

Air Pollution And Its Impact On Environment, Wildlife And Human Health

Vinod Kumar Chaudhary

Department of Environmental Sciences, Dr. Rammanohar Lohia Avadh University, Ayodhya, Uttar Pradesh, India

Abstract

Air pollution is the result of multiple human activities and natural calamities. Over the years, a number of natural activities such as volcanoes, forest fires, lightning possibly release various pollutants in the environment but the atmosphere has not been so much affected as is now being done by anthropogenic activities. Air pollution is determined by the introduction of harmful substances including particulate matter (PM₁₀, PM_{2.5}), Gases (e.g. carbon monoxide (CO), dioxides of Nitrogen (NO_x), ground level ozone (O₃), sulfur dioxide (SO₂), organic compounds (e.g. polycyclic aromatic hydrocarbon [PAH]), and metals in higher concentration pass through the environment. Air pollution is the main cause for the Cardio-vascular dysfunctions, respiratory and neurological disorders among human, while it impacts wildlife and plant too. More, it is also responsible for climate change as it causes global warming, ozone layer depletion and acid rain etc. This paper discusses about the air pollution and its impact on environment and human health.

Keywords; pollutants; environment; acid rain; global warming; neurological disorder

1. Introduction

Air pollution is the result of multiple human activities and natural calamities. Over the years, a number of natural activities such as volcanoes, forest fires, lightning possibly release various pollutants in the environment but the atmosphere has not been so much affected as is now being done by anthropogenic activities. Therefore, anthropogenic activities are the main reason of contaminating the environment and hence causing enormous pressure on environment which are responsible for climate change and various health effects (Kampa & Castanas., 2008). It is clear that human activities produce carbon dioxide, as well as dust particles and other gases which get release into the atmosphere with their carrying capacity. Indian cities are undergoing urbanization at a rapid pace therefore environmental pollution exacerbated due to urbanization, industrialization and increase in the number of vehicles. Also large numbers of people are migrating to urban areas for employment or other needs. Therefore, the number of population in cities is unsustainably increasing day by day as a result, the use of vehicles is being used more and traffic is becoming uncontrolled (Khandar, & Kosankar, 2014.). Anthropogenic activities are main driver for environmental degradation such as emissions from the road vehicles, Industrial power plants,

agricultural activities, wastes disposals, building construction, which produces dust, smelters, use of tobacco, metal-based industries. Air pollution is determined by the introduction of harmful substances including particulate matter (PM₁₀, PM_{2.5}), Gases (e.g. carbon monoxide (CO), dioxides of Nitrogen (NO_x), ground level ozone (O₃), sulfur dioxide (SO₂), organic compounds (e.g. polycyclic aromatic hydrocarbon [PAH]), and metals in higher concentration pass through the environment which deteriorate the quality of the life (Gheorghe & Ion, 2011). Therefore, Air pollution are responsible for the progressive change in the atmospheric composition of the gases in which some gases are emitted directly into the atmosphere while some result from the chemical reaction between other pollutants in the atmosphere named as primary and secondary pollutants respectively. US EPA, set an ambient air quality standards for six pollutants which is also known as criteria pollutants including carbon monoxide, lead, nitrogen dioxide, Ground level ozone, particulate matter, and sulfur dioxide (Huang et. al., 2011). Clearly, Air pollution is global concern and is an international public health issue with multiple aspects therefore exposure to high level as well as low level of air pollution adversely affects the human health, animals and vegetation (Ghorani-Azam et. al., 2016). Indoor air pollutants emitted by burning of kerosines, firewood, crop wastes, dung and outdoor pollutants emitted through many ways including combustion processes from motor vehicles, solid fuel burning and industry, Smoke from bushfire along with dust particles (Kankaria et. al., 2014). Primary contributor of pollutants which directly participate in atmospheric pollution are SO₂, CO, NO₂, Benzene, Particulate matters, Polycyclic Aromatic Hydrocarbons (PAHs), Chlorofluorocarbons, along with heavy metals such as Lead, Mercury, Copper, Nickel, Cadmium. Air pollution are the reason for the Acute and as well as Chronic Diseases (Chen et. al., 2007). Clearly, it is acknowledged that long term and short term exposure of air pollution incidentally increase multiple diseases like Asthma, cardiovascular disease, Lung cancer, respiratory diseases, Wheezing, Pulmonary Disease etc (Lee et. al., 2014). This paper highlights the major air pollutants along with their sources and also estimating the exposure of toxicological air pollutants on human health and their diseases.

2. Environmental impact of air pollution

2.1 Global warming

Global warming is caused mainly due to anthropogenic activities and it is defined as increase in the average temperature of earth because of excessive increase in the amount of existing greenhouse gases such as carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), ozone, and water vapor (Venkataramanan, 2011). Naturally occurring greenhouse gases are absolutely essential for the maintenance of life on earth. Mean temperature of earth would have been lower if greenhouse gases are absent or negligible. However, as the concentration of GHGs increases leads to rise in temperature (Anderson et. al., 2016). Global warming could have significant impacts on human health, agriculture, water resources, forests, wildlife, and melting of snow caps resulting in increase in the sea level (Al-Ghussain, 2018). Moreover, as global temperature rises, the intensity of weather events such as drought, storms, heat waves and floods increases (Dosio et. al., 2018).

2.2 Acid Rain

Acid rain occurs when chemical acids or pollutants present in nature reacts with water in atmosphere and fall on the earth. The acidity of rainwater comes from the oxides of nitrogen and oxides of sulphur which are emitted from combustion of coal in power plants and automobiles (Singh & Agarwal 2007). Major composition of acid rain is sulphuric acid and nitric acid and weak carbonic acid (Ashfaq et. al., 2012). In natural ecosystem, acid rain causes detrimental effect on morphological structure of plans, disturb the physiological activities and plant productivity, eventually leading to plant death. Acid rain can cause acidification of soil that affect plants, makes water unfit for fish and other aquatic organisms and unsuitable for drinking. It also leads to corrosion of buildings, and monuments (Pathak et. al., 2011).

2.3 Ozone depletion

Ozone is found in the stratosphere, absorbs UV rays coming from the sun's radiations, and hence protects us from harmful effect of UV rays. Whereas, tropospheric ozone act as pollutant as it have the ability to harm humans and other organisms. Unfortunately, stratospheric ozone layer has been damaged by ozone depleting constituents like chlorofluorocarbons (CFCs) and hydrochlorofluorocarbon (HCFCs) making stratospheric Ozone layer thin. Hence, allowing harmful sun's radiation to reach the earth surface and cause human health problems such as skin cancer and damage crops vegetation. In plants, ozone gas can reach to the whole throughout the plant through stomata blocks CO₂ transfer and reduces the photosynthesis activity (Madronich et. al., 1993, Teramura, 2006, Singh et. al., 2009).

3. Effect of wildlife

Global population growth contributes to release of toxic pollutants in air that may be deposited in soil or in water ecosystem can impact wildlife in many ways. Like human being, animals can develop several health problems when exposed to sufficient concentration level of air pollutants (Williams et. al., 2004). Due to high air pollutants toxicity, reproductive failure and birth effects can be observed in animals.

4. Health Hazard in human beings

In terms of health hazard, human body can come in contact with various types of air pollutants that may causes difficulties in normal function of living organs. According to epidemiological studies, the main toxicological impact of air pollution are on; respiratory organs, Cardiovascular system, dermatologic, immunologic and neurological disorders. However, long term exposure induce molecular and cell toxicity that can induce several types of cancer in humans (Nakano et. al., 2013; Kampa et. al., 2008). Whereas, sensitive people including children and older people as well as patients (suffering from respiratory and cardiovascular diseases) are more susceptible on exposure to air pollutants even in small amount (Makri et. al., 2008).

4.1 Cardio-vascular dysfunctions

Many experimental and epidemiologic studies have reported that direct exposure of air pollutants can cause multiple cardiac related dysfunctions (Nogueira, 2009, Snow et. al., 2014, Brook et. al., 2008, Anderson et. al., 2012). Several reports have listed that long term exposure to air pollutants due to traffic emission is associated with changes in blood cells affecting heart disease as well as coronary arteriosclerosis (Hoffmann et. al., 2007). Epidemiological studies had suggested that long term exposure of PM_{2.5} at the level of 10µg/m³ is responsible for an 11% increase in cardiac mortality. Long term and short term exposure to nitrogen dioxide is also responsible for increase in cardiac mortality. High level exposure to NO₂, is associated with right and left ventricular hypertrophy (Bourdrel et. al., 2017, Steenhof et. al., 2014). Short term exposure is associated with the increase in the risk of hypertension, stroke, myocardial infarcts, and acute heart failure (Katholi et. al., 2011). Cardiovascular dysfunction may result from mixing of carbon monoxide with other by products from automobile exhaust and patients can also sometimes produce “atherosclerotic heart disease” with high concentration of carboxyhemoglobin (Sule et. al., 2013).

4.2 Respiratory disorders

Studies conducted related to the impact of air pollutants on human health suggests that exposure of air pollution causes respiratory infections and allergy diseases such as asthma, pneumonia and possibly tuberculosis. Air pollution enhances the chance of chronic illness including lung cancer, chronic obstructive pulmonary disease (COPD), and emphysema as well as can significantly harm lung development (Laumbach et. al., 2012, PSR, 2018). Although the respiratory tract has several defense mechanisms such as mucosal cilia, air-blood barrier, air pollutants are able to penetrate or pass through the lung tissue, depending on the size and chemical nature of the air pollutants (D'Amato et. al., 2010). Depending on the dose and size of the inhaled pollutants, it may reach the upper and lower respiratory systems and can cause different level of effect on respiratory tract (Brunekreef et. al., 2009). Air pollutants, specifically particulate matters, dust particles, benzene and other respirable chemicals can cause severe damage to respiratory tract (Valavanidis et. al., 2013, Tam et. al., 2012).

4.3 Neurological disorders

Air pollutants are widely responsible for high rate of nervous system diseases, such as neurodegenerative diseases in adults and neurodevelopmental disorders in children (Brown et. al., 2005, Fombonne, 2013). Recent studies had shown the adverse impact of PM_{2.5} and ultrafine particles (PM_{0.1}) on inhalation can penetrate beyond the pulmonary systems to central nervous system and ultimately gaining access to peripheral circulation and the brain, which is mainly responsible for causing neurological diseases in human beings such as Alzheimer's disease, Parkinson's disease, migraine, headache, cerebro-cardiac stroke, and other form of dementia (Bandyopadhyay, 2016; Haynes et. al., 2011, Newman et. al., 2013; Calderón-Garcidueñas et. al., 2008) .

5. Conclusion

Air pollution in recent years had been emerged as one of the major group of pollution. Air pollution is caused by various kinds of pollutants. These pollutants may be categories as primary or secondary pollutants based on their state of presence in nature. These pollutants may be discharged from anthropogenic or natural sources. The presence of these pollutants above the desirable limit in the environment leads to several kinds of diseases in human beings and to the wild life and plant. Air pollution is also responsible for acid rain and global warming etc. Therefore, there is urgent need for management of air pollutants so that quality of air can be improved and hence risk associated with it can also be minimized.

References

- Al-Ghussain, L. (2018). *Global warming: review on driving forces and mitigation. Environmental Progress & Sustainable Energy*.
- Anderson, T. R., Hawkins, E., & Jones, P. D. (2016). CO₂, the greenhouse effect and global warming: from the pioneering work of Arrhenius and Callendar to today's Earth System Models. *Endeavour*, 40(3), 178-187.
- Ashfaq A, Sharma P. Environmental effects of air pollution and application of engineered methods to combat the problem. *J Indust Pollut Control*. (2012) 29.
- Bandyopadhyay, A. (2016). Neurological disorders from ambient (urban) air pollution emphasizing UFPM and PM 2.5. *Current Pollution Reports*, 2(3), 203-211.
- Bourdrel, T., Bind, M.-A., Béjot, Y., Morel, O., & Argacha, J.-F. (2017). *Cardiovascular effects of air pollution. Archives of Cardiovascular Diseases*, 110(11), 634–642.
- Brook RD. Cardiovascular effects of air pollution. *Clin Sci (Lond)* 2008;115:175-87.
- Brunekreef, B., Beelen, R. M. J., Hoek, G., Schouten, L. J., Bausch-Goldbohm, S., Fischer, P., ... & Jerrett, M. (2009). Effects of long-term exposure to traffic-related air pollution on respiratory and cardiovascular mortality in the Netherlands: the NLCS-AIR study. *Research report (Health Effects Institute)*, (139), 5-71.
- Brown, R. C., Lockwood, A. H., & Sonawane, B. R. (2005). Neurodegenerative diseases: an overview of environmental risk factors. *Environmental health perspectives*, 113(9), 1250-1256.
- Calderón-Garcidueñas, L., Mora-Tiscareño, A., Ontiveros, E., Gómez-Garza, G., Barragán-Mejía, G., Broadway, J., ... & Henríquez-Roldán, C. (2008). Air pollution, cognitive deficits and brain abnormalities: a pilot study with children and dogs. *Brain and cognition*, 68(2), 117-127.
- Chen, T. M., Kuschner, W. G., Gokhale, J., & Shofer, S. (2007). Outdoor air pollution: nitrogen dioxide, sulfur dioxide, and carbon monoxide health effects. *The American journal of the medical sciences*, 333(4), 249-256.

- D'Amato G., Cecchi L., D'Amato M., Liccardi G. Urban air pollution and climate change as environmental risk factors of respiratory allergy: an update. *J Investig Allergol Clin Immunol*. 2010;20:95–102
- Dosio, A., Mentaschi, L., Fischer, E. M., & Wyser, K. (2018). Extreme heat waves under 1.5 C and 2 C global warming. *Environmental Research Letters*, 13(5), 054006.
- Fombonne, E. (2009). Epidemiology of pervasive developmental disorders. *Pediatric research*, 65(6), 591-598.
- Gheorghe, I. F., & Ion, B. (2011). The effects of air pollutants on vegetation and the role of vegetation in reducing atmospheric pollution. *The impact of air pollution on health, economy, environment and agricultural sources*, 29, 241-80.
- Ghorani-Azam, A., Riahi-Zanjani, B., & Balali-Mood, M. (2016). Effects of air pollution on human health and practical measures for prevention in Iran. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences*, 21.
- Haynes, E. N., Chen, A., Ryan, P., Succop, P., Wright, J., & Dietrich, K. N. (2011). Exposure to airborne metals and particulate matter and risk for youth adjudicated for criminal activity. *Environmental research*, 111(8), 1243-1248.
- Hoffmann, B., Moebus, S., Mohlenkamp, S., Stang, A., Lehmann, N., ... Dragano, N. (2007). *Residential Exposure to Traffic Is Associated With Coronary Atherosclerosis*. *Circulation*, 116(5), 489–496.
- Huang, Y. C. T., & Brook, R. D. (2011). The clean air act: science, policy, and politics. *Chest*, 140(1), 1-2.
- Kampa, M., & Castanas, E. (2008). Human health effects of air pollution. *Environmental pollution*, 151(2), 362-367.
- Kankaria, A., Nongkynrih, B., & Gupta, S. K. (2014). Indoor air pollution in India: Implications on health and its control. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*, 39(4), 203.
- Kampa & Castanas, 2007. Human health effect of air pollution. ; Liu, Y., Xu, C., Liu, F., Xiao, G., Zhou, S., Huang, L., ... & Du, Q. (2022). Uneven development of the lead industry leads to regional differences in blood lead levels of children. *Environmental Pollution*, 293, 118504.
- Katholi RE, Couri DM. Left Ventricular Hypertrophy: Major Risk Factor in Patients with Hypertension: Update and Practical Clinical Applications. *Int J Hypertens*. 2011; 495349.
- Khandar, C., & Kosankar, S. (2014). A review of vehicular pollution in urban India and its effects on human health. *Journal of Advanced Laboratory Research in Biology*, 5(3), 54-61
- Laumbach, R. J., & Kipen, H. M. (2012). Respiratory health effects of air pollution: update on biomass smoke and traffic pollution. *Journal of allergy and clinical immunology*, 129(1), 3-11.

- Lee, B. J., Kim, B., & Lee, K. (2014). Air pollution exposure and cardiovascular disease. *Toxicological research*, 30, 71-75.
- Madronich S, de Gruijl F. Skin cancer and UV radiation. *Nature*. (1993) 366:23–9. doi: 10.1038/366023a0.
- Makri, A., & Stilianakis, N. I. (2008). Vulnerability to air pollution health effects. *International journal of hygiene and environmental health*, 211(3-4), 326-336.
- Nakano, T., & Otsuki, T. (2013). Environmental air pollutants and the risk of cancer. *Gan to kagaku ryoho. Cancer & chemotherapy*, 40(11), 1441-1445.
- Newman, N. C., Ryan, P., LeMasters, G., Levin, L., Bernstein, D., Hershey, G. K. K., ... & Sucharew, H. (2013). Traffic-related air pollution exposure in the first year of life and behavioral scores at 7 years of age. *Environmental health perspectives*, 121(6), 731-736.
- Nogueira JB. Air pollution and cardiovascular disease. *Rev Port Cardiol* 2009;28:715-33.
- Pathak, R. K., Wang, T., Ho, K. F., & Lee, S. C. (2011). Characteristics of summertime PM_{2.5} organic and elemental carbon in four major Chinese cities: Implications of high acidity for water-soluble organic carbon (WSOC). *Atmospheric Environment*, 45(2), 318-325.
- Physician For Social Responsibility (PSR) Report, United State affiliate of international Physicians for the prevention of Nuclear war. <https://www.psr.org/wp-content/uploads/2018/05/air-pollution-effects-respiratory.pdf>
- Singh, A., & Agrawal, M. (2007). Acid rain and its ecological consequences. *Journal of Environmental Biology*, 29(1), 15.
- Singh, E., Tiwari, S., & Agrawal, M. (2009). Effects of elevated ozone on photosynthesis and stomatal conductance of two soybean varieties: a case study to assess impacts of one component of predicted global climate change. *Plant Biology*, 11, 101-108.
- Snow SJ, Cheng W, Wolberg AS, Carraway MS. Air pollution upregulates endothelial cell procoagulant activity via ultrafine particle-induced oxidant signaling and tissue factor expression. *Toxicol Sci* 2014;140:83-93.
- Steenhof M, Janssen NA, Strak M, Hoek G, Gosens I, Mudway IS, et al. Air pollution exposure affects circulating white blood cell counts in healthy subjects: The role of particle composition, oxidative potential and gaseous pollutants – The RAPTES project. *Inhal Toxicol* 2014;26:141-65.
- Sule, Tunde Usman Nurudeen Alhasan, Abubakar, Z. P.M.B 13, Auchu, Edo State Nigeria, Abdulasisi Titi Umoru The influence of primary air pollutants on human health related risk (2013).
- Tam, W. W., Wong, T. W., Wong, A. H., & Hui, D. S. (2012). Effect of dust storm events on daily emergency admissions for respiratory diseases. *Respirology*, 17(1), 143-148.
- Teramura A. Effects of UV-B radiation on the growth and yield of crop plants. *Physiol Plant*. (2006) 58:415–27.

Venkataramanan, S. (2011). Causes and effects of global warming, *Indian Journal of Science and Technology*, 4, 226–229.

Valavanidis, A., Vlachogianni, T., Fiotakis, K., & Loridas, S. (2013). Pulmonary oxidative stress, inflammation and cancer: respirable particulate matter, fibrous dusts and ozone as major causes of lung carcinogenesis through reactive oxygen species mechanisms. *International journal of environmental research and public health*, 10(9), 3886-3907.

Williams, J. H., Phillips, T. D., Jolly, P. E., Stiles, J. K., Jolly, C. M., & Aggarwal, D. (2004). Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions. *The American journal of clinical nutrition*, 80(5), 1106-1122.

