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Air Pollution, Health and Perception

Banwari Dandotiya

Abstract

This chapter provides a general overview of the effects air pollution, pollutant sources in different regions and role of perception in assessment of pollution level and different health effects. The discussion in this chapter focuses basically on the different dimensions related to air pollution such as climatic and meteorological effects, anthropogenic and natural sources, ecosystem disturbances and their interrelationship in context of air quality. Basically, climate disturbances may be responsible for pollution episodes of certain regions. Discussions related to seasonal variations in air quality also included because seasonal meteorological elements exert different effects in different climatic regions. Air pollutants are emitted by a number of sources in the atmosphere such as urbanization, industrialization, transportation, and population growth, so these contributing factors and its effects of climatic events like temperature, wind speed and seasonal disturbances are relatively described in this chapter.

Keywords: air pollution, perception, health effects, climatic factors

1. Introduction

Air pollution in a great number of cities in India exceeds national and international standards. Air pollution in India is a growing threat to human health, especially in densely populated urban areas exposed to high concentrations of air pollutants. Meteorological parameters can contribute in high concentration episodes of air pollution [1]. Over the recent couple of years, air pollutant concentration and human exposure have received special attention due to increasing scientific evidences of causal relationship between exposure with air pollutants and negative health outcomes [2]. The detrimental effects of ambient air pollution on health of human being have been consistently observed in many epidemiologic studies globally, and it has been calculated that at least seven million deaths are annually attributable to the effects of air pollution.

In addition to the contributions of urban sources to air quality degradation, outdoor fires are a regional air pollution source dominated by fires in wheat and rice harvest [3–5]. For reducing health impacts from air pollution, it is important to know the sources contributing to human exposure. An important fraction of the exposure leading to those health impacts occurs in cities, due to the higher density of human activities and their emissions to the air. According to the region, however, high emissions can also occur from domestic fuel use in sub-urban or urban areas. Road traffic contributes significantly to the high levels of air pollution observed in urban areas around the world [6]. Ambient air pollution, especially in

urban context, has demonstrated multiple health effects in human body [7]. High air pollutant concentrations increases risks for a wide range of diseases including respiratory [8], post-respiratory [9, 10], and is a leading environmental cause of cancer deaths [11]. Health effects of air pollution have been significantly associated with exposure time. Previous study of an urban area was reported that ambient air pollutants have comparatively stronger relationships with temperature than they do with any other meteorological parameter [12]. Degraded air quality, especially in industrial area, has demonstrated various negative human health impacts [13]. Higher concentration of air pollutants in ambient air increases risk for a wide range of health effects including respiratory [14] and cardiac [15, 16] and is a leading environmental cause of cancer related deaths [17]. For instance, a heart attack or stroke resulting from exposure during a day of high ambient air pollutant concentration may be a consequence of chronic disease progression associated with long-term exposure [18]. Some effects are long-term and causation can be difficult to prove because sometimes higher concentrations of air pollutants worked as catalyzing factor for some health effects. Respiratory particles have the largest contribution to the total particle number concentrations on in ambient air [19, 20]. Their major sources include direct emissions (vehicular exhaust, heating, burning) and atmospheric nucleation [21, 22]. Respiratory particles enter into the human body by respiratory track, and approx. 60% of them can be deposited in the respiratory system [23, 24]. They can cause adverse health effects mainly by inflammation in respiratory organs or oxidative stress [25, 26].

In order to take actions to reduce exposure to air pollution and hence the associated health impacts, it is essential to know the sources and activities contributing to local levels of pollution. For this reason, an increasing number of local studies on the contribution of sources to air pollution levels have been developed, most often at city level. Perceptual studies also important in this context because perception of people is the main indicator of pollution level and experienced health effects. On the basis of perception information researchers also identified that pollutant which is present in higher concentration in ambient air of studied area [27]. In the context of air pollution perception plays a major role in identification of pollutant responsible for degradation of air quality in that area in the sense of health effects of air pollution identified in perceptual studies.

2. Climate and air pollution

Multiple linkages connect air pollutants and meteorological parameters in different manners [28, 29]. Air quality degradation may leads to give pace to climatic changes in many polluted regions by changing air pollution meteorology, precipitation and by triggering some amplifying responses in atmospheric chemistry and in anthropogenic and natural sources. Climatic processes and air quality are inextricably connected. Many sources of conventional non-conventional air pollutants are also sources of CO₂, other air pollutants and GHGs and/or particles that affect climate. These air pollutants interact with atmospheric solar and terrestrial radiation and perturb the planetary energy balance, leading to changes in climate [30]. Climate change can influences air pollution concentrations according to the changing pattern of climate by altering the frequency, severity, air stagnation events, precipitation, duration of heat waves, and other meteorology conducive to pollutant accumulation [31, 32]. A measure of the perturbation to the climatic system due to changes in various atmospheric constituents between the pre-industrial and present day atmosphere is radiative forcing. Positive radiative forcing induces a warming, whereas negative. Radiative forcing induces a cooling of the earth's surface and

troposphere. The increases in the atmospheric burdens of GHGs, including CO₂, and that of tropospheric O₃ and its precursor methane (CH₄) over the past few centuries have exerted a warming influence.

Climate simulations show that the population in tropical regions will be exposed to substantially more frequent daily temperature extremes due to global warming compared to the population at higher latitudes [33]. If anthropogenic air pollutants were a significant contributor to 20th-century climate, then it must have coincided with a large warming from increasing levels of CO₂ and other GHGs to produce the observed increase in global mean surface temperature [34]. Tropical latitudes are highly populated regions and home to a large share of the global food and goods production. With high population densities and little incentives for improvement in the work environment, there are millions of people working in factories with poor or non-existent ventilation systems or in agriculture where they are fully exposed to heat and poor air quality.

3. Air quality monitoring in India

The Central Pollution Control Board had adopted first ambient air quality standards on November 11, 1982 as per section 16 (2) (h) of the Air (Prevention and Control of Pollution) Act, 1981. The air quality standards have been revised by the Central Pollution Control Board on April 11, 1994 and were notified in Gazette of India, Extraordinary Part-II Section 3, sub section (ii), dated May 20, 1994.

Central Pollution Control Board initiated National Ambient Air Quality Monitoring (NAAQM) programme in the year 1984 with 7 stations at Agra and Anpara. Subsequently the programme was renamed as National Air Monitoring Programme (N.A.M.P.). The number of monitoring stations under N.A.M.P. has increased, steadily, to 295 by 2000–2001 covering 98 cities/towns in 29 States and 3 Union Territories of the country. Steadily the air quality monitoring network got strengthened by increasing the number of monitoring stations from 28 to 365 during 1985–2009. During the financial year 2010–2011, 93 new stations were added and the number of stations under operation was raised to 456 covering 190 cities in 26 states and 5 Union Territories as on 31st March 2011. As on 31st October 2011 the number of stations under operation has been further raised to 503 distributed in 209 cities, 26 states and 5 UTs [35].

4. Health effects

In large urban areas around the world, the effects of higher concentrations of air pollutants on human health present a growing problem. In this context we can say that only government is not responsible for increasing concentrations of air pollutants in urban and rural areas, awareness and ethics of residents of concerned area also responsible for such situations. Urban residents comparatively more susceptible to effects of air pollution because ambient concentration is high in urban areas than indoor concentration and ambient pollutants also affects indoor concentrations [36], results increase in exposure time with higher concentrations. Urban populations experience heavier exposures to air pollutions. Time of exposures increases with the density of traffic and with traffic congestion, a trend common in many large urban centers and magnitude of exposure increases among higher density populations. In rural areas indoor air pollution in households is predominantly contributed from wood combustion, smoking, paints and varnishes, unpaved roads and agricultural residue burning, resulting in terrible health implications [37],

but in rural areas ambient concentration of air pollutants not higher as much as in urban areas. The health effects of air pollution in rural and urban areas have been studied intensely in recent decades. Exposure to higher concentration of pollutants has been associated with increased mortality and hospital admissions (HAs) due to respiratory and cardiovascular diseases. These effects have been found in both short term and long-term studies rural, suburban and urban areas [38]. Exposure time have crucial role in health effect phenomenon in all type of residential areas. During covid-19 situation a number of studies were reported by researcher community in India and in the world, correlation has been drawn between number of covid patient and air quality indexes and associations between them reported in a great number of studies. Studies belongs to different areas of the world and depicted various observations but review of these kind of studies not indicated any kind of correlation of AQI and covid-19 patients because there were a number of places have number of patient with very good AQI. A perceptual study exhibits if the exposure time was long than not only old age residents were affected by air pollution but also residents of young age [39].

5. Role of perception

Perceptual studies have a crucial role in assessment of health effects and also a good indicator of responsible pollutant for AQI. We have done a perceptual study in Gwalior urban area for identification of impacts of air pollution and also awareness level of residents of different urban area such as residential, commercial, high traffic and greenery rich area. This perceptual study includes 22 types of major and minor health effects such as Asthma, lung problem, lung cancer, nose irritation, throat irritation, bronchitis, eye irritation, High blood pressure, nausea, sleeplessness, fatigue and cough etc. reported by respondents of study area. Study also includes questions regarding smoking habit, age group and exposure time. In the awareness section of this study questions included regarding awareness about air pollution, air pollutants, sources of air pollutants, gaseous and particulate pollutants and identification of air pollution as smoke and dust was one of the most interesting outcomes. This study identifies a fairly coherent knowledge regarding the health effects of air pollution and awareness in residents of Gwalior urban area. The results indicate that transportation and solid waste burning are important emitters of air pollutants in the urban area. In the perception of awareness respondents were experienced that the air pollutants harmful for health but they had very less aware about specific effect of air pollutants on health [40].

6. Seasonal effects on air pollutants

Local weather conditions must also be taken into account when assessing the air quality of a certain area, air quality depends on many meteorological and chemical variables [41]. Wind shear and turbulence exerts effects on the mixing and dilution of air pollutants [42]. Humidity is not always linked to the temperature and may be associated with the unequal distribution of moisture with height in the air masses [43]. Pollutants transported from Long distance are dominant during all seasons of the year [44]. Meteorological variables of temperature and wind speed are strongly related to area-wide air pollutant concentrations and a number of meteorological, topographic and settlement issues are significant factors that influence the accumulation, dispersion and chemical transformation processes of air pollutants [45]. In a correlation study of two years between air pollutants and meteorological

parameters indicated that maximum concentrations of air pollutants occurred in winter season due to inversion and stagnant air masses, other seasons have intermediate trends according to areas. Minimum concentrations were found in rainy season in this study and there is no strong relationship between air pollutants concentrations and relative humidity. Concentrations of pollutants show comparatively stronger relationships with temperature than they do with any other meteorological parameter such as relative humidity and wind speed [46].

7. Impacts on ecosystems

Air pollution affects ecosystems in a number of ways, altering basic ecosystem functions such as biogeochemical cycling and primary production which in turn affect the ecosystem services and therefore the benefits that humans get from the ecosystem such as clean drinking water, timber wood, medicinal products and appreciation of nature. The complex causal chains by which air pollution subsequently affects a range of ecosystem services have been reviewed extensively by a great number of researchers [47–51]. Eutrophication (nitrogen), acidification (nitrogen and sulfur) and direct toxicity (ozone, ammonia and nitrogen oxides) are the main mechanisms of ecosystem affected by current pollution levels all of which affect a wide range of services due to their impacts on underlying ecosystem functions and processes (**Figure 1**). Pollutants such as sulfur can responsible for excess levels of acid in lakes and streams and damage forest soils and trees, increasing concentration of atmospheric nitrogen can reduce the biodiversity of plant communities and harm almost all species of fish and other aquatic life, higher ozone concentrations can damages tree leaves and negatively affects scenic vistas in protected natural areas, mercury and other heavy metal compounds emitted as

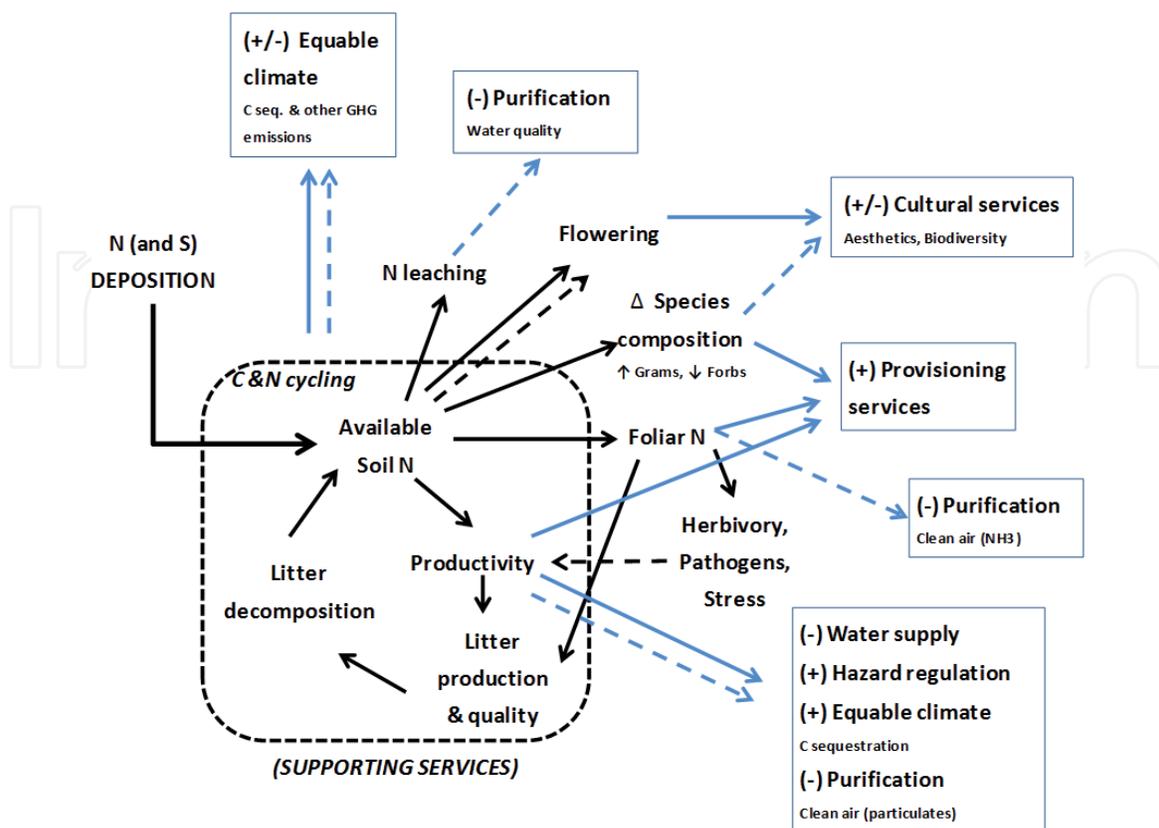


Figure 1.
Eutrophication [47, 48].

exhaust from fuel combustion can eventually accumulate in plants and animals, some of which are consumed by people [52]. Basically, increasing temperature and greenhouse gases derived from climate disturbances have the ability to induce this kind of phenomena [53].

The northernmost terrestrial regions are experiencing warmer and wetter climate and the rate of warming is projected to increase in the future [54]. Climate change is concerned with many anthropogenic drivers like air pollution, of change is already rapidly affecting northern ecosystems with consequences for living beings, infrastructure and economic condition [55]. The impact that climate change has on natural terrestrial and other ecosystems, on human society and economies could be disastrous, potential effects range from sea level rise and melting ice at higher latitudes and altitudes, to changing regional weather patterns. The increase in the atmospheric abundance of greenhouse gases alters the energy balance of the climate system of terrestrial ecosystems and causes a variety of natural disturbances related to ecosystems [56].

8. Sources of air pollution

There are a number of sources of air pollutants such as fossil fuel, human-induced impacts on forestry, clearing for agriculture, degradation of soils, agricultural activities, waste management, energy use, fertilizer, industrial processes, refrigeration and use of a variety of consumer products [57]. Some other micro pollutants emitted in processes like energy production by combustion: entailing burning of wood, coal, and oil (As, Cd, Cu, Hg, Ni, Pb, Sb, Se, V, and Zn), metallurgical industry: emission of dust near the extraction and point of exploitation, high-temperature processing of ores emit aerosols rich in trace elements (Cd, Cu, Ni, Pb, V, and Zn). The proportion of individual elements emitted in the aerosols depends on the type of ore processed, other industrial processes: high-temperature processing and manufacturing (As, Cr, Cu, Ni, Pb, and Zn), Transport: road traffic (Cd, Cu, Fe, Ni, Pb, and Zn), erosion of brake pads (Cu, and Sb), erosion of train rails (Cu), waste treatment: incineration of household waste (As, Cr, Cu, Ni, Pb, Sb, Se, V, and Zn) (**Figure 2**) [58].

Air pollution in energy production emissions in Indian context increased by 1,563 MtCO₂e (246%) from 1990 to 2014. International Energy Agency data show that total electricity generation quadrupled between 1991 and 2014, with an increasing share of coal and a decreasing share of hydropower [60]. Agriculture emissions increased 25% from 1990 to 2014, driven by emissions from synthetic fertilizers (47%) and enteric fermentation from livestock (30%) [61]. In India from 2002 to 2014, use of nitrogen fertilizers (total N) increased 62%, potash (K₂O) 59%, and phosphates (P₂O₅) 51% [62]. India's GDP increased 357% from 1990 to 2014, while GHG emissions increased 180%. In 2014, India emitted more than twice the GHGs relative to GDP than the world average [63]. Globalization in tourism industry [64, 65], public health expenditure and Asian emerging economies can contribute in sustainable economic growth [66, 67]. India pledged to achieve electric power installed capacity of about 40% from non-fossil fuel-based energy resources by 2030 with the help of technology transfer and low-cost international finance, create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent by 2030 through additional forest and tree cover, mobilize domestic and additional funds from developed countries to implement mitigation actions, and build capacity, create a domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative research and development for future technologies.

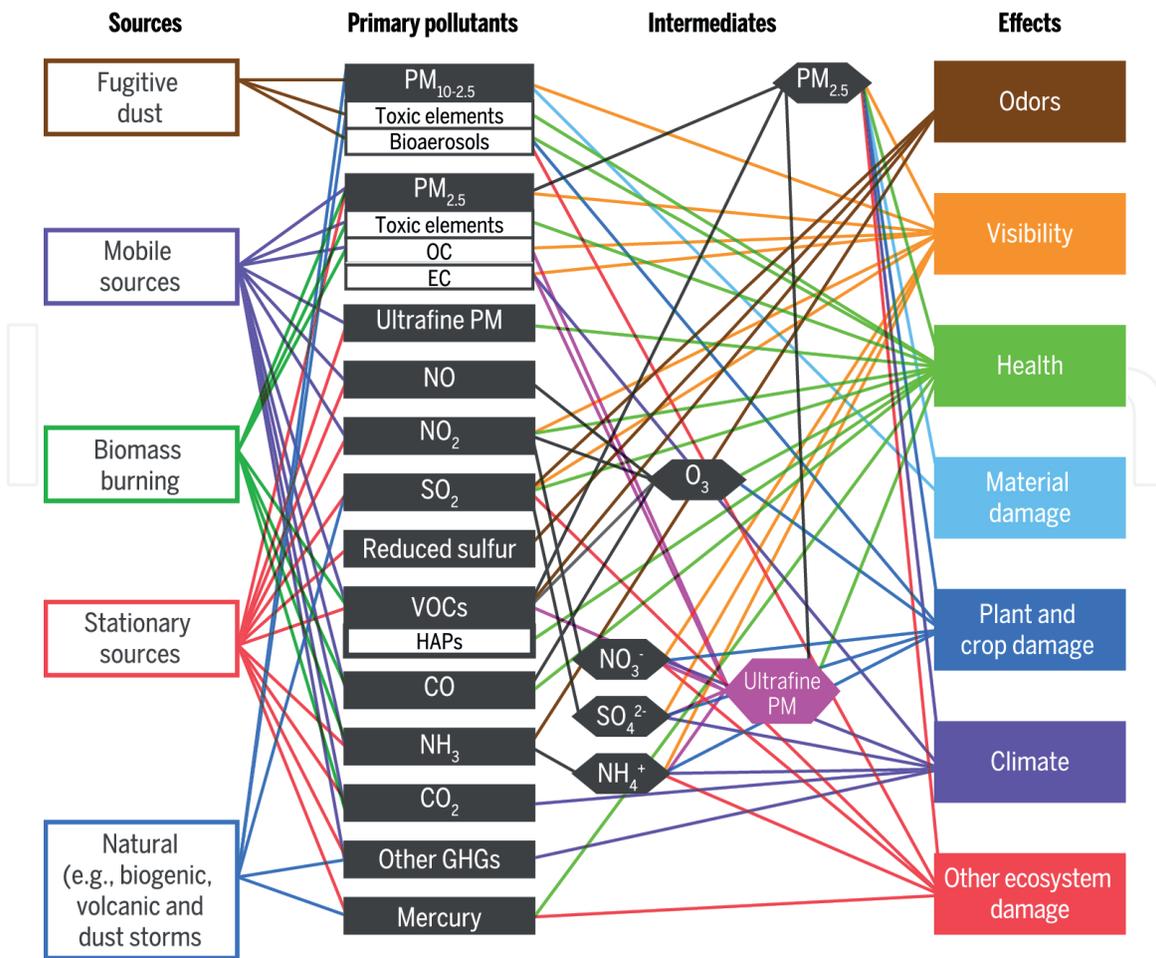


Figure 2.
Effects of air pollutants [59].

9. Conclusion

Air quality degradation is a growing threat to human health, especially in densely populated urban areas exposed to high concentrations of air pollutants. Meteorological parameters can contribute in high concentration episodes of air pollution. Over the last couple of years, air pollutant concentration and human exposure have received special attention due to increasing scientific evidences of causal relationship between exposure with air pollutants and negative health outcomes. Ambient air pollution, especially in urban context, has demonstrated multiple health effects in human health. Health effects of air pollution have been significantly associated with exposure time. Perceptual studies can play a crucial role in future; on the basis of perception information researchers also identified that pollutant which is present in higher concentration in ambient air of studied area. Interaction of air pollutants with atmospheric solar and terrestrial radiation and perturb the planetary energy balance, leading to changes in climate. Climatic changes can influences air pollution concentrations according to the changing pattern of climate by altering the frequency, severity, air stagnation events, precipitation, duration of heat waves and other meteorology conducive to pollutant accumulation. Exposure to higher concentration of pollutants has been associated with increased mortality and hospital admissions due to respiratory and cardiovascular diseases. These effects have been found in both short term and long-term studies in rural, suburban and urban areas. Exposure time have crucial role in health effect phenomenon in all type of residential areas.

Air quality depends on many meteorological and chemical variables. Wind shear and turbulence exerts effects on the mixing and dilution of air pollutants. Humidity is not always linked to the temperature and may be associated with the unequal distribution of moisture with height in the air masses. Pollutants transported from Long distance are dominant during all seasons of the year. Air pollution affects ecosystems in a number of ways, altering basic ecosystem functions such as biogeochemical cycling and primary production which in turn affect the ecosystem services and therefore the benefits that humans get from the ecosystem such as clean drinking water, timber wood, medicinal products and appreciation of nature.

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