04 December 2018
Issue 518
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Source: Relvas, H., and Miranda, A.I. (2018) An urban air quality modeling system to support decision-making: design and implementation. *Air Quality, Atmosphere & Health*. 11 (7): 815–824. DOI:10.1007/s11869-018-0587-z.

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European Commission

Science for Environment Policy

AI-enabled model rapidly assesses plans to cut air pollution

Researchers have developed a new computer model to help decision-makers quickly assess proposed strategies to cut air pollution, by generating an array of useful data and maps in under half a minute. The model uses artificial intelligence (AI) technology to quickly make sense of the complex problem of urban air quality, and innovatively considers the influence of public opinion in its assessment of emission reduction strategies — given that some are deemed more socially acceptable than others.

While we are seeing many positive changes in air quality across Europe, urban populations are often still exposed to levels of pollution that exceed EU standards and WHO guidelines, with significant impacts on human health and the environment. Fine particulate matter ($PM_{2.5}$) alone, for instance, has been estimated to cause 339,000 early deaths per year across the EU. Moreover, death rates could rise under the effects of climate change, which is expected to bring favourable conditions for ozone, another harmful pollutant.

This study presents the Integrated Urban Air Pollution Assessment Model, which is intended to help regional and local authorities design and assess air quality improvement plans. It uses 'artificial neural networks' (computer systems inspired by the human brain) to quickly capture the complex relationship between an emission's source, its concentration in the air, and its ultimate impact on human health.

To demonstrate the model, the researchers applied it to the urban area of Porto in Portugal. This area is densely populated and industrial, and often suffers from high levels of particulate matter. They tested three different strategies for reducing emissions: replacing half of all conventional residential fireplaces with more efficient equipment; implementing more clean technologies, such as filtering equipment, in local industries; and banning diesel cars over 10 years old.

In less than 30 seconds and for each strategy, the model was able to produce emission and concentration maps, predict the financial costs of poor health and mortality caused by the pollution, and determine the costs of implementation.

The fireplace replacement strategy was judged to be the most effective in improving air quality, reducing levels of PM_{10} (particulate matter of 10 µm or less in diameter) levels by up to four micrograms per cubic metre (µg/m^3). The clean technology plan was estimated to cut PM_{10} by 0.6 µg/m^3, while the diesel car plan could see reductions of up to 0.4 µg/m^3 in PM_{10}.

The relatively low impact of the clean technology and diesel car strategies can be explained by the fact that some local industries already use the best available techniques for minimising emissions, and that diesel cars have efficient particulate filters. Nonetheless, both strategies could cut the number of annual premature deaths by 12 and 4, respectively, the study states. The fireplace replacement strategy is calculated to cut the annual number of premature deaths by 65.

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The researchers then used the model to assess the scenarios according to three criteria: social acceptance, the avoided financial cost of poor health and premature deaths, and the cost of implementation. The social acceptance criterion is particularly innovative, the study states, as most models of this type only consider the latter two factors. Social acceptance, which is scored in this study by expert evaluation, is important in the implementation of air quality plans.

The fireside replacement strategy had the highest combined score overall, despite having the lowest social acceptance score of five out of 10 — compared with nine for clean technologies, and 6.5 for diesel car bans. Its implementation cost of €0.64 million/year is far lower than for the clean technology (€3.5 million/year) or diesel ban (€1.03 million/year) strategies. Its financial health benefits are estimated to amount to €2.59 million/year, compared with €0.48 million/year and €0.14 million/year for the clean technology and diesel ban strategies, respectively.

However, the study notes that the assessment is heavily dependent on the importance assigned to each criterion; in this case, social acceptance was assigned a much lower importance than the health and implementation costs.