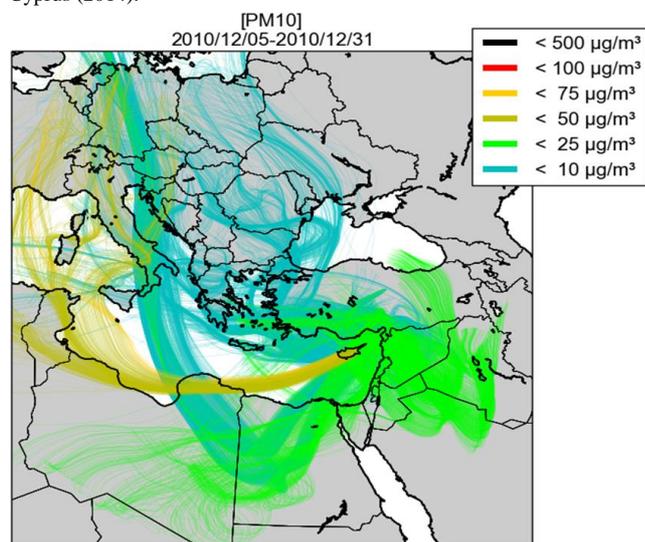
This project aimed at supporting and updating the operation of the Air Quality Management System (AQMS) that has been developed by LHTEE for the Department of Labour Inspection (DLI) of the Republic of Cyprus. As a part of a previous project, we have provided the model core and user interface parts of the system that deal with the prediction of ambient pollutant concentrations over Cyprus. The main task undertaken by this project was to support, maintain and improve the AQMS, through updates of both the modelling core and user interface of the system, as well as through the development and integration of new modules in order to implement additional functionality.

Within the framework of improving and expanding the AQMS the following enhancements of the current standard version have been implemented:

- Pilot application of a box model for the estimation of transboundary contributions to air pollution levels in Cyprus.
- Application of the AQMS for the source apportionment of NO₂ concentrations in urban areas of Cyprus, on the basis of the guidelines included in the Technical Report 2011/15 of the European Environment Agency “Modelling of Nitrogen Dioxide (NO₂) for air quality assessment and planning relevant to the European Air Quality Directive”.
- Development and incorporation of a tool for estimating the contribution of long-range pollutant transport to the air pollution levels in Cyprus, based on weighted back-trajectories.

In addition to the above tasks, LHTEE has organised and undertaken a number of educational and training events for the DLI staff, in relation to the appropriate usage and application of the AQMS modules.

Funded by the EU in the framework of the transition facility 2005 for Cyprus (2014).



Weighted back-trajectories for Cyprus

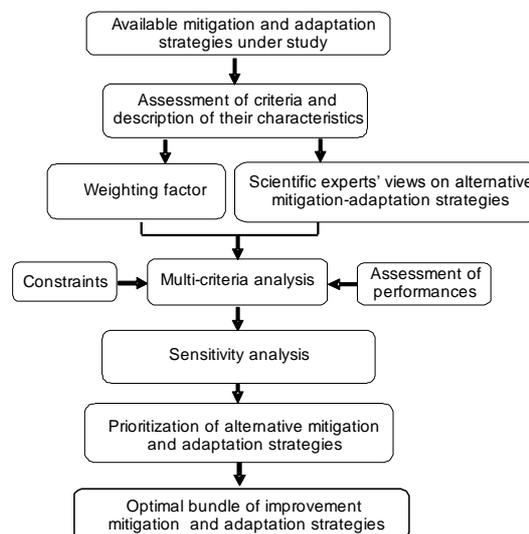
Analysis of the interactions between climate change and air quality with a suitable indicators system

The strategic goal of the HRACLEITOS II Programme was to support state-of-the-art Research and Innovation in Universities and Institutions.

LHTEE’s research focused on climate change, urban air quality and sustainable development issues. More specifically, interactions between climate change and air quality in the local to regional scale were the subject of a PhD thesis completed under the HRACLEITOS II programme. Specific indicators were used in order to synthesize, develop and implement a corresponding system of environmental indicators. The system was the result of in depth analysis and research of the international scientific literature in an effort to cover all economical, social and environmental dimensions of climate change and air quality. Interactions between specific indicators were realized both on a qualitative and a quantitative basis. 30 indicators were included in the system, 11 regarding air quality and 19 referring to climate change issues and impacts.

Environmental indicators theory was interrelated to multi-criteria decision analysis via DPSIR framework in order to provide policy support and optimal bundle of measures to promote strategic planning. The results outlined the need to focus on specific adaptation and mitigation alternative options against climate change. Quantitative analysis was realized by the adoption of environmental statistical techniques, using the available data for four conurbations with different environmental and social characteristics i.e. Athens, Paris, Los Angeles and Mexico City. The final aim was to support governance and policy modelling to simultaneously encounter climate change and improve air quality in urban areas.

Funded by NSRF 2007-2013.



Methodological approach for the comparative evaluation of mitigation and adaptation strategies

Research

Provision of services for evaluating the deliverables of the project "Towards a European qualification for Solid Waste Facilities Managers" (SWFM-QF)

Objective: The SWFM-QF project "Towards a European qualification for Solid Waste Facilities Managers" aims at developing a European qualification and training framework to address the needs of Facilities Managers in the waste management industry.

LHTEE contribution: External evaluator of deliverables of the project.

Funded by: SIGMA Consultants Ltd.

Integrated PET polymer recycling

Objective: This project aims at the exploitation of the by-products resulting from the recycling of PET bottles through the selection of a recycling process that is economically viable and environmentally sound.

LHTEE contribution: The main task under this project is to provide insights of the Greek recyclables market in order to support the Laboratory of Organic Chemical Technology in the conduction of laboratory-scale experiments on maximizing the efficiency of plastics separation during recycling.

Funded by: General Secretariat of Research and Technology.

Urban morphology and atmospheric boundary layer modelling (CityClim)

Objective: The aim of the CityClim project is to bring the LES modelling of urban ABLs onto a completely new, more realistic level of description. A detailed morphological database of Helsinki will be constructed for the benefit of further modelling activities. At the same time a high-resolution nested-domain urban LES will be developed that simultaneously resolves both small in canopy and large ABL-scale phenomena. Furthermore, currently employed surface momentum and heat flux parameterizations for NWP, air quality and climate models will be assessed and improved.

LHTEE contribution: In collaboration with the MET-research unit of FMI, LHTEE will perform basic verification and functional testing of the nested LES-system with special focus on surface-flux modelling in urban areas.

Funded by: Academy of Finland

Services

During the year, the Laboratory provided consulting and other services in the following cases:

- Siting of air quality measurement equipment around the Hellenic Gold S.A. mine and mineral processing plant locations with the aid of meteorological modelling.
- Joint EuMetChem-WGNEE permanent web-site/Wiki page with case studies.

Events

Members of the Laboratory participated at several important events giving speeches, chairing sessions or contributing to seminars. Some of the most interesting ones include:

Prof. N. Moussiopoulos gave a speech in a workshop on "Contributions of Thracians to social and cultural life of Thessaloniki" in Thessaloniki, on January 19th.

Prof. N. Moussiopoulos chaired a session of the symposium "How should Greece look like", organised by Aristotle University Thessaloniki, on February 13th-14th.

Prof. N. Moussiopoulos was a keynote speaker at the workshop on "Education: The response to the crisis", in Thessaloniki, on March 7th.

Prof. N. Moussiopoulos attended an event on "Greek shipping: Yesterday-Today-Tomorrow", in Athens, on April 7th.

Prof. N. Moussiopoulos was a member of the Scientific Committee of the "Designing Creative Synergies 2014" Conference and chaired the session on "Educating Designers". The conference was co-organized by Aristotle University Thessaloniki, International Hellenic University and Mitropolitiki Anaptixiaki Thessalonikis S.A. and was held in Thessaloniki, on April 28th.

Prof. N. Moussiopoulos was among the main speakers in an event in honour of Professor Ernst, in Karlsruhe, on May 11th.

Our Laboratory organized a workshop in the frame of the Pay As You Throw programme at the International Hellenic University in Thessaloniki, on May 29th.

Our Laboratory organized a workshop in the frame of the Urban Empathy programme at the International Hellenic University in Thessaloniki, on September 26th.

Prof. N. Moussiopoulos visited on October 27th the Stevens Institute of Technology in New Jersey. He met with Provost Professor George Korfiatis and the Dean of Wesley J. Howe School of Technology Management, Professor Gregory Prastacos. Discussing topics were, among other, environmental research aspects and the role of universities with regard to innovation and entrepreneurship.

Dr. Christos Vlachokostas participated as an invited speaker at the Air Quality, Health and Ecosystems workshop organized by the School of Engineering of the Università degli Studi di Brescia, on November 10th.

Prof. N. Moussiopoulos attended 5th Panhellenic Conference on Public Health and Social Medicine in Thessaloniki, on November 21st-23rd.

News

OIKOPOLIS 2014 and ECOCITY awarded Mr. A. Athanasiadis for his diploma thesis.

Dimitra Spyridi completed successfully her Doctorate and obtained her degree.

Maria Mavroudi collaborated temporally with our Laboratory.

We congratulate John Douros for the birth of his daughter and Stamatia Kontogianni for the birth of her twin sons.

Papers in Journals

Vlachokostas Ch., Baniias G., Athanasiadis A., Achilles Ch., Akylas V. and Moussiopoulos N. (2014)

CENSE: A tool to assess combined exposure to environmental health stressors in urban areas, *Environment International* **63**, 1-10.

Slini T., Giama E. and Papadopoulos A.M. (2014)
The impact of economic recession on domestic energy consumption, *International Journal of Sustainable Energy*, doi: 10.1080/14786451.2014.882335.

Slini T., Giama E. and Papadopoulou Ch.-O. (2014)
Distance learning education for mitigation/adaptation policy: a case study, *International Journal of Sustainable Energy*, doi: 10.1080/14786451.2013.876026.

Koroneos C., Haritakis I., Michaloglou K. and Moussiopoulos N. (2014)
Exergy analysis for power plant alternative designs, Part I, *Energy Sources* **26:13**, 1277-1285.

Koroneos C., Haritakis I., Michaloglou K. and Moussiopoulos N. (2014)
Exergy analysis for power plant alternative designs, Part II, *Energy Sources* **26:13**, 1287-1295.

Al-Khatib I.A., Ajlouny H., Al-Sari M.I. and Kontogianni S. (2014)

Residents' concerns and attitudes toward solid waste management facilities in Palestine: A case study of Hebron district, *Waste Management & Research* **32(3)**, 228-236.

Antonopoulos I.-S., Perkoulidis G., Logothetis D. and Karkanias C. (2014)

Ranking municipal solid waste treatment alternatives considering sustainability criteria using the analytical hierarchical process tool, *Resources, Conservation and Recycling* **86**, 149-159.

Gariazzo C., Leidl B., Trini Castelli S., Baumann-Stanzer K., Reisin T.G., Barmpas F., Tinarelli G., Milliez C.M., Bemporad E. and Armand P. (2014)

COST Action ES1006. Evaluation, improvement and guidance of local-scale emergency prediction and response tools for airborne hazards in built environments: Ongoing activities, experiments and recent results, *Chemical Engineering Transactions* **36**, 529-636.

de Hoogh K., Korek M., Vienneau D., Keuken M., Kukkonen J., Nieuwenhuijsen M.J., Badaloni Ch., Beelen R., Bolignano A., Cesaroni G., Cirach Pradas M., Cyrus J., Douros J., Eeftens M., Forastiere F., Forsberg B., Fuks K., Gehring U., Gryparis A., Gulliver J., Hansell A.L., Hoffmann B., Johansson Ch., Jonkers S., Kangas L., Katsouyanni K., Künzli N., Lanki T., Memmesheimer M., Moussiopoulos N., Modig L., Pershagen G., Probst-Hensch N., Schindler Ch., Schikowski T., Sugiri D., Teixidó O., Tsai M.-Y., Tuomi T.-Y., Brunekreef B., Hoek G., Bellander T. (2014)

Comparing land use regression and dispersion modelling to assess residential exposure to ambient air

pollution for epidemiological studies, *Environment International*, **73**, 382-392.

Nanaki E.A., Koroneos C.J., Xydis G.A. and Rovas D. (2014)

Comparative environmental assessment of Athens urban buses - Diesel, CNG and biofuel powered, *Transport Policy*, **35**, 311-318.

Achillas Ch., Baniias G., Tzetzis D., Kyratsis P. and Moussiopoulos N. (2014)

Investing in product design education in times of economic crisis, *International Journal of Product Design*, **5 (1)**, 24-41.

Articles in Books

Akylas V., Tsegas G., Douros I. and Moussiopoulos N. (2014), Quantifying the impact of temperature capping inversions on annual PM concentration levels: a case study for Thessaloniki, **Honorary publication for Professor A. Flokas**, (Helmis C. and Nastos P., eds), Published by the National and Kapodistrian University of Athens, Athens, 21-27.

Participation at Conferences

The list contains only the titles of papers given as oral presentations. Poster presentations were also made in several conferences.

5th Macedonian Environmental Conference, 14-16 March, Thessaloniki, Greece

Development of an air quality management system for Thessaloniki (J. Douros)

PM_x emission factors - dispersion from fugitive sources in lignite mines of western Macedonia

Impact of economic crisis on wintertime airborne particulates and their chemical constituents in Thessaloniki, Greece

9th International Conference on Air Quality-Science and Application, 24-28 March, Garmisch-Partenkirchen, Germany

Air quality at the street level in Cyprus (N. Moussiopoulos)

Refinement and evaluation of a statistical approach for determining concentration increments in urban areas (N. Moussiopoulos)

A modelling approach to assess the contribution of domestic wood burning on ambient PM_{2.5} levels in the greater Thessaloniki area, Greece (N. Moussiopoulos)

2 posters were presented

Photocatalysis: Science and Application for Urban Air Quality, PhotoPAQ Conference 2014, 15-17 April, Lyon, France

Numerical modelling results for the abatement of air pollution in urban areas within the frame of the LIFE+ PhotoPAQ project (F. Barmpas)

2nd Symposium on Urban Mining, 18-21 May, Bergamo, Italy

Urban Empathy: An EU funded project towards the promotion of a sustainable urban model at the European level (Ch. Achillas)

1 poster was presented

International Conference on EnE14/ENV.net, Environment to Europe, Chapter 27-EU integration in the sector Environment and Climate Change, 4-6 June, Beograd, Serbia

Climate change and economy: Tourism aspects for Greece (Ch. Vlachokostas)

International Symposium on Computational Wind Energy, 8-12 June, Hamburg, Germany

The combined influence of the ventilation system and the vehicle's motion on the dispersion of traffic emissions in the Leopold II road tunnel (F. Barmpas)

A novel scheme for describing multiscale interactions on atmospheric flow and pollutant dispersion in the urban atmospheric boundary layer (N. Moussiopoulos)
 COST Action ES1006 model evaluation protocol for cases of emergency response in urban areas (F. Barmpas)

2nd International Conference on Sustainable Solid Waste Management, 12-14 June, Athens, Greece

Assessment of alternative strategies for the management of waste from the construction industry (Ch. Karkanias)

Evaluation of home composting programmes in the frame of urban sustainable development policies (Ch. Karkanias)

International Conference on Protection and Restoration of the Environment XII, 29 June-3 July, Skiathos, Greece

Climate change and urban air quality: investigation of the interactions with environmental indicators (G. Banias)

End-of-life photovoltaic panels: An emerging waste stream (G. Banias)

5th International Conference on Information, Intelligence, Systems and Applications, 7-9 July, Chania, Greece

On the elasticity of residential energy consumption

2nd International Conference on ICT for Sustainability, 24-26 August, Stockholm, Sweden

1 poster was presented

International Conference on Industrial and Hazardous Waste Management, CRETE 2014, 2-5 September, Chania, Greece

Environmental impact of alternative construction and demolition waste management practices: A Life Cycle Analysis approach (G. Banias)

16th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, 8-11 September, Varna, Bulgaria

Updates on COST Action ES1006. Evaluation, improvement and guidance for the use of local-scale emergency prediction and response tools for airborne hazards in built environments

1st National Landfill Mining Conference, 16 September, Thessaloniki, Greece

Hierarchical ranking of landfill restoration plans focusing on landfill mining (N. Moussiopoulos)

9th International Conference on Urban Regeneration and Sustainability (Sustainability City

2014), 23-25 September, Siena, Italy

Involving decision-makers in the transformation of results into urban sustainability policies

2nd European Conference on Customized Employment-Projects for Cities-Opportunities for Growth 2014, 24-26 September, Oraiokastro, Thessaloniki, Greece

Empowering European policies for urban sustainability: the Urban Empathy project and decision-making tools (E. Feleki)

Engendering Cities: Designing Sustainable and Inclusive Urban Environments, 25-26 September, Rome, Italy

1 poster was presented

14th EMS Annual Meeting & 10th European Conference on Applied Climatology (ECAC), 6 – 10 October, Prague, Czech Republic

Further refinement and evaluation of a statistical approach for determining concentration increments in urban areas (N. Moussiopoulos)

5th International Symposium on energy from Biomass and Waste, 17-20 November, Island of San Servolo, Venice, Italy

Pay-As-You-Throw: Modern Pilot Application in Greece (Ch. Karkanias)

A decision support tool for sustainable municipal solid waste storage, discharge and collection services in crisis affected countries (Ch. Karkanias)

Environmental protection through utilization of recycled glass as fluxing agent in the structural ceramics industry (A. Malamakis)

10th National Conference on Renewable Energy Sources, 26-27 November, Thessaloniki, Greece

Data temperature analysis during 1983-2012 in Athens and Thessaloniki, Greece and climate change impact on Greek cities (Th. Slini)

Contribution to COST actions

COST Action ES1004

European framework for online integrated air quality and meteorology modelling

- Core Group meeting, Geneva, Switzerland, 10 February (N. Moussiopoulos)
- Management Committee and Working Group meetings, Garmisch-Partenkirchen, Germany, 23-25 March (N. Moussiopoulos and G. Tsegas)
- Core Group meeting, Hamburg, Germany, 13 June (N. Moussiopoulos and J. Douros)
- Management Committee meeting, Thessaloniki, Greece, 20-21 October (N. Moussiopoulos, J. Douros and G. Tsegas).
- Core Group meeting, Brussels, Belgium, 8-9 December 2014 (N. Moussiopoulos)

COST Action ES1006

Evaluation, improvement and guidance for the use of local-scale emergency prediction and response tools for airborne hazards in built environments

- Management Committee and Working Group meetings, Prague, Czech Republic, 22-24 September (F. Barmpas)

Laboratory Personnel

Permanent staff with teaching and research assignment

Nicolas Moussiopoulos Professor, Dr.-Ing. habil. (Director)

Fotios Bampas, Dr.-Eng, Aersp. Engineer, MSc
 Ioannis Douros, Dr.-Eng., Physicist, MSc
 Georgios Perkoulidis, Dr.-Eng.

Theodora Slini, Dr.-Eng., Mathematician
 Christos Vlachokostas, Dr.-Eng.

Researchers and PhD Candidates

Evangelia Fragkou
 Stamatia Kontogianni
 Apostolos Malamakis
 Maria Mavroudi
 Georgios Tsegas
 Vasilios-Ioannis Akylas

Biologist, Environ., PhD
 Dr.-Eng.
 Dr.-Eng.
 Dr.-Chem. Engineer
 Physicist, PhD
 Mech. Engineer

Apostolos Athanasiadis
 Lefteris Chourdakis
 Eleni Feleki
 Christos Karkanias
 Dionisios Logothetis
 Alexandra Michailidou

Mech. Engineer
 Mech. Engineer
 Chem. Engineer, MSc
 Environ. Scientist, MSc
 Mech. Engineer
 Mech. Engineer

Administration/Support team

Afedo Koukounaris
 Eugenia Agorastoudi

Administration Officer
 Administrative Support

Dimitrios Altinoglou
 Georgios Kotriklas

Administrative Support
 System Administrator



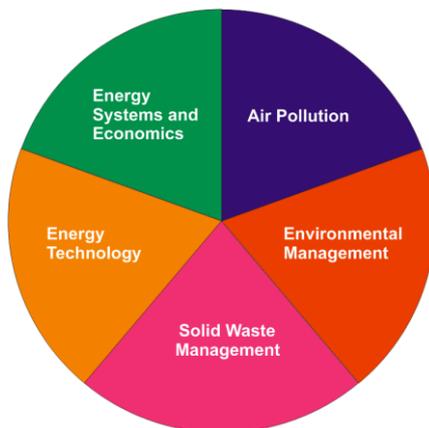
Laboratory address

8th floor, Building D
 School of Engineering
 Phone: +30 2310 996011
 Fax: +30 2310 996012

Mail address

Box 483
 Aristotle University Thessaloniki
 GR-54124 Thessaloniki, Greece
info_lhtee@aix.meng.auth.gr
 URL: <http://aix.meng.auth.gr>

Main Research Topics



Air Pollution and Climate Change

- Multi-scale air pollution studies
- Air pollution-climate interactions
- Air quality assessment and management
- Environmental impact assessment
- Integrated environmental assessment

Waste Management

- Contaminated site management
- Recycling, logistics, waste scenaria
- Thermal treatment and energy recovery
- Pricing schemes, decision support tools
- Sustainable consumption, social issues

Energy Systems and Technology

- Energy conservation and renewable energy sources
- LCA and environmental management
- Sustainable production

