SOUTH CENTRE

POLICY BRIEF

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Air pollution -- the silent top global cause of death and of climate change

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I. Introduction and Background

Air pollution is emerging as one of the main causes of deaths and serious ailments in the world. Emissions that cause air pollution and are Greenhouse Gases are also the main factor causing climate change. Therefore, reducing air pollution should be of the highest priorities, both globally and nationally.

Recent research is showing that air pollution is the number one environmental cause of human deaths and kills more people annually than road accidents, violence, fires and wars combined.

This "silent killer" is not as dramatic or visible as car crashes, murders, terrorist attacks or natural disasters, but it is nevertheless even more dangerous as it contaminates vital organs, causing serious diseases and deaths to many millions of people.[1]

Altogether 6.5 million people worldwide are estimated by the World Health Organization to have died prematurely in 2012[2] because of air pollution. There was a total of 56 million deaths worldwide in 2012. This means that 11.6% of all deaths worldwide, or one in nine, were attributable to air pollution, outdoor and indoor combined.

The Economist

Heavy dust and smog make for a difficult journey in New Delhi, India in November 2016.

In comparison, there were 5 million deaths from all injuries including from road accidents (1.3 million deaths), falls, fires, and war in 2012, according to WHO data.

In several WHO documents[3], it was estimated that there are 4.3 million deaths attributable to indoor pollution and another 3.7 million deaths to outdoor pollution. The number of outdoor pollution deaths has most recently been revised to 3 million.

Because some deaths may be due to both outdoor and indoor pollution, it is not possible to add up the two figures to obtain the total deaths. Thus in its latest estimate (September 2016), the WHO has explained that there were 6.5 million deaths from both outdoor and indoor air pollution in 2012.[4]

With 11.6% of total deaths annually attributed to it, air pollution is one of the top (if not the top) causes of deaths in the world. Tobacco use is usually described as the world's leading preventable cause of death; it is responsible for nearly 6 million deaths annually, or around 10% of total deaths. Air pollution may have taken over as the world's leading cause of death.

A new UNICEF study (released on 31 October 2016) has also revealed that air pollution is a major contributing factor in the deaths of around 600,000 children under five every year, and around 2 billion children live in areas where outdoor air pollution exceeded the WHO air quality guidelines.

Besides its threat to human lives and health, air pollution is also the major cause of climate change as it is responsible for much of the Greenhouse Gas emissions. At current rates of emissions, there will be a rise in global temperature of far more than 1.5 or 2 degrees Celsius compared to pre-industrial era levels, and this is widely believed to have the potential to cause catastrophic effects to the global environment, food supplies and also to human health.

Thus, air pollution ranks as the biggest threat to both human health and the environment.

Reducing this pollution should therefore be at the top of the global agenda as well as national agendas.

II. Outdoor Air Pollution

In September 2016, the WHO for the first time published country-by-country details about the extent of outdoor air pollution and the deaths associated with it, in its report, "Ambient air pollution: a global assessment of exposure and burden of disease."

The WHO report[5] shows that 3 million premature deaths worldwide were linked to ambient or outdoor air pollution in 2012. Of this, 88% of the deaths were in developing countries and two out of three occurred in Southeast Asia and the Western Pacific regions.

Two countries alone accounted for more than half of the total deaths -- China with 1.03 million and India with 621,138.

Other high-numbered countries include Russia (140,851), Indonesia (61,792), Pakistan (59,241), Ukraine (54,507), Nigeria (46,750), Egypt (43,531), the United States (38,043), Bangladesh (37,449), Turkey (32,668), Japan (30,790) the Philippines (28,696), Vietnam (27,340), Poland (26,589), Iran (26,267), Brazil (26,241), Germany (26,160).

Most of the deaths attributable to outdoor air pollution were caused by non-communicable diseases, especially ischaemic heart diseases (36% of the total deaths), strokes (36%), lung cancer (14%), chronic obstructive pulmonary disease (8%), and acute lower respiratory infections (8%).

The situation is truly pervasive: 92% of the world's population are exposed to the dangers of unsafe air quality as they live in places that do not meet the WHO health standard for outdoor air quality.

The world as a whole has an annual median exposure to outdoor mean annual concentration of PM2.5 of 39 microgram per cubic metre. This is four times above the WHO's guideline limit of 10 microgram per cubic metre for PM2.5.

The regions with the highest outdoor air pollution rates are Eastern Mediterranean high-income countries (91 microgram per cubic metre of PM2.5), Eastern Mediterranean low and middle income countries (55), Southeast Asia (55), Western Pacific low and middle income countries (49) and Africa (32).

Countries with high incidence of outdoor air pollution include Saudi Arabia (108 microgram per cubic metre of PM2.5), Qatar (103), Egypt (93), Bangladesh (84), Kuwait (75), Cameroon (65), Mauritania (65), United Arab Emirates (64), India (62), Libya (61), Pakistan (60), Bahrain (60) and China (54).

The PM2.5 level is the annual median concentration of particulate matter of a diameter less than 2.5 micrometres. PM2.5 includes very fine (and thus the most damaging) particles of pollutants such as sulphate, nitrates, ammonia, sodium chloride, black carbon and mineral dust, which penetrate and lodge deep inside the lungs and in the cardiovascular system, posing the greatest health risks of developing cardiovascular and respiratory diseases and lung cancer.

Air quality is normally measured in terms of daily or annual mean concentrations of PM10 or PM2.5 particles (with diameter of 10 or 2.5 micrograms) per cubic metre of air volume.

(The limits in the WHO guidelines for particulate matter (PM) outdoor pollution is an annual mean of 10 microgram per cubic meter for particles below the size of 2.5 microns in diameter, and 20 microgram per cubic metre for particles below 10 microns in size.)

Besides from fine air particles, there are also serious health risks from exposure to particular pollutants, including ozone, nitrogen dioxide and sulphur dioxide. Excessive ozone can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases. Nitrogen dioxide is linked to bronchitis in asthmatic children, and reduced lung function growth. Sulphur dioxide can affect the respiratory system (with inflammation causing coughing and aggravating asthma and chronic bronchitis) and lung functions and is linked to increased cardiac disease. Sulphur dioxide also combines with water to form sulphuric acid, the main component of acid rain which causes deforestation.[6]

The world suffered 84.9 million years of life lost in 2012, attributable to outdoor air pollution, according to the WHO report on ambient air pollution. Years of life lost is a measure of the extent of premature death compared to the normal expected life span.

Of the total years of life lost, 26% was due to lung cancer, 17% to stroke, 17% to acute respiratory disease, 16% to ischaemic heart disease and 8% to chronic obstructive pulmonary disease.

The WHO report was based on satellite data, air transport models and ground station monitors for more than 3000 rural and urban locations.

The study does not include indoor or household air pollution, which may be even more dangerous than outdoor air pollution.

Besides the WHO, the UNICEF has also been researching into the impact of air pollution on children's health. Its new study, *Clear the air for children,* published in October 2016, revealed that outdoor air pollution is a major contributing factor in the deaths of around 600,000 children under five every year, and it threatens the lives and futures of millions more every day[7]. UNICEF Executive Director Anthony Lake said that: "Pollutants don't only harm children's developing lungs – they can actually cross the blood-brain barrier and permanently damage their developing brains – and, thus, their futures. No society can afford to ignore air pollution."

The study made use of satellite imagery which showed that around 2 billion children live in areas where outdoor air pollution exceeded the WHO air quality guidelines. The regions with the most number of children living in areas that exceed the guideline limits are South Asia (620 million), Africa (520 million) and East Asia and the Pacific (450 million children). Also, 300 million children (or almost one in seven) live in areas with the most toxic levels of outdoor air pollution – six or more times higher than international guidelines.

III. Indoor Air Pollution

Worldwide, 4.3 million people die annually as a result of indoor air pollution, mainly from stroke (34%), ischaemic heart disease (26%), chronic obstructive pulmonary disease (22%), pneumonia (12%) and lung cancer (6%), according to the WHO.[8]

The main form of the deadly household pollution is the use of solid fuels for cooking and heating. Nearly 3 billion poor people rely on wood, animal dung, charcoal, crop wastes and coal which are burned in highly polluting simple stoves or open fires.

The resulting pollution, which includes small soot particles that penetrate deep into the lungs, especially affects women and children who spend a lot of time near the kitchen or hearth.

In poorly ventilated homes, indoor smoke can be 100 times higher than the acceptable levels for fine particles, according to WHO. The use of kerosene lamps for lighting also exposes the families to very high levels of fine particles.

The emissions of black carbon and methane from the stoves also contribute to outdoor air pollution and increase climate change as both are powerful Greenhouse Gases.

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The WHO has new indoor air quality guidelines for household fuel combustion and recommendations on types of fuels and technologies to protect health, in addition to guidelines on specific indoor pollutants. It will also do a study of indoor pollution and when the figures are published they will reveal the full problems caused by air pollution.

IV. Pollutants affecting health and those affecting climate change and the environment

The components of air pollution that most affect health may be different from components that most affect climate change and other environmental problems. Some components significantly affect both.

From the health point of view, the most dangerous **pollutants from outdoor air pollution**[9] are:

- particulate matter, especially PM2.5 particles with a diameter of 2.5 micrometres or less (the main components of which are sulphate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water),
- ozone (formed by reaction with sunlight of pollutants such as nitrogen oxides and organic compounds from vehicle and industry emissions),
- nitrogen dioxide (a toxic gas which is the main source of nitrate aerosols, an important part of PM2.5; and of ozone; the major source of the pollutant are heating, power generation and vehicle and ship engines),
- sulphur dioxide (from burning of sulphur-containing fossil fuels of coal and oil for domestic heating, power generation and motor vehicles).

Pollutants from **indoor air pollution**[10] include:

- particulate matter, especially PM2.5 particles with a diameter of 2.5 micrometres or less (most of it comes from smoke arising from cooking with solid fuels – coal, wood, animal dung, crop waste).
- carbon monoxide,
- black carbon, and
- methane.

Black carbon and methane are also powerful Greenhouse Gases that increase climate change, while sulphur dioxide is also recognised as an indirect Greenhouse Gas and it also combines with water to form sulphuric acid which is the main component in acid rain (which causes deforestation which in turn is a major factor in climate change).

The most important **Greenhouse gases** causing global warming[11] are

- carbon dioxide (resulting from burning of fossil fuels, solid waste, trees and wood products as well as chemical reaction from cement manufacture, etc),
- methane (from production and transport of coal, natural gas, oil; deforestation; from livestock and agricultural practices; and decay of organic waste in solid waste land-

fills) ,

• nitrous oxide (from agricultural and industrial activities and combustion of fossil fuels and solid waste) and

• fluorinated gases (hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride, and nitrogen trifluoride, mainly emitted from industrial processes).

The UNFCCC[12] covers the following six direct Greenhouse Gases: Carbon dioxide, Methane, Nitrous oxide, Perfluorocarbons, Hydrofluorocarbons and Sulphur hexafluoride. It also recognises indirect greenhouse gases including the following: sulphur dioxide, carbon monoxide, nitrogen oxides (NOx), and non-methane volatile organic compounds (NMVOC).

There are strong co-benefits and synergies from actions to reduce emissions of pollutants linked to health concerns, and actions to reduce Greenhouse Gases that cause climate change and other gases that affect the environment in other ways. Some pollutants described as among the most hazardous to health by the WHO are also recognised by the UNFCCC as among the Greenhouse Gases causing climate change, such as methane, sulphur dioxide, and carbon monoxide. Moreover, there are other gases that cause harm to both human health and the environment (other than to climate change). There should thus be coordinated action to address emissions of both pollutants that damage health and emissions that increase climate change and harm the environment in other ways.

V. Actions required to address air pollution

As evidence mounts on the threats posed by air pollution to both human health and the environment, action must be urgently taken to address this problem.

At the global level, the Paris Agreement that will soon come into force is meant to curb the growth of Greenhouse Gas emissions. Health Ministers also approved a global "roadmap" to address air pollution in May 2016 at the World Health Assembly. And the Agenda 2030's sustainable development goals have targets for reducing air pollution.

But much more needs to be done, especially at the national level, to seriously tackle this crisis.

The adverse health effects of air pollution have been growing worse with an 8% increase from 2008 to 2013 in deaths globally caused by urban air pollution, according to WHO[13]. Although the situation has improved in developed countries, it has deteriorated in most developing countries.

Countering air pollution should thus be a top priority. What should be done? First, more details and data should be collected in all countries, through improvements in monitoring air pollution and its adverse health effects.

Second, a public education campaign is needed to make the public more aware of the dangers of air pollution so they can take actions to prevent the pollution and to avoid being exposed.

Third, and most important, the causes of the pollution must be identified and action plans drawn up to eliminate or reduce the factors and these sources.

Outdoor air pollution is caused by transport vehicles that emit pollutants, coal-fired power plants, industrial factories, burning of wastes and fires in forest and agricultural areas. Indoor pollution is mainly caused by the use of fuels that are based on wood and coal.

Besides the direct effects on human health, the pollution is also a major cause of global warming, which in turn also affects health.

It is thus doubly important to tackle these causes. Actions should include the following:

• Reduce vehicle emissions through better energy-efficiency and air-pollution standards for vehicles and control of private transport.

• Give priority to public transport and promote clean transport such as railways, bicycles and walkways.

• Phase out of coal powered plants, shift to clean modes of power generation, and promote renewable energy.

• Impose strict air pollution controls in industry and phase in clean low-emissions technologies.

• Promote energy efficiency in the design of buildings.

• Phase out the use of wood and charcoal as household fuels used in traditional stoves, and replace them with safe and efficient stoves.

• Reduce waste through recycling and reuse, introduce alternatives to open incineration of solid waste and stop the open burning of household wastes.

• Stop the burning of forests, mangroves and in agriculture; this is the most important to prevent the Southeast Asian "haze".

• Take measures so as to adhere to the WHO guidelines for outdoor and indoor air pollution. (The WHO guideline for particulate matter (PM) outdoor pollution is 10 microgram per cubic meter annual mean for particles below the size of 2.5 microns in diameter, and 20 microgram for particles below 10 microns in size.) (See Annex.).

Air pollution reduction measures should become part of wider health and environmental strategies and be given priority and resources in the country's development plans.

VI. Recent global recognition and actions

The problem must also be given the global attention it deserves. In May 2016, the World Health Assembly for the first time adopted a road map to tackle air pollution and its causes (WHA Document A69/18; 6 May 2016)[14]. The four-point road map calls on the health sector to: (1) expand the knowledge base on air pollution, its health effects and effectiveness of policies; (2) increase monitor-

ing of air pollution locally, assess the health impacts, its sources; (3) Take on leadership role in national policies to respond to air pollution and at the global level; (4) build its own capacity to influence policy and decision making processes to take joint action on air pollution and health.

The UN's Agenda 2030 and its Sustainable Development Goals, adopted by world leaders in September 2015, also has goals and targets relevant to air pollution[15]. These include goals and associated targets relevant to health (Goal 3); cities (Goal 11) and household energy (Goal 7). The three indicators most relevant to air pollution are:

- SDG Indicator 3.9.1 for goal 3 on health (mortality rate attributed to household and ambient air pollution);
- SDG Indicator 11.6.2 for goal 11 on cities (annual mean levels of fine particulate matter (PM) in cities; and
- SDG Indicator 7.1.2 for goal 7 on energy (proportion of population with primary reliance on clean fuels and technologies).

Cutting down on air pollution, which is closely related to emissions of Greenhouse Gases, is one the major actions (if not the very top action) countries are expected to take to fight climate change, and thus most relevant to the implementation of the Paris Agreement of the UN Climate Change Convention adopted in December 2015.

Indeed, drastically reducing air pollution would be tackling the world's biggest health and environmental problems, as air pollution is the major source of deaths and diseases, as well as the main cause of climate change.

VII. Conclusion

Action plans on air pollution are thus urgently needed at both national and global levels.

According to Dr. Maria Neira, WHO's Director, Department of Public Health, Environmental and Social Determinants of Health: "Fast action to tackle air pollution can't come soon enough. Solutions exist with sustainable transport in cities, solid waste management, access to clean household fuels and cook-stoves, as well as renewable energies and industrial emissions reductions."

We are only at the starting phase of understanding the huge health problem that air pollution causes. There is already much greater awareness of the grave crisis that it has caused to the environment.

While the actions needed are quite clear, getting them implemented will be an immense challenge, as the causes of air pollution are presently so embedded in modern lifestyles and economic structures.

Annex: WHO Guidelines and Recommendations for Air Pollution

1. WHO Ambient Air Quality Guidelines for Particulate Matter[16]

WHO's Ambient Air quality guidelines for annual and for 24-hour mean of particulate matter:

- Particulate matter with a diameter of less than 2.5 micrometres ($PM_{2.5}$)[17]: The limit is 10 µg/m^3 (microgram per cubic meter) for annual mean and 25 µg/m^3 for 24-hour mean.
- Particulate matter with a diameter of less than 10 micrometres (PM_{10}): The limit is 20 µg/m^3 (microgram per cubic meter) for annual mean and 50 µg/m^3 for 24-hour mean.

2. WHO Ambient Air Quality Guidelines for other ambient pollutants[18]

The recommended limits for other ambient pollutants are:

Ozone: 100 µg/m^3 for 8-hour mean

Nitrogen dioxide: 40 µg/m^3 for annual mean and 200 µg/m^3 for 1-hour mean

Sulphur dioxide: 20 µg/m^3 for 24-hour mean and 500 µg/m^3 for 10-minute mean

3. WHO Guidelines and Recommendations for Indoor Air Quality: household fuel combustion[19]

3.1 WHO Recommended Targets for $PM_{2.5}$ and Carbon Monoxide

- Emissions of $PM_{2.5}$ (particulate matter with a diameter of less than 2.5 micrometres) should not exceed 0.23 mg/min when unvented (without a chimney or hood) and 0.80 mg/min when vented (with chimney or hood).
- Emissions for carbon monoxide should not exceed 0.16 g/min for unvented devices and 0.59 g/min for vented devices.

3.2 To meet the guidelines in 3.1, clean fuels need to be prioritised. However, due to challenges in transiting to clean fuels in lower-income homes and rural areas in developing countries, intermediate steps using improved solid fuel devices will be required. In this case, transition fuels and technologies with health benefits should be prioritised, using the targeted rates as a guide.

3.3 Unprocessed coal should not be used as a household fuel. Reason: emissions from household use of coal is carcinogenic; unprocessed coal often contains toxic elements; and incomplete combustion of coal in inefficient stoves and space heaters leads to multiple illnesses and premature death.

3.4 The household use of kerosene as a household fuel is discouraged. Reasons: There are concerns around high emissions of health-damaging pollutants; and there are

high risks of burns, fires and poisoning amongst households using kerosene for cooking and heating.

3.5 Although there are only a few studies looking directly at the health impacts of clean fuels like biogas, ethanol, liquefied petroleum gas (LPG) and natural gas, evidence from emissions testing suggest these fuels along with electricity are the best alternatives to solid fuels in low and middle income countries for reaching PM and carbon monoxide pollutant air quality guidelines levels.

End notes:

[1] The seriousness of this problem was highlighted by the heavy smog that enveloped Delhi for days at the beginning of November 2016, forcing the government to declare an emergency, schools to be closed and a ban on construction work for several days. The level of the harmful PM2.5 pollutants had almost reached 1,000 at some times in the Indian capital city, far above the safety level of 60.

[2] WHO (2016), WHO releases country estimates on air pollution exposure and health impact (News release, 27 Sept. 2016).

[3] See WHO (2016), Health and the environment: Draft road map for an enhanced global response to the adverse health effects of air pollution (Report by the Secretariat for the 69th World Health Assembly) which states that the World Health Assembly through resolution WHA68.8 acknowledged that "4.3 million deaths occur each year from exposure to household (indoor) air pollution and that 3.7 million deaths each year are attributable to ambient (outdoor) air pollution". It also states that the same WHA resolution "noted with deep concern that indoor and outdoor air pollution are both among the leading avoidable causes of disease and death globally, and the world's largest single environmental health risk." See also WHO news releases of 27 May 2016 on the Sixty-ninth World Health Assembly update; and of 26 May 2015 on "WHA closes, passing resolutions on air pollution and epilepsy", both of which mention that 4.3 million deaths are linked to indoor air pollution and 3.7 million deaths to outdoor air pollution.

[4] The 6.5 million total deaths from air pollution is the latest estimate by WHO as published in September 2016. Its explanation can be found in its document, WHO (2016), "Ambient Air Pollution: A global assessment of exposure and burden of disease— FAQs." This document also gives a new estimate of 3 million deaths from outdoor pollution in 2012, reduced from the often quoted 3.7 million deaths.

[5] WHO (2016), Ambient Air Pollution: A global assessment of exposure and burden of disease, available at http://www.who.int/phe/health_topics/outdoorair/databases/en/.

[6] WHO (Sept. 2016), Fact sheet on ambient air quality and health.

[7] UNICEF (2016), Pollution: 300 million children breathing toxic air (Press release, 31 Oct. 2016); and UNICEF (2016), Clear the air for children (full report).

[8] WHO (2016), Household air pollution and health (Fact sheet 292, Feb. 2016).

[9] WHO (Sept. 2016), Ambient (outdoor) air quality and health: Fact sheet.

[10] WHO (Feb. 2016), Fact sheet on Household air pollution and health.

[11] Environmental Protection Agency (USA), Greenhouse Gas Emissions (https://www.epa.gov/ghgemissions/overview-greenhouse-gases).

[12] UNFCCC, GHG Data from UNFCCC (http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php).

[13] WHO (2016), Press release on Air pollution levels rising in many of the world's poorest cities (12 May 2016).

[14] WHO (2016), Health and the environment: Draft road map for an enhanced global response to the adverse health effects of air pollution (Document A69/18 for the 69th World Health Assembly, 6 May 2016).

[15] A brief description of the SDGs linked to the health effects of air pollution is in WHO (2016), Ambient Air Pollution: A global assessment of exposure and burden of disease.

[16] WHO (Sept. 2016), Fact sheet on Ambient (outdoor) air quality and health.

[17] $PM_{2.5}$ includes pollutants such as sulfate, nitrates and black carbon, which penetrate deep into the lungs and in the cardiovascular system, posing the greatest risks to human health.

[18] WHO (Sept. 2016), Fact sheet on Ambient (outdoor) air quality and health

[19] WHO (Nov. 2014), Frequently Asked Questions: WHO guidelines for indoor air quality: household fuel combustion.

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