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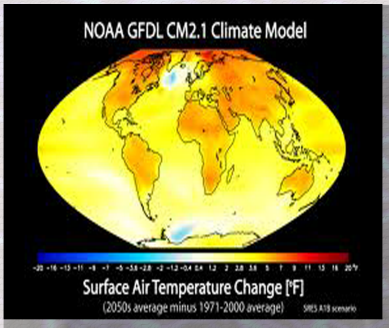
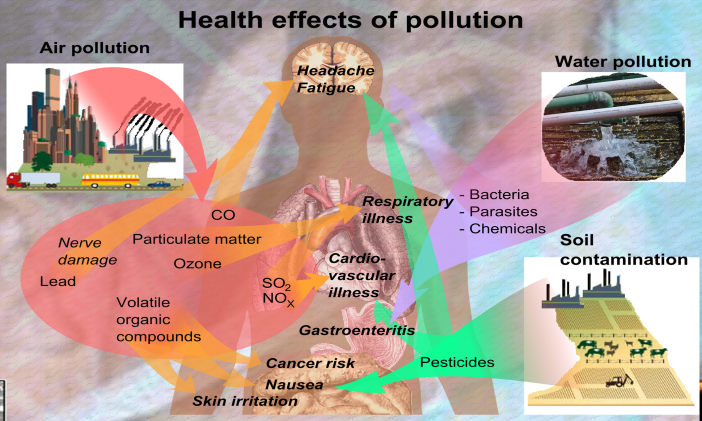
The Air Quality and Health





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Editorial

Environment is the essential component of human life on which all living things depends for survival. There is a continuous interaction going on in each component of Earth system, change in one component affects the functioning of other either in positive or negative way and hence unsustainable use of natural resources during past few decades disturbs the functioning of Earth's ecosystem and alter the normal composition of Earth's atmosphere significantly. This result in the severe problems like acid rain, global warming, climate change, biodiversity loss, air pollution etc. and place the striking problems like food security, energy security, unpredictable weather in front of human race. "Health Impact" of air pollution is one of the major problems faced by all parts of the world. Different pollutants especially criteria pollutants adversely affects the functions of lungs, major respiratory organ of the body, and also are responsible to cause asthma, cardiovascular diseases and so many other problems.

In the present issue you will find out information about general impact of different air pollutants on environment and human health, and linkages between air pollution epidemiology and emission. We hope our attempt to convey complicated scientific information in simple language will help to create awareness amongst the common public which is the first step towards safeguarding our environment

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The Air we breathe

Planet earth is the only known place in the universe which supports life. The major driving force for existence of life on planet Earth is its atmosphere, consisting of a mixture of gases, solid and liquid particles collectively called as aerosols and water in various forms eg. vapour, liquid and solid, which is retained by Earth's gravity.

In the atmosphere the concentration of Nitrogen, Oxygen, Argon, Nion, Heleum and Krypton remains constant over space and time whereas the concentration of CO2, water vapor and other trace gases including CH4, SO2, NOx (NO, NO2), O3 along with the particulate matter, which are known as trace gases, varies from place to place and time to time. Although trace gases make up less than 1 % of the atmosphere they have a much greater influence on both short-term weather and long term climate. Even a small change in their concentrations has potential to alter the heat retention capacity of Earth and affect biological life through different toxic mechanism to list out some may include alteration in natural green house effect, global warming, see level rise, extreme weather conditions, change in disease dynamics etc.

Although the major components of the atmosphere vary little today they have changed dramatically over the last decade as a consequence of which human race is facing much exaggerated problem of food and water security, increased health concerns, air, water and soil pollution and so on. The atmospheric condition where the concentration of these gases found to be much above its natural background concentration and can produce undesirable effects on man and environment is known as air pollution, now days which is a big issue of concern in any urban environment and urban air quality is listed as one of the world's worst toxic pollution problems (World's worst polluted places report, 2008)

There are different natural processes going on such as volcano, forest fires, earthquake, decomposition of organic matter, dust storm and salt sprays which release considerable amount of pollutants in to the air, however, during past few decades it has been noticed that the problem of air pollution is became more severe and different anthropogenic activities including fossil fuel burning, bio-fuel burning, waste management, agricultural production etc. are responsible for release of vast amount of Green House Gases (CO2, CH4, NO2 etc) and air pollutants (PM10, PM2.5, CO, O3, Sox etc.). When the local concentrations of these substances exceed certain threshold limit they have adverse effect on plants, animals, human health & cause discomfort to life. In the subsequent sections we will briefly introduce you with the effects of air pollutants on human health and environment.

Health and Environmental effects of air pollutants

The six commonly found air pollutants in the atmosphere that carry the health or performance impairment risk are carbon monoxide (CO), particulate matter (PM) (PM2.5 category belong to articles having size less than 2.5 micrometer and PM10 for particles having size less than 10 micrometer), nitrous oxides (NOX), sulphur dioxide (SO2) , ground-level ozone (O3), and volatile organic compounds (VOCs). Prolonged exposure to these pollutants can cause difficulty in breathing, respiratory disease and heart disease. Links between high levels of air pollution and lung disease, cardiovascular disease and even cancer are being established in the medical literature. Some of the major health effects of these pollutants are discussed in the subsequent sections.

High level of **CO** has immediate detrimental influences on breathing and the oxygen transport system of the body; it is associated with a decrease in the oxygen carrying capacity of the blood and a reduced maximal oxygen uptake. Inhalation of CO causes the CO molecules to replace oxygen molecules in the blood forming carboxyhemoglobin, which inhibits the oxygen intake resulting in the less oxygen in the blood. When there is less oxygen present, the muscles tire more quickly and it has obvious negative implications on daily performance of an individuals.

Inhalation of **particulate matter** causes diseases like asthma, lung cancer, chronic respiratory disease, acute respiratory symptoms, and decreased lung function. The size of Particulate Matter (PM) is most important in determining its toxicity, because its size is directly linked to their potential for causing health problems. Total Suspended Particle (TSP) is much less relevant to the health impact of air pollution than PM10, PM2.5 and even smaller particles. Larger particles are not harmful because generally they get blocked from entering in to the respiratory system as they get filtered by small hair in the nose and do not cause health problems, but PM smaller than about 10 μm, can settle in the bronchi and lungs, particles smaller than 2.5μm, can penetrate directly into the lung, whereas particles smaller than 1 μm can penetrate into the alveolar region of the lung and tend to be the most hazardous when inhaled. Researchers suggest that even short-term exposure to the PM2.5 at elevated concentrations could significantly contribute to heart disease. The combination of PM10, sulphur dioxide and water vapor forms sulphuric acid coated particles that deposit deep inside the lung and cause irritation and asthma-like symptoms. The particles themselves are made up of a variety of compounds, including carcinogenic hydrocarbons and lead. **Nitrogen dioxide (NO2) and sulphur dioxide (SO2)** are both very soluble gases that convert to nitric and sulphuric acid

when they make contact with the moist lining of the mouth and lungs. They cause soreness of the nasopharynx and lungs, coughing and breathlessness, as well as inducing symptoms of asthma in both healthy people and asthmatics.

Presence of **ozone (O3)** in the stratosphere protects earth from UV radiation but its presence at ground level (in the troposphere) is not good indication. Ground level O3 induces asthma-like symptoms and lung inflammation. In addition to irritating the lungs directly, O3 also acts on the nervous system to inhibit breathing, making it difficult and painful to take deep breaths; it has been suggested that this may be part of a protective reflex of the body to minimize the lungs exposure to the irritant. Medical research has shown that responsiveness to O3 is a function of concentration, exposure duration, and level of ventilation.

The ability of **VOCs** to cause health effects varies greatly from those that are highly toxic, to those with not-known health effect. The extent and nature of the health effect is depending on many factors including level of exposure and length of time exposed. Eye and respiratory tract irritation, headache, dizziness, visual disorders, and memory impairment are among the immediate symptoms that some people have experienced soon after exposure to some organics. Apart from health effects some pollutants are responsible for the visibility reduction and smog formation, e.g. PM is responsible for the visibility reduction due to the scattering of light. VOCs contribute to the blue-brown haze associated with photochemical smog. Some of the air pollutants like BC, OC, NOx have significant impact on global radiation balance and, in turn, on the global climate change through direct and indirect radiative forcing.

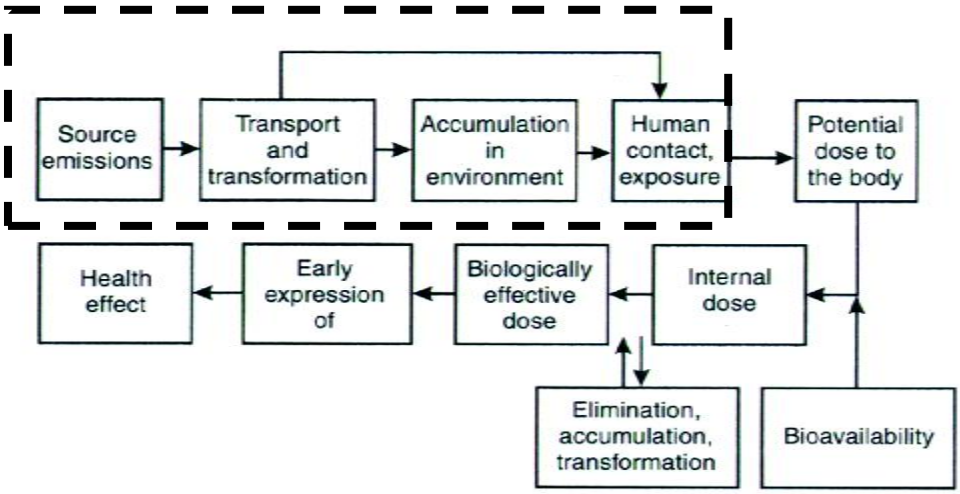
Linkages of Air pollution Epidemiology and Emissions

In the Indian urban areas, the dominant sources of air pollution are often transport sector and in the rural areas, the domestic /residential wood combustion /cooking is also one of the major factors (Dalvi, et al., 2006; Ghude, et al., 2008; Sahu and Beig, 2008). The most significant individual pollution episodes are caused by wild fires, fire management burns and dust storms. The frequency of air pollution episodes are likely to peak in India during El Nino years when the Indian monsoonal rainfall is most likely to be poor causing dry environment, frequent of hot days, wild fires and dust storms. However, a wide range of gap exists between the atmospheric chemistry communities who are capable of providing accurate data and understand the physical and the chemical characteristics of air pollutants and medical practitioners who diagnose its impact on Human health. This is one of the major reasons that scientific evaluation of air quality index could not be properly done in

many countries including India until now which need to be attempted by scientists.

The public health impacts of air pollution can be classified in two categories namely (a) acute and (b) chronic health outcomes, due to exposures to particulate and gaseous air pollutants, which can be assessed with mortality, hospital admissions, and other clinically significant health indicators. The three-legged stool in the discipline of Environmental Health to study health effects caused by chemicals is epidemiology, toxicology, and exposure science. Epidemiologists assess the association of chemical exposures and health outcomes with statistics, considering other factors such as demographic, dietary, etc. The findings are evaluated /confirmed by toxicologists who search for plausible biological mechanisms of compounds in humans in the laboratories. After the toxicity of certain chemicals are confirmed, Exposure Scientists investigate the processes of human in contact with chemicals. Exposure science is the bridge between environment and health. It is also the field that atmospheric chemists can make significant contributions.

Following figure shows the complex progression involving various physical, chemical, and biological processes from emission sources to health effects manifested; none of the current methodology is able to consider all factors from sources to health effects in detail.



Due to the complex nature of the human body, it is difficult to conclude properly whether the health effects might occur and the extent of the effects caused by pollutants in the inner environments of the humans are significantly different among individuals, depending on individual factors such as genetic predisposition, nutritional status, pre-existing diseases, stress, etc. In order to protect public health, it is important to examine influential factors on population levels. Thus, it is important to focus on the outer environments of humans where pollutants move through multiple environmental media after release and reach human population receptors via multiple pathways as shown in schematic diagram. Air pollution epidemiology over the past

50 years has been continuously challenged by the limitations of coarsely resolved exposure measures. Time series studies of daily mortality, asthma symptoms or hospital admissions have had to rely upon particle and gas measurements made at a relatively few locations in a city (Pope and Dockery, 2006; Schwartz, 1994). Recent studies have shown that better characterization and better spatially resolved exposure estimates leads to improved quantification of exposure-health relationships. For example, where populations lived relatively close to the monitors, the adjusted regression coefficient for mortality and particles was larger than in the other kind of study that relied on the more dispersed EPA ambient monitoring network.Exposure occurs at the environment-human interface, where pollutants are contacted in the course of human activities. It is difficult to assess exposure accurately. Therefore, accurately assessing exposure remains a big challenge in the environmental health sciences. Atmospheric chemists can advance the exposure science by instrumentation and model development to better quantify exposure. As a result, the exposure-health relationships can be accurately evaluated by epidemiologists. On the other hand, exposure science can provide preventive measures and prioritize control strategies in advance while epidemiology assesses health outcomes after certain biological changes have already occurred.

Exposure science is a scientific process of estimating or measuring the magnitude, frequency, and duration of exposure to chemicals, along with the number and characteristics of the population exposed (Zartarian et al., 2005). Sophisticated technologies and innovative study design are used to identify exposure sources, pathways, routes, and factors and characterize the exposure that occurs in various environmental settings. These findings have significant public health implications. For instance, government agencies can prioritize control strategies focusing on major exposure sources accordingly. Furthermore, the general public can be educated to avoid exposures by knowing the critical exposure pathways, routes, and factors of human activities. Consequently, public health can be protected in advance and health risks can be reduced based on scientific findings of exposure science. Atmospheric chemists engage in such works would have significant impacts on our society. In a long run, the advancement in our understanding in this area will require shared insights and partnerships between air chemistry community and epidemiologists /medical investigator which is hitherto practiced. From our scientific understanding and expert opinion, we may conclude the following: (1) Ambient particles remain poorly characterized, and the specific characteristics of particles responsible for

the observed health effects are poorly understood which need to be explored; (2) we need to identify sub-groups of the population particularly susceptible to the effects of fine particles, mapping the distribution of particles within the community, and identifying the sources and characteristics responsible for the observed associations; (3) We need the epidemiological assessment of the health effects of the spatial distribution of fine particulates (provided by air pollution community) which could be attributed to chemical and physical characteristics of these particles and the ability to measure exposures in the community; (4) The assessment of major sources and controlling factors of human exposure to toxic constituents in different areas (different climate, culture, city vs. rural, etc.), especially for the most susceptible sub-populations, are essential to provide preventive measures and prioritize control strategies in advance; (5) pollution sources are concentrated in cities where population densities are also high; fresh emissions cause direct human exposure as well as resulting in high spatial variability of pollutant distribution. It is important to better estimate the spatial distribution of toxic constituents within cities on street levels, considering the street canyon effects, heat island effects, etc.

It has become necessity to understand and keep an account of the activities which are responsible for emission of verities of air pollutants and maintain the good quality of air by implementing various mitigation strategies at local, national and global level. The common air pollution sources which are responsible for- the deterioration of air quality has been given in the next section of the report.

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