Policy Brief for GSDR – 2016 Update

The rapidly growing death toll attributed to air pollution: A global responsibility

Pedro Piqueras[1,2], Ashley Vizenor[1,2 *]

[1]University of California, Riverside, Department of Chemical and Environmental Engineering., [2] College of Engineering Center for Environmental Research and Technology (CE-CERT), Riverside, California, USA

Introduction

According to estimates published by the World Health Organization, 7 million people died as a result of air pollution exposure in 2012 (WHO, 2014). This number signifies one out of eight total global deaths, confirming that air pollution is now the world's largest single environmental health risk, killing more people than malaria and AIDS. Air quality isn't just the concern of a single nation; the matter calls for universal cooperation, as air is a natural resource that does not obey geopolitical boundaries.

Air pollution is largely caused by the burning of fossil fuels resulting from unsustainable regional policies and the lack of affordable green technology transfer. While the severity of pollution may be regionally dependent, polluted air causes a myriad of life-threatening diseases. Consequently, it aggravates the economic and social welfare of those that suffer its repercussions, thus impeding prosperity and development at a global scale.

Interdisciplinary strategies are necessary to achieve global health standards and to reduce the death toll while ensuring stability in both developing and developed countries. Understanding the source of the issue, its consequences and establishing partnerships at the local, national and global level are imperative in designing mitigation strategies, instituting minimum air quality standards and enforcing environmental law. Through mutual collaboration and deliberate commitment, the international community is surely capable of addressing this issue and subsequently ensuring healthier living conditions to all citizens of the world.

Outdoor air pollution

Outdoor air pollution contributes to 3.3 million premature deaths worldwide per year and it is estimated that the number of deaths will double by 2050 if the issue remains unattended (Lelieveld et al, 2015). Globally, the production of energy for commercial and residential use is the main source of emitted atmospheric pollutants. In most of the Global North (Europe, Russia, Japan, South Korea and the Northeastern United States), agriculture is the leading cause of air pollution related deaths, making it the second most polluting source worldwide. The largest agricultural pollutant is ammonia, which comes from the defecation of livestock, which can be carried more than 300 miles through the air before being dumped back onto the ground or into water, where it also causes algal blooms and fish kills (NRDC, 2013). The following major contributors to anthropogenic (man-made) emissions and therefore the number of victims are industry, biomass burning and traffic. The Western

Pacific region, followed by the eastern part of the Mediterranean and Southeast Asia suffer the highest mortality rate per capita in the world, with 70% of total deaths occurring in South and East Asia. China, India and Pakistan account for the highest death toll (1.36 million, 645,000 and 111,000 respectively). Of the Western countries, the United States ranks highest, with a mortality rate of 54,905. (Lelieveld et al, 2015).

Indoor air pollution

One-third of the world's population burns organic material such as wood, dung or charcoal for cooking, heating and lighting (Fullerton et al, 2008). Pollution from the combustion of these fuels causes severe diseases and significant death rates worldwide. Citizens of developing countries are especially susceptible to indoor air pollution due to a lack of ventilation in a large percentage of households. It is estimated that 4.3 million deaths are caused annually by indoor air pollution only (WHO, 2014). Indoor air pollutants affect the respiratory and cardiovascular systems, and the severity of the effect varies according to the intensity and the duration of exposure, and the health status of the population exposed (Hoskins, 2010). The main victims of this type of pollution are women and children, as they tend to spend the longest amount of hours indoors. Indoor air pollution can also affect a fetus' development during its gestation and it can cause complications both during the pregnancy and after the child is born (Kadir et al 2010).

Sources and consequences

Chronic obstructive pulmonary disease (COPD), ischemic heart disease (IHD), acute lower respiratory illness (ALRI) and lung cancer have been associated with most air pollution related deaths (WHO, 2014). COPD is mainly caused by ozone, while IHD, ALRI and lung cancer have been associated with the inhaling of fine particles (PM or particulate matter). While ozone can only form outdoors, PM can be present in both indoor and outdoor settings.

Ozone (O_3) is not a pollutant that is directly emitted into the air. It is a gas that forms as a product of chemical reactions between anthropogenic nitrogen oxides (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Although ozone is beneficial in the stratosphere to protect the earth from harmful solar radiation (McClaure-Begley et al, 2014), ground-level or tropospheric ozone can trigger a variety of health problems, particularly for children and the elderly. It can also lead to an increase in markers of morbidity such as asthma attacks, hospital admissions, and death.

PM or "particulate matter", are microscopic particles suspended in the air that can be emitted by human activities or natural events. These particles can be primary (emitted directly from a source) or secondary (forming from the reaction of existing gaseous pollutants in the atmosphere). $PM_{2.5}$, particles of 2.5 micrometers in diameter or less, are much smaller than a grain of sand and even twenty times thinner than a human hair. They are small enough to enter the lungs and directly penetrate into the blood stream. Exposure to $PM_{2.5}$ has been shown to be the largest contributor to the adverse cardiovascular effects that result in increased hospitalizations and emergency visits for heart attacks, strokes and death (Shah et al 2015). Although all $PM_{2.5}$ is detrimental to

health, carbonaceous $PM_{2.5}$ from combustion of fossil fuels, such as gasoline and coal, are more toxic than natural particles like dust or small sand fragments (Tuomisto et al, 2008).

The climate-health connection

While air pollution is a known threat to human health, it also poses a threat to global climate. Most people are aware of the warming of the planet due to anthropogenic carbon dioxide (CO_2) emissions. Nonetheless, these emissions only affect human health indirectly by intensifying climate change's catastrophic aftermath. Breathing carbon dioxide is not harmful to humans. However, short lived climate pollutants (SLCP), such as particulate matter, methane (CH_4) and tropospheric ozone, can cause harmful health effects as previously mentioned, while also affecting climate. Their relative climate potency, when measured in terms of how they heat the atmosphere, can be tens, hundreds, or even thousands of times greater than that of CO_2 (ARB, 2015), but they do not remain in the atmosphere as long.

The potential benefits from reducing SLCPs are similar to those of CO_2 reduction. Mitigating SLCP emissions could lead to climate benefits as it will assist the slowdown of global warming and consequently reduce sea level rise while improving regional air quality. It will also benefit economic well-being by reducing disease and protecting endangered ecosystems worldwide (ARB, 2015)

Mitigation for global development

Air pollution is a multifaceted, complex and interlocked global burden. Every nation plays an important role and as such, all nations have the responsibility to assuage the matter.

In order to advance the sustainable development agenda, there are a series of objectives that the global community must pursue to overcome the challenges attributed to pollution that the world is currently facing. These include furthering public awareness on air pollution, encouraging scientific progress in regards to air pollution and its subsequent effects on health and climate change, demanding the institution of clean air standards, and protecting our community members by making local efforts to reduce public risks. Endeavors should be focused on marginalized areas where the harm is greatest and technologies haven't yet reached.

By implementing clean and affordable modern technology inside homes, the death toll and disease rates among women and children due to indoor air pollution could be greatly diminished. This would grant possibilities for female empowerment while also ensuring healthy and learning- conducive childhoods.

As many countries are still in process of industrialization, it is important to promote air pollution mitigation technologies such as catalysts, filters and renewable energy replacements to make cities safer, sustainable, and more resilient. This is only possible by the implementation of global partnership and mutual agreement.

Efforts should identify the opportunities and challenges of air pollution as one of today's predominant issues for global science policy. Universal fundamental principles should therefore be adopted in response to this issue. It is important to globally recognize

access to clean air as a crucial component of health and as a service that should be incorporated within the pantheon of essential public health services akin to clean water, vaccinations and primary care.

Monitoring and lessening harmful emissions of both outdoor and indoor air pollution would improve the wellbeing of all citizens while halting climatological variations that could later cause more convoluted complications. By approaching the issue one community at a time, millions of lives could be saved while axiomatically addressing climate change. It is a nexus that is vital to the survival of all civilizations and the planet as a whole.

References

ARB, 2015 "Short-Lived Climate Pollutants." 2016. Accessed February 15. (http://www.arb.ca.gov/cc/shortlived/shortlived.htm).

Fullerton, Duncan G., Nigel Bruce, and Stephen B. Gordon. 2008. "Indoor Air Pollution from Biomass Fuel Smoke Is a Major Health Concern in the Developing World." *Transactions of the Royal Society of Tropical Medicine and Hygiene* 102 (9). trstmh.oxfordjournals.org: 843–51.

Hoskins, John A. 2010. "Health Effects Due to Indoor Air Pollution." In *Survival and Sustainability*, 665–76. Environmental Earth Sciences. Springer Berlin Heidelberg.

Kadir, Muhammad Masood, Elizabeth M. McClure, Shivaprasad S. Goudar, Ana L. Garces, Janet Moore, Marie Onyamboko, Christine Kaseba, et al. 2010. "Exposure of Pregnant Women to Indoor Air Pollution: A Study from Nine Low and Middle Income Countries." *Acta Obstetricia et Gynecologica Scandinavica* 89 (4). Taylor & Francis: 540–48.

Lelieveld, J., J. S. Evans, M. Fnais, D. Giannadaki, and A. Pozzer. 2015. "The Contribution of Outdoor Air Pollution Sources to Premature Mortality on a Global Scale." *Nature* 525 (7569). nature.com: 367–71.

McClure-Begley, A., I. Petropavlovskikh, and S. Oltmans. 2014. "NOAA Global Monitoring Surface Ozone Network, 1973--2014, National Oceanic and Atmospheric Administration, Earth Systems Research Laboratory Global Monitoring Division." *Boulder, CO, Doi* 10: V57P8WBF.

NRDC, 2015 "Facts about Pollution from Livestock Farms." (http://www.nrdc.org/water/pollution/ffarms.asp).

Shah, Anoop S. V., Kuan Ken Lee, David A. McAllister, Amanda Hunter, Harish Nair, William Whiteley, Jeremy P. Langrish, David E. Newby, and Nicholas L. Mills. 2015. "Short Term Exposure to Air Pollution and Stroke: Systematic Review and Meta-Analysis." *BMJ* 350 (March). British Medical Journal Publishing Group: h1295.

Tuomisto, Jouni T., Andrew Wilson, John S. Evans, and Marko Tainio. 2008. "Uncertainty in Mortality Response to Airborne Fine Particulate Matter: Combining European Air Pollution Experts." *Reliability Engineering & System Safety* 93 (5). Elsevier: 732–44.

WHO (2014) "Burden of Disease from Ambient Air Pollution for 2012." n.d. (http://www.who.int/phe/health_topics/outdoorair/databases/AAP_BoD_results_March2014.pdf)

WHO (2014) "Household (Indoor) Air Pollution." 2014, November. World Health Organization. (http://www.who.int/indoorair/en/)

WHO (2014) "WHO | 7 Million Premature Deaths Annually Linked to Air Pollution." 2014, March. World Health Organization. (http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/)