

# Science for Environment Policy

## Understanding uncertainty in air-quality modelling with new framework

**A recent study develops a framework for implementing IAMs using the Lombardy region of Italy as a case study.** Researchers have run an uncertainty and sensitivity analysis with an environmental model, specifically with an Integrated Assessment Model (IAM) for air quality, demonstrating how model components are sources of uncertainty in the output of an integrated assessment. Policy responses should therefore consider uncertainty and sensitivity when developing measures to improve air quality.

**It is important to evaluate modelling approaches used in environmental management, such as those used to model pollution, to ensure confidence in the decisions that are made as result of their use.** Policies related to air quality control, for instance, can have high social and economic impacts; understanding uncertainty in model results is therefore of particular importance. In Europe, the [FAIRMODE](#) (Forum for Air Quality Modelling) initiative is developing guidelines on 'fitness for purpose' to assess if an air quality model reaches the minimum level of quality to be used in the science-to-policy interface. IAMs are a set of interlinked models, a robustness analysis therefore has to assess the system as a whole.

This study evaluated the robustness of an IAM used in the air-quality domain, specifically the decision to take abatement measures for the particulate matter PM<sub>10</sub>. The researchers first reviewed previous research into methods of analysing uncertainty and sensitivity in air quality models. Uncertainty analysis deals with the effect that uncertainties in inputs into a model have on the results. Sensitivity analysis concerns the accuracy of a model's response to different inputs.

The researchers developed a framework for looking at the uncertainty and sensitivity of IAM results. This involves assessing the uncertainty within different components of the model. The framework was applied to the Lombardy region of Italy, which is a densely populated and industrialised area that is often affected by high PM<sub>10</sub> concentrations. In particular, applying uncertainty analysis showed that mitigation strategies significantly reduced PM<sub>10</sub> concentrations in the model, even when taking into account uncertainties in the results.

Components of the model which can lead to uncertainty include 'drivers', 'pressures', 'air-quality states', 'impacts' and 'responses'. Drivers of air pollution are represented by the levels of activity (traffic, industry, etc.), for which the most important source of uncertainty is the road traffic sector. In particular, there is a lack of reliable data related to non-exhaust emissions. Pressures refer to estimates of pollution emissions and so uncertainty is related to emissions factors — which are the average rates of emissions of sources of greenhouse gases (carbon dioxide, methane) and air pollutants (particulate matter, nitrogen dioxide, ozone). For example, for [agricultural](#) emissions, there is relatively high uncertainty in both activity levels and emission factors. This could be very significant for decisions on which PM<sub>10</sub> abatement measures to take, since agriculture is a major source of ammonia emissions, which can influence levels of particulate matter (PM) pollution.

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Air-quality state reflects the concentrations of pollutants, and related uncertainties can be derived from how this state is measured or which model is used to simulate air quality. The health impacts from air pollution are usually expressed in terms of years of life lost, so that the calculation of exposure levels is the greatest source of uncertainty for this section. For example, it is not possible to directly identify the people affected by mixtures of smoking or air pollutants. Also, health outcomes may not be specifically linked to air pollution, but may be due to combined effects with other factors, such as diet and level of exercise. Finally the researchers say that responses to air pollution should be developed with scientists with a range of different expertise considering costs and the emissions reductions needed for the air quality level desired. They say that at the international level, it is usual to focus on policies "that do not significantly change due to changes in the uncertain model elements".

The study is one of the first to focus on the overall IAM in the context of air quality control. The method used provides an approach for future studies in order to increase the reliability of IAMs as a tool in policymaking. The researchers say that policies in the context of IAMs should define long-term, efficient air-pollution control strategies. In order to ensure that the air-quality policies developed based on IAMs deliver the expected results under a range of scenarios (e.g. climate and energy use), sensitivity and uncertainty analysis need to be applied when developing and running models.

