Estimating the future health impacts of air pollution at the global, regional and urban scales

The project Air-Climate Health Impact Assessment (A-C HIA)

Why is it important to assess future air pollution impacts?

All of us are exposed to air pollution and it poses major health risks throughout the world, in France and other parts of Europe. Exposure to air pollution, including fine particles ($PM_{2.5}$) and ozone, has adverse effects on human health throughout the lifespan.

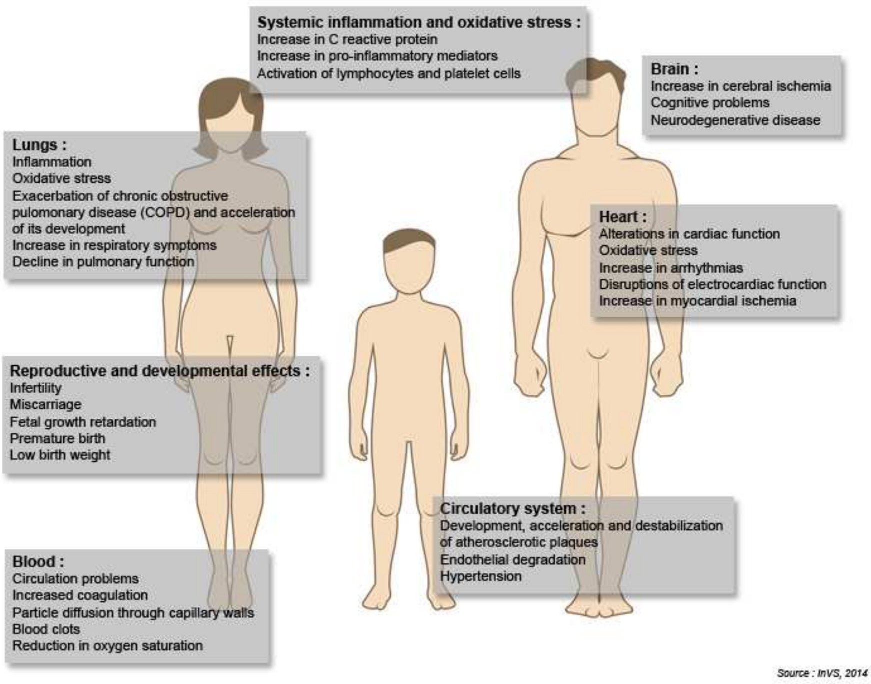
Adverse effects of air pollution exposure include the development of chronic diseases including lung cancer, cardiovascular and respiratory diseases. Air pollution also has been linked to adverse effects on the reproductive system and on neuro-development.

Action to reduce air pollution brings immediate and lasting benefits for the health and well-being of the population.

The A-C HIA project evaluated the influence that policies aimed at reducing air pollution emissions could have on public health in 2030 and 2050, taking into account the influence that climate change may have on air pollution.

The links between air pollution, climate and health provide an incentive to develop ambitious, coordinated strategies to simultaneously reduce pollutants affecting both health and climate change.

A-C HIA, a necessary tool for policy planning, enabling the comparison of potential health benefits associated with future air pollution emission reductions.



Main health impacts of air pollution

How can we estimate future health impacts of air pollution?

One of the unique successes of A-C HIA has been the integration of air quality models enabling the development of comparable results at the global, continental and urban scales.

The A-C HIA project utilized the most current modeling tools for climate, air quality and public health. It compared health impacts of different scenarios of future climate as well as air pollution emissions.

The first step consisted of estimating air pollution concentrations in 2030 and 2050 across the globe, in Europe, and in the Paris region. First it was necessary to select scenarios of future air pollution emissions. The project chose two emission scenarios developed by the European Commission in 2013: the first assumed that currently-enacted air pollution legislation would be fully implemented; the second assumed that all countries will achieve maximally feasible reductions in emissions.

These future air pollution emissions scenarios, along with assumptions about future climate, served as inputs to models that calculated air pollution concentration patterns over space and time.

Meteorology plays an important role in the formation and dispersion of air pollution and in turn, air pollutants can influence meteorology (for example, in forming clouds). Meteorological information used in modeling air pollution comes from the output of climate system models.

Climate models enable us to project future climate that could result from the future evolution of greenhouse gases, based on scenarios developed by the Intergovernmental Panel on Climate Change (IPCC).

The A-C HIA project used the middle-of-the road scenario RCP 4.5, which falls in between more pessimistic and optimistic scenarios.

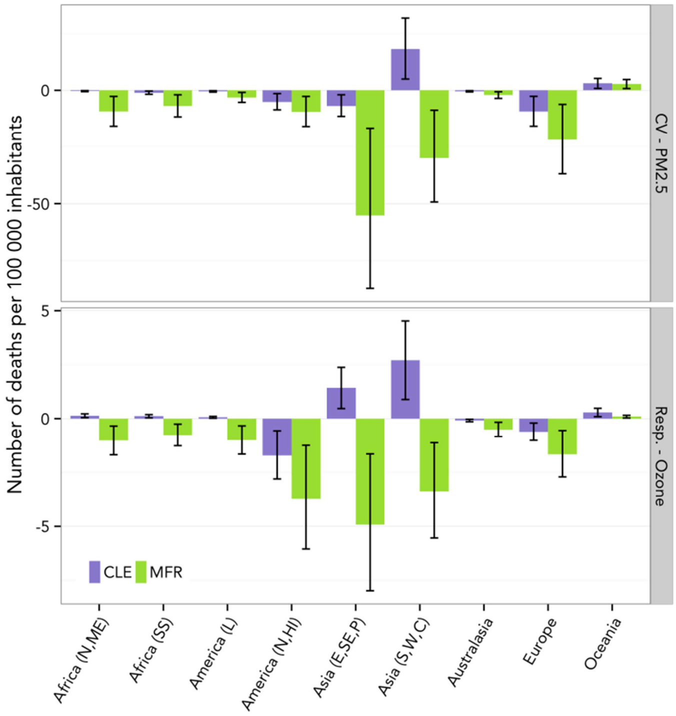
The second step in A-C HIA was to translate the resulting expected air pollution concentrations into impacts on the health of populations. This was done taking into account the latest scientific understanding of the relationships between levels of fine particle and ozone pollution and increased mortality risks.

What are the expected global impacts?

Today more than 2.3 billion people in the world are exposed to levels of fine particles in excess of those recommended by the World Health Organization (10µg/m³). Under the pollution emission scenario in which each country applies future emission reductions according to their current legislation, in 2030 more than 2.8 billion people will still be exposed to levels that are too high. In India, for example, the number of people exposed would go from over 640 million in 2010 to over 1 billion in 2030.

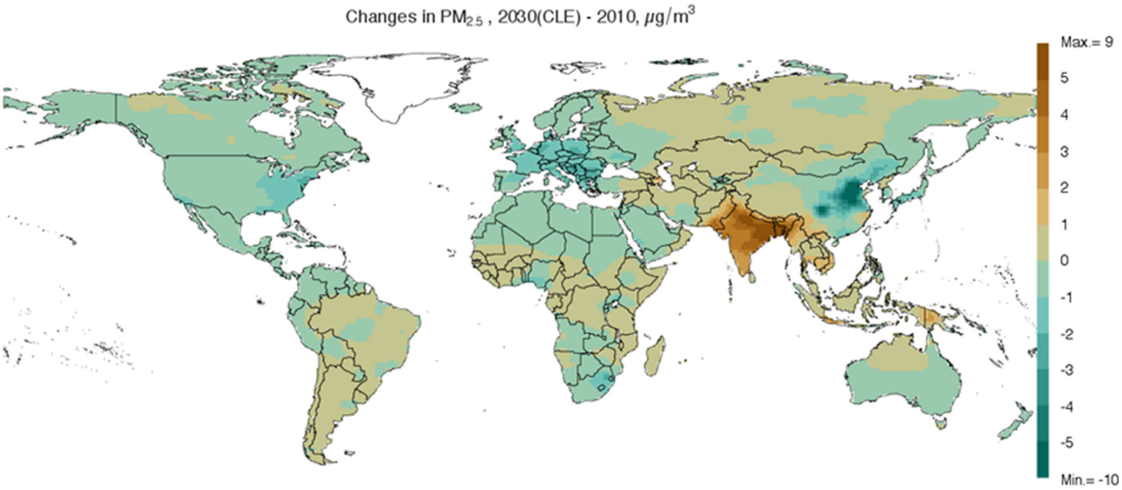
Under this scenario, in 2030 the number of cardiovascular deaths due to fine particles will be larger than at present, with an additional 6,800 annual premature deaths, the majority of which would occur in Asia.

The scenario reflecting the implementation of all available pollution control technologies would lead to a decline in global mortality. Asia is the region that would benefit the most, where fine particle concentrations are projected to decline by four-fold. That scenario also leads to improvements in air quality in both North and South America. In contrast, little change would be projected in Africa.

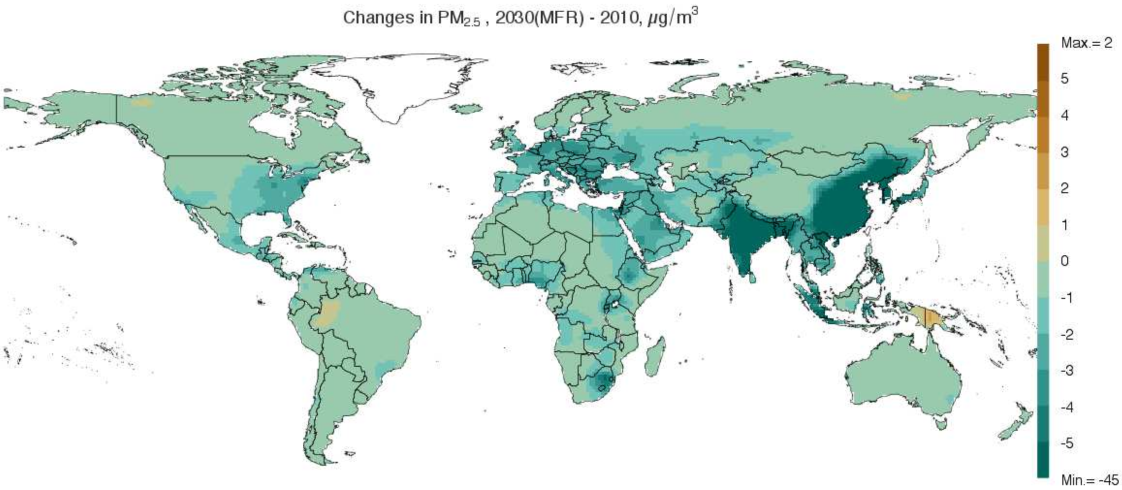


Changes from 2010 to 2030 in the number of global deaths by region due to fine particles and ozone (per 100 000 persons)

Globally, if all countries were to apply pollution controls according to the best available current technologies, 1.5 million premature deaths due to cardiovascular disease could be avoided each year.



Change in concentrations of fine particles ($PM_{2.5}$) in 2030 compared to 2010, estimated according to the scenario of maximum feasible technology.



Change in concentrations of ozone in 2030 compared to 2010, estimated according to the scenario of maximum feasible technology.

Blue indicates reduced concentrations in 2030 vs. 2010 whereas brown indicates increases over time.

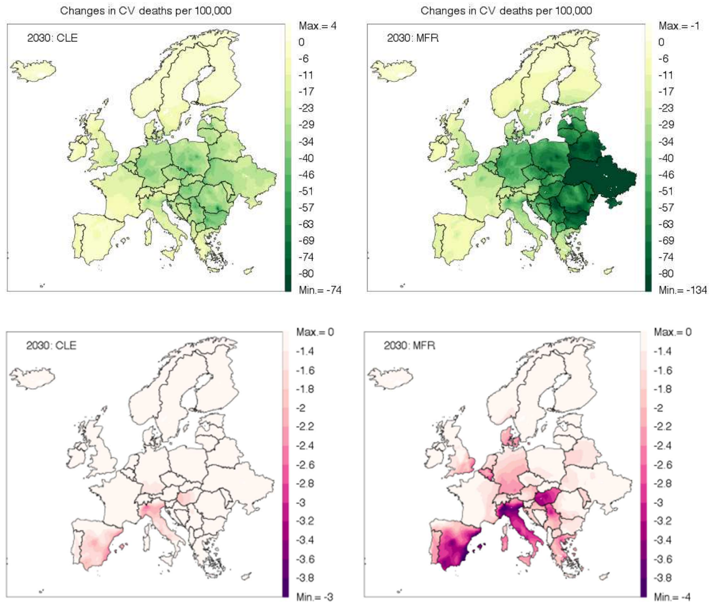
What are the expected impacts in Europe?

In Europe, both scenarios would lead to improvements in air quality and health.

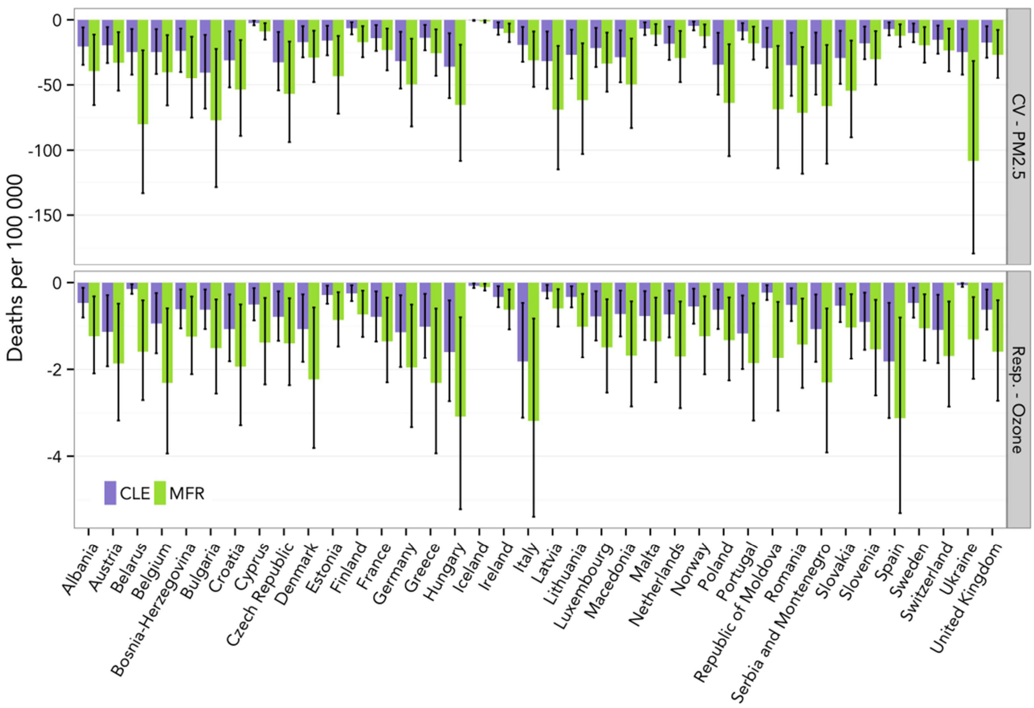
In 2010, more than 250 million Europeans were exposed to levels of air pollution in excess of those recommended by the WHO. The number so exposed could be reduced by half in 2030 if current regulations are fully implemented. By 2030, 109,000 premature cardiovascular deaths could be avoided each year.

If countries put in place all available control technologies to reduce air pollution emissions, the health benefits would double.

The largest benefits related to $PM_{2.5}$ reductions would occur in Eastern Europe whereas benefits for ozone would be largest in Southern Europe.



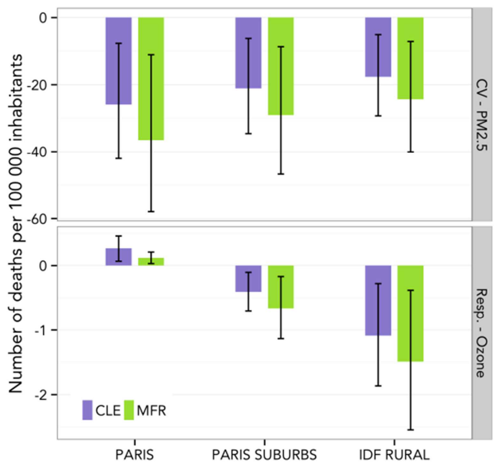
Change in deaths due to fine particles (green) and ozone (rose) in Europe in 2030 as compared with 2010 (per 100,000 persons). The panels on the left reflect implementation of current air regulations; the panels on the righ reflect maximum feasible technologies.



Change in deaths associated with fine particles and ozone in Europe in 2030 as compared with 2010 (per 100,000 persons)

What are the expected impacts in the Paris region?

For the Ile-de-France region, we compared health impacts of air pollution in 2050 to those in 2010.



Change in the number of deaths associated with fine particles and ozone in Ile-de-France in 2050 as compared with 2010 (per 100,000 persons)

In Ile-de-France, in 2050, the more ambitious pollution reduction scenario could avoid more than 2,800 premature deaths each year, a reduction in cardiovascular deaths of nearly 20%.

How might the impacts change between 2030 and 2050?

At the global and European scales, few changes are anticipated between 2030 and 2050 in fine particle-related health impacts. Both scenarios assume that the vast majority of particle reduction measures will already be in place by 2030. In contrast, for ozone at the global scale we anticipate an increase in concentrations and resulting health impacts between 2030 and 2050, related to an increase in meteorological conditions conducive to ozone formation.

What are the limitations of this study?

As with other studies of this general kind, the results of A-C HIA are subject to several uncertainties related to the models and emission scenarios we used. We were not able to take into account all factors that could influence air pollution health effects in the future, and instead examined the impacts/benefits of just two alternative air pollution emission scenarios. To simplify the analysis, for example, we assumed that the population of at-risk persons would stay the same over time.

The spatial scale of analysis and the availability of relevant environmental and health data also affected our results. Due to these factors, results at the global scale were more uncertain than those at the European scale, which were themselves more uncertain than results in Ile-de-France.

Finally, the project only examined air pollution effects on cardiovascular and respiratory deaths, which are only a part of the full range of health impacts related to air pollution. Morbidity effects of air pollution (including asthma, lunch cancer, cardiovascular diseases, etc.) were not included, largely because the necessary data on baseline rates of these diseases were not readily available for all countries across the world.

What do these results mean for public health?

Today, air pollution is an important risk factor for people throughout the world.

Policy makers rely on emissions scenarios and models describing the behavior of the atmosphere to examine and decide among alternative policies aimed at improving the quality of the air. The A-C HIA project contributes importantly to this process by showing the health benefits and impacts of alternative policy choices.

We considered two air pollution emission pathways and one scenario of climate change. The results indicate that substantial benefits for human health could be obtained by putting in place more ambitious, but still achievable, air pollution reductions. The resulting benefits would be shared across multiple countries throughout the world, as well as for individual cities like Paris.

On account of the many impacts of air pollution that were not included in the analysis, the health benefits demonstrated in A-C HIA should properly be viewed as lower-bound estimates.

The additional technologies needed to further reduce air pollution emissions from various sectors will be challenging and costly. However, these costs need to be evaluated alongside the substantial health and economic benefits that will accompany those reductions.

It is important to note that the scenarios considered here only take into account technological measures and do not consider air quality and health benefits resulting from changes in behavior and consumption patterns. For example, increasing the use of active modes of transport (cycling or walking) and public transport can also contribute to improved air quality while promoting better health and welfare.

In the context of climate change, it is essential to coordinate policies to reduce emissions of air pollutants and greenhouse gases, thereby gaining substantial health benefits in the short term while also limiting negative impacts on climate in both the short and long terms.

A-C HIA in a few words

Air pollution affects the health of populations across the world, including in Europe and in France.

The A-C HIA project took place between 2011 and 2014. It was carried out by an interdisciplinary team of specialists in the modeling of air quality, climate and health.

The project compared the benefits resulting from two different future scenarios of air pollution policies between 2010, 2030 and 2050, taking into account climate change during the same period.

The more ambitious air pollution control scenario would enable avoidance of nearly 1.5 million premature deaths across the globe each year by 2030. Nevertheless, by 2050, the negative influence of climate change upon ozone air pollution could offset some of these benefits in certain regions.

However, the strong interactions between air pollution and climate change offer the opportunity to achieve benefits for both health and climate from well-chosen policies. In the coming years, substantial and localized health and economic benefits from air pollution reductions could occur from coordinated strategies.

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The project team

Victoria Likhvar, Didier Hauglustaine, Laboratoire des Sciences du Climat et de l'Environnement (LSCE), Gif-sur-Yvette, France

Patrick Kinney, Department of Environmental Health Sciences, Columbia University in the City of New York, Etats-Unis

Augustin Colette, Institut National de l'Environnement Industriel et des Risques, Ineris, Paris, France

Myrto Valari, Konstandinos Markakis Laboratoire de Météorologie Dynamique (LMD), Institut Pierre Simon Laplace (IPSL), Ecole Polytechnique, Palaiseau, France

Mathilde Pascal, Sylvia Medina, Département Santé Environnement, Institut de Veille Sanitaire, InVS, Saint Maurice, France.

To learn more, http://ac-hia.com

info@ac-hia.com