

Good CityZens

Drs Michael Gauss and his colleagues **Maria Kanakidou** and **John Burrows** summarise the outcomes of a collaborative project addressing the effects of megacities on air pollution and climate change



improved our understanding of the impacts of megacities on air pollution over the past two decades and our predictions of future changes. It has been a great success in terms of the collection of measurement and modelling data as well as their analysis, yielding important results on recent air quality trends and climate-air quality interactions.

Importantly, CityZen has brought the air quality and climate research communities – which have traditionally evolved as two different sectors – closer together. In this respect, the multi-modelling studies conducted during CityZen have resulted in important input to European air quality legislation, which will be exploited further during the ongoing review of EU air quality policy to be accomplished in 2013.

CityZen has produced more than 30 research articles in the peer-reviewed literature, with more being in preparation. CityZen is the first project of its kind and has been a trailblazer in showing the effects of megacities on air pollution from the local to the global scale.

How will the work and results produced by CityZen continue now that the project has ended? Will you use your findings to influence climate policy and city planning?

CityZen has gathered a large amount of measurement and modelling data, already analysed but also having much potential for further investigations. Several studies and publications are in the pipeline and research papers will be presented at future conferences, for example, at the Planet under Pressure conference in London in March 2012.

Climate-friendly air quality measures have been studied in CityZen, for example emission control measures that reduce air pollution without contributing to global warming. Several of the partners are in close contact with local air pollution authorities in their respective countries and it is expected that the project findings will support city planning in the future.

The synthesis of the results of CityZen has identified emerging issues for research in the 2012-20 period. We anticipate that the EU will take these results into account in formulating the next phase of its research programme.

Could you begin by explaining the objectives of the CityZen project?

The overarching objective of CityZen has been to quantify the environmental effects of megacities on air pollution and climate change during the recent past and as predicted for the next few decades. In addition, the couplings and feedback between climate change and air pollution were to be investigated. In particular, we set out to answer questions such as how climate change will influence air pollution, and how it will affect the efficiency of emission control measures.

The multi-scale character of the environmental issues associated with megacities meant that tools had to be developed that bridge local, regional and global scales. Facilitating the use and applicability of our results for policy development, well beyond the lifetime of the project, has been an important goal.

What methods did you use to gather data on air pollution distribution and change in and around hotspots over the last decade?

CityZen has used a combination of the new satellite observations, ground-based measurements and modelling to gather data and to analyse trends during the last 10 to 15 years. This was not previously possible. Combining and consolidating data from different satellite instruments covering a range of time periods has been one important component and outcome of the project.

A multi-model experiment including both regional and global models has been undertaken to study trends in air pollution. Several of the models that participated in this

study have been used to provide the scientific basis to European air quality policy. Targeted ground-based measurement activities have studied the sources of air pollution at selected emission hotspots in Europe and China.

Did you encounter any setbacks during the course of your research?

No major setbacks were encountered but the ambitious nature of the project has made it challenging. However, this is an evolving field of research, and novel developments both in observations and in modelling can further increase confidence in the CityZen findings.

The modification of the atmosphere by man is very non-linear. The tools for studying and diagnosing the feedback between atmospheric chemistry and climate change are new and evolving worldwide. The chemical complexity of the atmosphere and the changes in the influence by the vegetation, ocean and meteorology with climate changes are challenging to quantify accurately, requiring further evolution of our measurement systems and our numerical modelling capability. Sustainable development requires measurements and modelling to manage internationally the impact of air pollution on human health, food production and ecosystem services.

The CityZen project ended in August 2011. How would you rate its success and were you able to achieve what you set out to understand about the environmental effects of megacities?

Fortunately, the project objectives have been achieved in full. CityZen research was undertaken by an international group of talented researchers and has significantly

Megalopolitan measures

The EU-funded **CityZen** project has been quantifying the influence of megacities on air quality and climate, and assessing future change scenarios in order to influence environmental policy making

SINCE 2008 THE majority of the world's population has been living in urban areas, many in megacities – cities with populations over 10 million – and this trend is expected to continue. Megacities and regional hotspots have developed with anthropogenic emissions and changes in land usage that are likely to have large environmental implications, both in the regional hotspots themselves and on a larger scale.

Rapid economic growth and changes in lifestyle in megacities are not often followed by an equally rapid growth in infrastructure, such as road construction or public transportation systems, and this can lead to inefficient traffic flow and enhanced air pollution. Increasing emissions from emerging and evolving megacities, as well as changes in the emission patterns amplifies several environmental problems; particularly in relation to air pollution, climate change, water resources and soil. The need to deal with this situation in a policy context has now become urgent, as it affects a large part of the world's population.

INVESTIGATING MEGACITIES AND AIR POLLUTION

In 2008, the megaCITY – Zoom for the environment (CityZen) project was initiated to address this pressing research need, and for the last three years the project team has been investigating air pollution distribution and change in and around selected megacities and emission hotspots using satellite and in situ observations, as well as atmospheric models.

Funded through the EU's Seventh Framework Programme (FP7), CityZen has involved researchers from 17 institutes in 10 countries from Europe, Africa and Asia and has been coordinated by Michael Gauss at the Norwegian Meteorological Institute in Oslo.

CityZen has been using a series of local, regional and global scale models to analyse the impacts of air pollution hot spots on regional and global air quality, together with potential future changes assuming various climate scenarios. The Eastern Mediterranean, the Po Valley in Italy, the BeNeLux region and the Pearl River Delta in China were chosen for intensive case studies. The environmental issues considered in the project included: reduced air quality; ecosystem damage; transport of air pollution to the regional and global scales; the influence of air pollution on weather and climate; and the effects of climate change on the emissions and air quality in megacities and their surroundings.

In order to address these issues, the following main objectives were defined for CityZen:

- Quantify and understand current air pollution distribution and development in and around selected megacities and hot spot regions
- Estimate the future impact from emission changes
- Estimate how megacities influence climate change

- Estimate how megacities are responding to climate forcing
- Study mitigation options to reduce air pollution in and around megacities
- Develop tools to estimate interactions between different spatial scales
- Provide technical underpinning of policy work

INTERNATIONAL APPROACH

Gauss believes that an international approach to the global problems of air pollution and climate change is essential, both within science and in policy. The CityZen consortium included some of the leading institutes in air quality and climate research from European, Asian and African research communities: "As air quality and climate change are inherently connected, CityZen represents an important step towards the integration between these communities," Professor Maria Kanakidou explains.

CityZen is unusual among EU projects, in having three formal partners outside the European Union. Professor John Burrows, reflects that the project's contact with Turkey was especially fruitful, since new unique datasets on air pollution in Istanbul and remote locations in Turkey were collected and analysed within the project: "Clearly, learning from the success of CityZen for future projects in this regard makes excellent sense," he enthuses.



The heterogeneous character of the consortium and the inclusion of partners from different fields – many of whom had not previously worked together, and three of whom had no or limited experience of EU projects, required significant coordination efforts on Gauss's part in order to integrate European research into a global context: "These efforts have been rewarding, the established collaboration will continue and the findings and developed tools will be highly valuable for research and policy support beyond the lifetime of CityZen," he notes.

UNPRECEDENTED RESULTS

Now complete, the project has produced some unprecedented results. Importantly, CityZen has demonstrated that climate change and air pollution, which in the past have been separated, are highly connected and need to be studied in combination.

Furthermore, from model and observational results, the CityZen team have made it possible to derive globally comparable trends, and to make predictions for the future. For example, the consortium has documented recent changes in air quality levels and threshold exceedances in the conurbations, the megacities and some downwind locations. They have found that concentrations of key ozone precursors have been decreasing over Europe during the last decade, but increasing over China. However, decreases in surface concentrations of ozone over Europe have been very small, reflecting the non-linearity of ozone catalytic production in the troposphere.

Moreover, the team has found that the impact of megacities emissions on air quality is increased when combined with emissions from natural sources and from long-range transported pollution. Open fire emissions have also been shown to significantly increase air pollutant levels over large areas downwind, including megacities, and are expected to increase in a warmer climate. Air quality will also deteriorate

in the future due to temperature increases if no compensating measures are taken. Projected emission reductions would, over Europe, lead to reductions in ozone and particulate matter.

Unsurprisingly, no positive influences of megacities on the environment were found: "We have, however, noted that within densely populated areas, there is potential to plan infrastructure and resource usage in a more efficient manner and, for example, lowering the energy consumption per human capita should be possible," Burrows adds. Further studies are required to recommend an optimum balance taking into account different socioeconomic issues.

DISSEMINATING RESULTS, INFLUENCING POLICY

Long-range transported air pollution and the influence of global climate change on local air pollution justify the urgent need for international regulation of all relevant surface emissions of air pollutants and radiatively active atmospheric constituents.

As an important outreach activity for policy use, all partners in the consortium have been asked to identify the main policy messages from their research within CityZen, and compile them into five concise policy brief leaflets to be disseminated among policy makers and stakeholders.

The dissemination of CityZen results will continue to occur through the project's web sites, peer-reviewed publications, reports, presentations, press releases and other channels. Results from CityZen will feed into the ACCENT-Plus Ozone and Methane synthesis and into the forthcoming EU report to support the review of European Air Quality policy. Individual partners are also contributing to the next assessment of the Intergovernmental Panel on Climate Change and they will continue to contribute with their tools and results to the scientific basis for climate policy.

INTELLIGENCE

CityZen

MEGACITY – ZOOM FOR THE ENVIRONMENT

OBJECTIVES

CityZen investigates the environmental effects of megacities and large emission hot spots on their local, regional and global environment.

PARTNERS

Meteorologisk institutt, Norway • Peking University, China • Centre National de la Recherche Scientifique; Institut National de l'Environnement Industriel et des Risques, France • Universität Bremen; Rhenish Institute for Environmental Research at the University of Cologne; Forschungszentrum Jülich GmbH, Germany • University of Crete, Greece • Consiglio Nazionale Delle Ricerche, Italy • Norsk Institutt for Luftforskning; Universitetet i Oslo, Norway • Institute of Marine Sciences-Middle East Technical University, Turkey • University of Leicester, UK • International Institute for Applied Systems Analysis, Austria • National Observatory of Athens, Greece • Cairo University Center for Environmental Hazard Mitigation, Egypt • Istanbul Technical University, Turkey

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