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Environmental Health Effects of the three Air Pollutants: Particulate Matter , Oxides of Sulphur and Oxides of Nitrogen

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Abstract—*The three air pollutant such as particulate matter (PM), sulphur oxides and nitrogen oxides are mainly responsible for impacts of air pollution to the environmental health directly or by converting into other pollutants by undergoing chemical reactions . Particulate matter (PM 10 and PM2.5) effects more people than any other pollutant. The major components of PM are mainly sulfates, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. There is a close, quantitative relationship between exposure to high concentrations of small particulates (PM10 and PM 2.5) and increased mortality or morbidity, both daily and over time. When concentrations of PM 10 and PM 2.5 are reduced, related mortality will also go down – presuming other factors remain the same. This allows policy makers to project the population health improvements. SO2 emission in the atmosphere is due to burning of fossil fuels, by emissions from power plants and other industrial facilities and processes such as extracting metal from ore; natural sources such as volcanoes; locomotives, ships and other vehicles and heavy equipment that burn fuel with a high sulfur content. SO2 emissions in the air leads to the formation of other sulfur oxides which reacts with other compounds in the air to form small particles (PM pollution). Sources of NO2 emissions are from burning of fuel i.e. emissions from cars, trucks and buses, power plants, and off-road equipment. NO2 along with other NOx reacts with other chemicals in the air to form both particulate matter and ozone. High concentration of NO2, if inhaled , can cause respiratory diseases. NO2 and other NOx interact with water, oxygen and other chemicals in the atmosphere to form acid rain. Nitrate particles in the air make the air hazy and difficult to see though.*

Keywords: *Air pollution , Environmental health effects, Nitrogen dioxide, Sulfur dioxide, Particulate matter,*

Introduction

Outdoor air pollution is a major environmental health threat to human population. Ambient air quality monitoring is required to determine the existing quality of air, evaluation of the effectiveness of control programme and to identify areas in need of restoration and their prioritization. For effective protection of human health, information on air pollution source, type and concentration is essential. An inventory of air pollutants is a first step to control of air pollution. Air pollutants can be primary or secondary depending upon their formation mechanism. Identification investigation and monitoring of air pollutants, their sources of emissions and their effects on health can be mapped and these indicators can be used for creating effective plans, programmes and projects to reduce air pollution.

Particulate matter, Oxides of Nitogen and Oxides of Sulfur as Air Pollutants

Clean air is a basic need of every human being and air pollution is one of the major environmental health threat to it. Millions of pre mature deaths are due to poor air quality. Polluted air is a major health threat and nitrogen dioxide, sulphur dioxide , particulate matter such as PM 10 and PM 2.5 are polluting air and are mainly responsible for air pollution .These three major air pollutant , particulate matter (PM) , sulphur oxides and nitrogen oxides are mainly responsible for impacts of air pollution to the environmental health directly or by converting into other pollutants by undergoing chemical reactions. Small particulate pollution have health impacts even at very low concentrations. There are serious risks to health from exposure to ozone (O3), nitrogen dioxide (NO2) and sulfur dioxide (SO2).

Emissions from energy sector is also linked with health and air pollution. Inefficient fuel combustion for energy use is another major source of air pollutant emissions.

Air quality measurements are typically reported in terms of daily or annual mean concentrations of PM10 particles per cubic meter of air volume (m3). Air quality measurements are described of such PM concentrations in terms of micrograms per cubic meter (µg/m3). Caliberated measurement tools can report the correct and exact concentrations of air pollutants in the air.Guideline values of Particulate matter PM 10, Particulate matter PM 2.5, nitrogen dioxide, sulphur dioxide given by WHO are as follows.(Table 1)

Guideline values of the three air Pollutants

Table 1

Particulate matter	$PM_{2.5}$	10 μg/m^3 annual mean 25 μg/m^3 24-hour mean
	PM_{10}	20 μg/m^3 annual mean 50 μg/m^3 24-hour mean
Nitrogen Dioxide	NO_2	40 μg/m^3 annual mean 200 μg/m^3 1-hour mean
Sulfur Dioxide	SO_2	20 μg/m3 24-hour mean 500 μg/m3 10-minute mean

Particulate matter

Particulate matter (PM) effects more people than any other pollutant. The major components of PM are sulfate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. A complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air is called particulate matter. The particles with a diameter of 10 microns or less, (PM_{10}), which can penetrate deep inside the lungs are most harmful .Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer.

$PM_{2.5}$ 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. Lower concentrations of $PM_{2.5}$ levels are generally observed in monsoon months as particulate matters are washed out due to wet deposition.

There is a close, quantitative relationship between exposure to high concentrations of small particulates (PM_{10} and $PM_{2.5}$) and increased mortality or morbidity, both daily and over time. Conversely, when concentrations of small and fine particulates are reduced, related mortality will also go down – presuming other factors remain the same. This allows policymakers to project the population health improvements that could be expected if particulate air pollution is reduced.

Nitrogen dioxide (NO_2)

The major source of nitrogen dioxide is the burning of fossil fuels: coal, oil and gas. Most of the nitrogen dioxide in cities comes from motor vehicle exhaust (about 80%). Other sources of nitrogen dioxide are petrol and metal refining, electricity generation from coal-fired power stations, other manufacturing industries and food processing.

The current WHO guideline value of 40 μg/m^3 (annual mean) was set to protect the public from the health effects of gaseous.

As an air pollutant, NO_2 has several correlated activities. At short-term concentrations exceeding 200 μg/m3, it is a toxic gas which causes significant inflammation of the airways.NO2 is the main source of nitrate aerosols, which form an important fraction of $PM_{2.5}$ and, in the presence of ultraviolet light, of ozone.

The major sources of emissions of NO2 are combustion processes in different sectors for example heating process, power generation, and engines in vehicles and ships.

Long-term exposure to NO2 increases bronchitis in asthmatic people. and reduced lung function . High levels of nitrogen dioxide exposure can give people coughs and can make them feel short of breath. People who are exposed to nitrogen dioxide for a long time have a higher chance of getting respiratory infections. Nitrogen dioxide reacts in the atmosphere to form acid rain, which can harm plants and animals.

Sulfur dioxide (SO_2)

The main source of SO2 is the burning of sulfur-containing fossil fuels, power generation and motor vehicles. SO2 is the component of greatest concern and is used as the indicator for the larger group of gaseous sulfur oxides (SOx). Other gaseous SOx (such as SO3) are found in the atmosphere at concentrations much lower than SO2.

Control measures that reduce SO2 can generally be expected to reduce people's exposures to all gaseous SOx. This may have the important co-benefit of reducing the formation of particulate SOxsuch as fine sulfate particles.

Emissions that lead to high concentrations of SO2 generally also lead to the formation of other SOx. The largest sources of SO2 emissions are from fossil fuel combustion at power plants andother industrial facilities.

The largest source of SO2 in the atmosphere is the burning of fossil fuels by power plants and other industrial facilities. Smaller sources of SO2 emissions include: industrial processes such as extracting metal from ore; natural sources such as volcanoes; and locomotives, ships and other vehicles and heavy equipment that burn fuel with a high sulfur content.

SO_2 can affect the respiratory system and the functions of the lungs, and causes irritation of the eyes. Inflammation of the respiratory tract causes coughing, mucus secretion, aggravation of asthma and chronic bronchitis and makes people more prone to infections of the respiratory tract. Cardiac disease and mortality increase with exposure with higher SO2 levels.

SO2 emissions that lead to high concentrations of SO2 in the air generally also lead to the formation of other sulfur oxides (SOx). SOx can react with other compounds in the atmosphere to form small particles. These particles contribute to particulate matter (PM) pollution: particles may penetrate deeply into sensitive parts of the lungs and cause additional health problems. In acid rain, SO2 combines with water to form sulfuric acid; which causes deforestation.

Other Air Pollutants

Cities causes air pollution as they concentrate on people, energy use, construction activity and traffic .The energy production , inefficient fuel combustions and emissions from transport sector are important sources of air pollutant emission. Industrialization, population growth and globalization are main factors causing air pollution

Sources of air pollutant may vary from industrial, vehicular to domestic. Indoor exposure to pollutants from the household combustion of solid fuels on open fires or traditional stoves increases the risk of pre mature deaths. Indoor air pollution in developing countries causes several respiratory diseases, cardiovascular disease, chronic obstructive pulmonary disease and lung cancer. Several communities reside on land in close proximity to pollution sources. In Delhi the traditional use of biomass for cooking and two coal fired power plants(Badarpur and Rajghat) are the main sourse of PM $_{2.5}$ emissions in Delhi

Fires are another major source of air pollution and can lead to severe problems if the smoke is inhaled for a period of time. These fires can either be forest fires, oil well fires, burning of leaves in the backyard or as in the case of rural areas, large-scale burning of agricultural waste. Transport's contribution to climate change include: long-lived carbon dioxide (CO2) emissions and; short-lived black carbon generated primarily by diesel vehicles.

Black carbon, a short-lived climate pollutant, is the second highest contributor to global warming after CO_2. Black carbon has a warming effect many times more powerful than carbon dioxide, but it persists in the atmosphere for only a few weeks – so measures to reduce black carbon can also have an immediate effect on slowing the pace of climate change.

Diesel transport is one of the world's major sources of black carbon (along with household biomass cookstoves). Not only does black carbon have a significant warming effect, but it is also a major component of particulate matter, the air pollutant most closely associated with increased air-pollution related mortality and morbidity.

Ground-level ozone is another short-lived climate pollutant stimulated by transport pollution. Ozone is created by a mix of are pollutants, including oxides of nitrogen (NO_x) produced by vehicle engines and methane emissions from other sources (e.g.
landfills and animal waste). Ozone contributes to chronic respiratory diseases, particularly childhood asthma.

Air quality monitoring maps in detail the scale, causes and effects of the problem .Major Pollutant emitting sectors are transport, energy waste management, buildings and agriculture.

Central Pollution Control Board executed a nation-wide programme of ambient air quality monitoring known as N.A.M.P.

The monitoring of the three air pollutants for example, Sulphur Dioxide (SO2), Nitrogen dioxides (NO2) and Respirable Suspended Particulate Matter (RSPM/PM10) pollutants is carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week, to have 104 observations in a year.

Reducing pollutant emissions improves water and soil quality, crop yields and, in turn, food security. Reducing outdoor air pollution also reduces emissions of CO2 and short-lived climate pollutants such as black carbon particles and methane, thus contributing to the near- and long-term mitigation of climate change.

World energy outlook 2016 (WEO-2016) show the link between energy, air pollution and health. Energy generation, transportation, and industries emits large number of pollutants.. The report shows air pollution a major health risk after high blood pressure, poor diets and smoking and a major public health crisis, with many of its root causes and cures to be found in the energy sector.

Adverse effects of air pollutants ranges from nausea, difficulty in breathing and skin irritations, to birth defects, and cancer. Moreover, the severity of health problems associated with air pollution exposure is not uniform within populations. Sources of air pollution may vary from industrial, vehicular to domestic . Several communities reside on land in close proximity to pollution sources. New air quality legislation can be implemented to protect the health of people.

Conclusion

For effective protection of human health, information on air pollution source, type and concentration can be collected and different types of health indicators can be created to map in detail the scale, causes and effects of the problem due to air pollution.The new air quality management plans , air quality monitoring programmes and projects can be implemented for controlling air pollution. Air quality monitoring and evaluation tools can be created for the health management of the people. To control air pollution from vehicles. industries and other

sources, reduction of pollutant emission is necessary. Small particulate pollution have health impacts even at very low concentrations. There are serious risks to health from exposure to ozone (O3), nitrogen dioxide (NO2) and sulfur dioxide (SO2).

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