



UNEP Year Book 2014 emerging issues update

Air Pollution: World's Worst Environmental Health Risk



Unacceptable environmental, social and economic costs

There is an urgent need to reduce levels of air pollution globally. Although air quality measures have had positive results at some locations in the world, millions of people in both developing and developed countries die prematurely every year because of long-term exposure to air pollutants. The health of many more is seriously affected.

Most cities where outdoor air pollution is monitored do not meet the World Health Organization (WHO) guidelines for acceptable pollutant levels. People who live in these cities have increased risks of stroke, heart disease, lung cancer, chronic and acute respiratory diseases (including asthma) and other health problems. Indoor air pollution is another major cause of poor health and premature death, especially in developing countries.

Sources of air pollution include traffic (especially diesel vehicles), industrial sectors (from brick making to oil and gas production), power plants, cooking and heating with solid fuels (e.g. coal, wood, crop waste), forest fires and open burning of municipal waste and agricultural residues.

Particulate matter 2.5 micrometres or less in diameter (PM_{2.5}) is produced by incomplete combustion of fossil fuels and biomass and one of the biggest concerns. One-hundredth the thickness of a human hair, PM_{2.5} can penetrate deep into the lungs and blood stream and is dangerous at any concentration. The International Agency for Research on Cancer (IARC) concluded in 2013 that particulate matter is carcinogenic to humans. Ground-level ozone (O₃) is another important air pollutant, which damages human health and crops. It is estimated that global losses to soybean, maize and wheat crops due to ground-level ozone pollution could be US\$17-35 billion per year by 2030. Reducing emissions of PM_{2.5} and ground-level ozone not only has an immediate effect on air quality, but also mitigates near-term climate change and helps achieve food security.

Over 3.5 million people die each year from outdoor air pollution. Between 2005 and 2010, the death rate rose by 4%

worldwide, by 5% in China and by 12% in India. *Cost of air pollution* to society in 2010 was estimated at US\$1.4 trillion in China and US\$0.5 trillion in India according to a recent study by the Organisation for Economic Co-Operation and Development (OECD). In Europe, exposure to air pollution from road transport costs about US\$137 billion per year and harm caused by air pollution from the 10,000 largest polluting facilities in 2009 – including through lost lives, poor health and crop damage – was about US\$140-230 billion.

The economic cost of air pollution

The cost of air pollution to the world's most advanced economies plus India and China is estimated to be US\$3.5 trillion per year in lives lost and ill health. In OECD countries the monetary impact of death and illness due to outdoor air pollution in 2010 is estimated to have been US\$1.7 trillion.

Improving air quality has the potential to provide enormous economic benefits. In the United States, the direct economic benefits of reducing PM_{2.5} and ground-level ozone pollution under the 1990 Clean Air Act Amendments are estimated to be up to 90 times the cost of implementing them. About 85% of the economic benefits would be due to fewer premature deaths linked to reducing PM_{2.5} in the outdoor environment, with the early deaths of 230,000 people avoided in the year 2020 alone.

[Read more about air pollution in the UNEP Year Book 2010 sections on harmful substances and climate change.](#)

Air pollution: the leading cause of environmentally related deaths

The health impacts of air pollution are much larger than was thought only a few years ago. The World Health Organization (WHO) estimates that in 2012 around 7 million premature deaths resulted from air pollution, more than double previous estimates. The new estimate is based on increasing knowledge of air pollution-related diseases and use of improved air quality measurements and technology. According to WHO, outdoor air pollution caused 3.7 million premature deaths in 2012. Indoor air pollution is responsible for about 4.3 million premature deaths every year.

Outdoor air quality is rapidly deteriorating in major cities in low and middle income countries (LMICs). The WHO guideline for average annual particulate matter (PM₁₀) levels is 20 micrograms per cubic metre. For fine particles (PM_{2.5}) the average annual level is 10 micrograms per cubic metre and 25 micrograms per cubic metre for a 24 hour period. Air pollution levels in cities in LMICs sometimes far exceed these levels. In Kathmandu, Nepal, for example, PM_{2.5} levels of over 500 micrograms per cubic metre have been measured.

About 3 billion people in the world cook and heat their homes with coal and biomass. Air pollutant emissions need to be reduced not only from these inefficient energy systems, but also from agricultural waste incineration, forest fires and charcoal production. In Africa, due to the rapid growth of its cities and megacities, a large increase in air pollutant emissions from burning of fossil fuels and traditional biomass use for energy services is expected in the near future. They

could contribute 50% of global emissions in 2030, according to some estimates. A World Bank study found that in Sub-Saharan Africa implementation of low-sulphur fuels (50 ppm) and cleaning up of vehicles, including motorcycles, would result in health benefits estimated at US\$43 billion over a ten-year period.

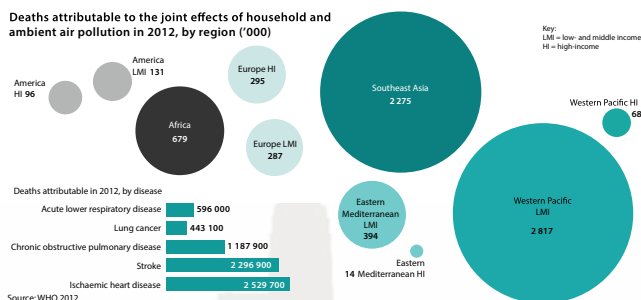
Effective policies and strategies to reduce air pollution work. In many countries, emissions and concentrations of harmful pollutants such as carbon monoxide (CO), sulphur dioxide (SO₂) and lead are lower than a few decades ago. Africa has made good progress in introducing cleaner fuels with the phase-out of leaded petrol. Swiss studies confirm the substantial health benefits of air quality improvements, even in a country with relatively low levels of air pollution.

Many efforts to reduce air pollution go hand in hand with technological enhancements that also improve energy efficiency, thereby producing additional economic and environmental benefits. Although technology is available to make vehicles, agriculture, industrial installations, power plants, waste treatment facilities and other sources less polluting, innovations and their adoption may take time. Moreover, progress in emission reductions per unit can often be outweighed by rapid increases in the number of units (e.g. vehicles).

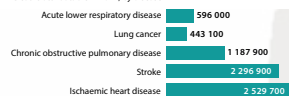
Air pollution in developed countries has decreased in recent years, partly due to tighter emission controls, including on vehicles. Nevertheless, evidence suggests that road transport accounted for 50% of the cost of the health impacts of air pollution – both death and illness – in OECD countries in 2010 (or close to US\$1 trillion). With the rapid growth of traffic in developing countries such as China and India, air pollution has outpaced the adoption of tighter vehicle emission standards. There is insufficient evidence to estimate the share of road transport in total health impacts due to air pollution in developing countries.

Choking to death

Deaths attributable to the joint effects of household and ambient air pollution in 2012, by region ('000)



Deaths attributable in 2012, by disease



Source: WHO 2012

The transboundary challenge of air pollution

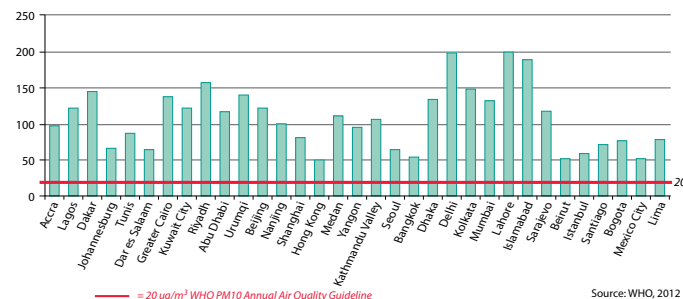
Investing in implementing effective policies to make air cleaner will cost countries far less in the long run than allowing air pollution to worsen. Air pollution is a transboundary issue, and lessons can be learned from past successes in any country. In many cases technological improvements to reduce air pollution can pay for themselves as additional benefits such as energy efficiency are realized.

Enforcement of existing regulations is essential. As part of China's campaign to tackle air pollution, fines for polluting in the first three months of 2014 were ten times the total in the same period the previous year, and more than three times as many polluting companies were fined. The government has announced plans to take up to 6 million vehicles that do not meet emission standards off the roads by the end of 2014. A cap was placed on new vehicle sales in 2013.

The Global Fuel Economy Initiative is working to improve the fuel economy capacity of the global vehicle fleet. Successful international cooperation to phase out leaded petrol under the UNEP-led Partnership for Clean Fuel and Vehicles (PCFV) – and more recent actions to reduce PM_{2.5} emissions and promote a shift to low-sulphur fuels – suggest that the global fleet is becoming less polluting. When the PCFV was launched in 2002, approximately half the world's countries used leaded petrol. As of October 2013, only six countries were still using a small amount. The PCFV phase-out avoids an estimated 1.3 million premature deaths per year.

Research is being carried out in a number of countries to reduce emissions of air pollutants from cookstoves. Over the years, many types of improved cooking stoves have been developed. For example, the Ruiru Youth Community Empowerment Program in Kenya has developed a less polluting firewood-burning stove that is up to 60% more efficient than the open fires traditionally used in rural areas. Youth volunteers have trained around 16,000 local women on the advantages of the new stoves and how to install them. A household cooking and heating stoves initiative of the Climate and Clean Air Coalition (CCAC) helps develop

Annual Average PM 10 Levels of Major Cities



test protocols and standards to ensure lower emissions from such stoves. It also supports projects that scale up alternative cooking solutions.

In several countries low-cost monitoring devices are being developed to measure air pollution levels and exposures. Smartphone apps, for example, allow users to check air quality and look at real-time data on major outdoor air pollution. Also under development are online platforms for releases of real-time monitoring information. UNEP's Surya project uses mobile phones to monitor indoor air pollution.



© Safia Osman

Meeting agreed standards to achieve economic and health benefits

Countries are curbing air pollution by enforcing air quality standards and stimulating the development of cleaner technologies. Target-setting to improve air quality should be based on the latest science – including the best possible estimates of impacts of air pollution on the health of people and ecosystems. Scientists and policy-makers worldwide have ready access to *internationally agreed guidelines* such as the World Health Organization (WHO) air quality guidelines, the Environmental Health Criteria documents and International Agency for Research on Cancer (IARC) studies.

International air quality guidelines

The WHO air quality guidelines provide assessments of the health effects of air pollution and thresholds for pollution levels that are harmful to health. They inform policy makers and provide appropriate targets for a broad range of air quality management policy options in different parts of the world. Environmental Health Criteria documents address the effects of chemicals or combinations of chemicals and physical and biological agents on human health and the environment. The work of the IARC is focused on cancer.

Some countries are more advanced than others in regard to establishing limit and target values as well as requirements to reduce emissions from pollutant sources, monitor emissions and concentrations, and determine exposures. Countries lacking experience can profit from the knowledge already acquired by more advanced ones, keeping in mind local and regional differences including climatic conditions, income levels and consumption patterns.

It has long been recognized that air pollutants are easily transported across borders. Over 50 countries are engaged in effective cooperative work under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution. Existing cooperation

between government agencies and other bodies at national and regional levels through networks and other mechanisms can be further expanded. Air quality assessments would help identify gaps in countries' capacity to address air pollution and identify new opportunities for cooperation.

Data collection and sharing is of fundamental importance in addressing air quality issues and measuring policy effectiveness. Despite some progress, air quality data are often scattered or incomplete and not easily available.

Emissions of outdoor air pollution from major sources can be reduced through policies and investments that support less polluting and more energy-efficient transport, housing and industries, as well as improved power generation, municipal waste management and agricultural practices. Actions that reduce air pollution can also reduce climate impacts. Black carbon, for example, is one of three short-lived climate pollutants targeted for reduction by the CCAC along with methane (CH₄) and hydrofluorocarbons (HFCs). It has been estimated that 'fast action' on black carbon and methane would potentially cut the rate of climate change in half for the next several decades, as well as reducing air pollution-related deaths by as much as 2.4 million per year and avoiding annual crop losses of 50 to more than 100 million tonnes. Opportunities clearly exist to tackle air pollution and other severe health and environmental problems cost-effectively using integrated approaches.



© UNEP

For video links please go to <http://vimeo.com/80295930>

Further information about air pollution

- Avner, S. et al. (2011). Global crop yield reductions due to surface ozone exposure: 2. Year 2030 potential crop production losses and economic damage under two scenarios of O₃ pollution. *Atmospheric Environment*, 45, 13, 2297-2309 <http://www.sciencedirect.com/science/article/pii/S1352231011000070>
- Bell, M.L. and Davis, D.L. (2001). Reassessment of the lethal London fog of 1952: novel indicators of acute and chronic consequences of acute exposure to air pollution. *Environmental Health Perspectives*, Suppl. 3, 389-394 <http://www.ncbi.nlm.nih.gov/pubmed/11427388>
- Burnett, R.T., et al. (2014). An Integrated Risk Function for Estimating the Global Burden of Disease Attributable to Ambient Fine Particulate Matter Exposure. *Environmental Health Perspectives*, DOI:10.1289/ehp.1307049 <http://ehp.niehs.nih.gov/1307049/>
- Duggan, J. (2014). China to scrap millions of cars to ease pollution. China to take 6 million old cars off the road in a bid to improve air quality in smog-hit regions. News article, 27 May <http://www.theguardian.com/environment/chinas-choice/2014/may/27/china-scrap-millions-cars-reduce-air-pollution>
- e-360 (2013). Beijing to limit new cars by 40 percent in anti-pollution drive. News article, 5 November http://e360.yale.edu/digest/beijing_to_limit_new_cars_by_40_percent_in_anti-pollution_drive/3994/
- EEA (European Environment Agency) (2011). Industrial air pollution cost Europe up to € 169 billion in 2009, EEA reveals <http://www.eea.europa.eu/media/newsreleases/industrial-air-pollution-cost-europe>
- EEA (2013a). Reducing the € 45 billion health cost of air pollution from lorries <http://www.eea.europa.eu/media/newsreleases/reducing-the-20ac-45-billion>
- EEA (2013b). New Sensing Technologies and Methods for Air-Pollution Monitoring http://www.cost.eunetair.it/cost/meetings/docCopen/11-BOOKLET_TD1105_EEA_Copenhagen.pdf
- Evans, J., et al. (2013). Estimates of global mortality attributable to particulate air pollution using satellite imagery. *Environmental Research*, 120, 20,33-42 http://patarnott.com/satsens/pdf/globalMortalityPM_satellite.pdf
- Fang, Yuanyuan et al. (2013). Impacts of 21st century climate change on global air pollution-related premature mortality. *Climatic Change*, 121(2):239-253 <http://link.springer.com/article/10.1007%2Fs10584-013-0847-8>
- Gurung, A. and Bell, M.L. (2012). Exposure to airborne particulate matter in Kathmandu Valley, Nepal. *Journal of Exposure Science and Environmental Epidemiology*, 22(3):235-242
- IARC (International Agency for Research on Cancer) (2013). Air Pollution and Cancer. IARC Scientific Publication No. 161 (K. Straif, A. Cohen and J. Samet, eds.) <http://www.iarc.fr/en/publications/books/sp161/index.php>
- IARC and WHO (World Health Organization) (2013). IARC: Outdoor air pollution a leading environmental cause of cancer deaths. News release, 17 October http://www.iarc.fr/en/media-centre/pr/2013/pdfs/pr221_E.pdf
- Lioussé, C., et al. (2014). Explosive growth in African combustion emissions from 2005 to 2030. *Environmental Research Letters*, 9, 3, 035003 <http://iopscience.iop.org/1748-9326/9/3/035003/article>
- Loomis, D., et al. (2014). The International Agency for Research on Cancer (IARC) evaluation of the carcinogenicity of outdoor air pollution: focus on China. *Chin J Cancer*. 33(4):189-96 <http://www.ncbi.nlm.nih.gov/pubmed/24694836>
- OECD (Organization for Economic Co-operation and Development) (2012). OECD Environmental Outlook to 2050 (Chapter 6, "Health and Environment") <http://www.oecd.org/environment/indicators-modelling-outlooks/oecdenvironmentaloutlookto2050theconsequencesofinaction.htm>
- OECD (2014). The cost of air pollution: Health impacts of road transport <http://www.oecd.org/environment/cost-of-air-pollution.htm>
- Pyper, J. (2014). Air pollution is a \$1.7T health problem, OECD finds. News story, 22 May <http://www.eenews.net/stories/1060000041>
- UNEP (United Nations Environment Programme) (2010). "Harmful Substances and Hazardous Wastes" and "Climate Change" chapters in UNEP Year Book 2010: New Science and Developments in Our Changing Environment http://www.unep.org/yearbook/2010/PDF/2_Harmful_substances_2010_low.pdf http://www.unep.org/yearbook/2010/PDF/3_climate_change_2010_low.pdf
- UNEP (2011) Near-term Climate Protection and Clean Air Benefits: Actions for Controlling Short-Lived Climate Forcers - A UNEP Synthesis Report <http://www.unep.org/ccac/Publications/Publications/tabid/130293/Default.aspx#sthash.89chc6Yl.dpuf>
- University of Massachusetts (2014). Updating Air Pollution Measurement Methods with UMass Amherst Air Quality, Health Effects. News release, 6 January <http://www.umass.edu/newsoffice/article/updating-air-pollution-measurement-methods>
- US EPA (United States Environmental Protection Agency) (2011). Second Prospective Study – 1990 to 2020 <http://www.epa.gov/cleanairactbenefits/prospective2-2.html>
- US EPA (2013a). EPA Village Green Project <http://village-green.epa.gov>
- US EPA (2013b). Scientists evaluate air sensors developed during EPA's Air Sensor Evaluation and Collaboration Event <http://www.epa.gov/nerl/features/sensors.html>
- US EPA (2013c). Next generation air monitoring <http://www.epa.gov/research/airsience/air-sensor-research.htm>
- US EPA (2014). Clean Cookstove Research: <http://www.epa.gov/research/airsience/air-cleancookstove.htm>
- Wang Hongyi (2014). University unveils new air purifier technology. News article, 7 January. http://www.chinadaily.com.cn/china/2014-01/07/content_17219181.htm
- WHO (World Health Organization) (2005). WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Global update 2005. Summary of risk assessment http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf?ua=1
- WHO (2014a). Air quality deteriorating in many of the world's cities. News release, 7 May <http://www.who.int/mediacentre/news/releases/2014/air-quality/en/>
- WHO (2014b). 7 million premature deaths annually linked to air pollution. New release, 25 March <http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/>
- WHO (2014c). Ambient (outdoor) air quality and health. Fact Sheet No. 313, update March 2014 <http://www.who.int/mediacentre/factsheets/fs313/en/>
- WHO (2014d). Frequently Asked Questions. Ambient and Household Air Pollution and Health. Update 2014 http://www.who.int/phe/health_topics/outdoorair/databases/faqs_air_pollution.pdf?ua=1
- World Bank (2013). An analysis of physical and monetary losses of environmental health and natural resources. Vol. 1 of India - Diagnostic assessment of select environmental challenges <http://documents.worldbank.org/curated/en/2013/06/18009327/india-diagnostic-assessment-select-environmental-challenges-vol-1-3-analysis-physical-monetary-losses-environmental-health-natural-resources>
- World Bank and the Development Research Center of the State Council, the People's Republic of China (2014). Urban China: Toward Efficient, Inclusive, and Sustainable Urbanization <http://www.worldbank.org/content/dam/Worldbank/document/EAP/China/WEB-Urban-China.pdf>