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The Impacts of Air Pollution on Human Health and Well-Being: A Comprehensive Review

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Abstract: ***Air pollution is a pressing global environmental challenge with far-reaching consequences for human health and well-being. This research paper presents an extensive examination of air pollution, its diverse sources, and its detrimental effects on both individual and community health. The paper explores the various types of pollutants found in the atmosphere, their origins, and the mechanisms through which they impact human health. Additionally, it delves into the global burden of air pollution, shedding light on the alarming scale of its impact, and emphasizes the urgent need for effective mitigation strategies to safeguard public health and preserve the environment. Also, this paper will review various existing literature related to the topic and review it. The study also identifies some of the key factors that moderate this relationship, such as socio-demographic variables, perception of health risks, and coping strategies. The findings of this study have important implications for policymakers, urban planners, and public health officials, who must consider the impact of air pollution on health while formulating policies and interventions to address this critical issue.***

Keywords: Air Pollution, Air Quality Index, Environment, Health issues, Urban spaces, Well-being.

1. INTRODUCTION

The introduction highlights the urgency of addressing air pollution as a significant environmental and public health concern. It emphasizes the importance of understanding its origins, constituents, and health implications to make informed decisions for policy interventions.

Air pollution is a pressing contemporary challenge, notable not only for its role in climate change but also for its serious repercussions on both public and personal well-being. This leads

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to higher instances of sickness and mortality. Numerous harmful substances significantly contribute to human illnesses. Particulate Matter (PM), consisting of minuscule particles of different sizes, infiltrates the respiratory system via inhalation, resulting in respiratory and cardiovascular disorders, disruptions to reproductive and central nervous systems, and potentially even cancer.

While ozone in the upper atmosphere acts as a shield against ultraviolet radiation, it becomes harmful in excessive amounts at ground level, causing damage to the respiratory and cardiovascular systems. Furthermore, nitrogen oxide, sulphur dioxide, volatile organic compounds (VOCs), dioxins, and polycyclic aromatic hydrocarbons (PAHs) are all classified as pollutants that endanger human health. Carbon monoxide can lead to acute poisoning when inhaled at high concentrations. Heavy metals such as lead, once absorbed into the human body, can cause either immediate poisoning or prolonged intoxication, depending on the level of exposure. Addressing this critical issue necessitates a combination of public awareness and a multidisciplinary approach involving scientific experts. Both national and international bodies must act to the emergence of this threat and put forth some sustainable solutions. (Manisalidis 2022)

Types and Sources of Air Pollution:

This section provides a comprehensive overview of the different air pollutants that contribute to air pollution. It examines the sources of these pollutants, including anthropogenic activities like industrial emissions, transportation, and agriculture, as well as natural sources like wildfires and volcanic eruptions.

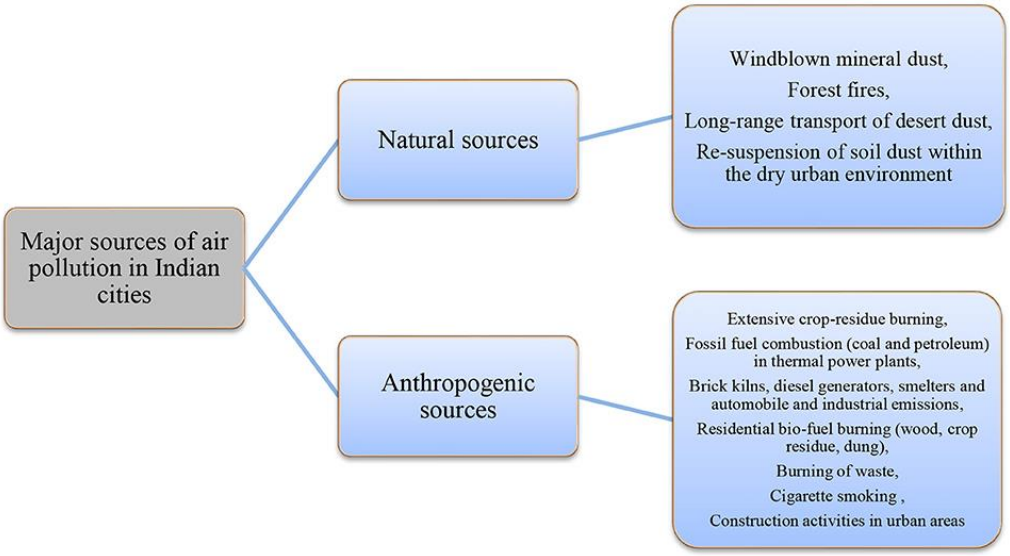

Figure 1 Sources of air pollution in India

Following are Some Pollutants:

- **Ozone**: Surface ozone is formed by photo chemical action on NO_x and Volatile Organic Compounds (VOC) by solar radiation. Major anthropogenic sources of these two compounds (NO_x and VOC) in the city of Delhi is transportation sector, industries and

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power generation. (Sahu et al., 2015). Automobile exhaust emission consists of toluene, sum of xylene and ethyl-benzene isomer (Henze, 2008). VOC play a significant role in formation of PM_1 having adverse health effects(Li et al., 2009)

- **$PM_{2.5}$ and PM_{10}**: Particulate matters ($PM_{2.5}$) – Tiny particles that can be inhaled and cause respiratory problems. Particulate matters smaller than 2.5 mm are considered as most noxious pollutant as they can be inhaled and enters the lung and damages the respiratory tissues. In Urban and indoor air, cigarette smoke and asbestos fibres are categorised among most dangerous particle because of their carcinogenic effect that leads to cancer (Cunningham et al, 2005). Air pollutants such as $PM_{2.5}$ induces depressive symptoms (Roberts et al., 2019) and decreases emotional wellbeing in human (Zhang et al., 2019). Lancet (2013) estimated that every increase of $PM_{2.5}$ by 5µg/m³ induces harmful impact on pregnant women by increasing risk of low birth weight at term increases by 18%. WHO recommended annual limit for PM is 5 µg/m^3 but in a survey of 20 most polluted cities in India 2022, New Delhi ranks fifth with 84.17 µg/m^3 over 17-times higher than the WHO recommended limit According to study conducted in 2011 in Delhi, major sources of PM_{10} are power sector (10.5 %), industrial (26%), transport (29%) and residential sector (34.5%). For $PM_{2.5}$ the major contributors in order are power (4%), industry (24%), Residential (27%) and transport (45%) (Sahu et al., 2011). We observe that for $PM_{2.5}$ the major contributor is transport and for PM_{10} the residential sector contributes the most. $PM_{2.5}$ and PM_{10} are the main polluters for the city of Delhi.
- **NO_2 and SO_2**: Sulphur dioxide (SO2) is a gas that can lead to respiratory issues and contribute to the formation of acid rain, while nitrogen dioxide (NO2) contributes to the creation of smog and acid rain. These gases have a lasting impact on the respiratory system, with children being the most susceptible group (Fadul, 2019; Pandey et al., 2005). The primary source of these pollutants is vehicular emissions. According to data from the Central Pollution Control Board (CPCB), the concentration of SO2 in Delhi is below 10 µg/m^3, which falls within the acceptable limit (CPCB, 2020). Pollution from traffic poses a significant threat to both biodiversity and human health. The adverse effects of NO2, a byproduct of traffic, include an increase in psychological stress (Davis et al., 2018)
- **Carbon Monoxide:** According to Enger & Smith (2000), even a minute concentration of 0.001% carbon monoxide in the air over an extended period can lead to fatality. This is because CO has a high affinity for binding with haemoglobin, a propensity that persists even with minimal exposure, resulting in its accumulation. Consequently, this diminishes the oxygen-carrying capability of haemoglobin. Furthermore, the emissions of CO from vehicles in congested traffic can induce symptoms like headaches, impaired vision, and drowsiness.
- **Ammonia: Studies** have shown that Ammonium Chloride is responsible for aerosol liquid water which is the cause of 'haze' like situation in Delhi. (Chen et al., 2022)
- **Lead:** Lead primarily originates from various sources, including emissions from Diesel/Petrol, paints, metal mining and smelting, waste incineration, battery recycling, as well as wood and coal burning. In November 2016, New Delhi witnessed an intense episode of air pollution, characterized by an unprecedented Air Quality Index (AQI) surpassing 500. This event affected the entire National Capital Region (NCR) due to stagnant air and the presence of biomass burning aerosols in the plains of Punjab and Haryana. Prior to this

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severe air pollution episode (SAPE), the concentration of PM2.5 was measured at 142 μg/m³. This value escalated to 563 μg/m³ during the episode and subsequently decreased to 240 μg/m³ afterward**.**(Kanawade et al., 2020)

- **CO2**:
  The greenhouse effect attributes significant pollutant status to Carbon dioxide, earning it the title of the planet's most detrimental climate pollutant (Vaidyanathan, 2014). This gas, crucial to both human respiration and plant vitality, is an integral and naturally occurring component of the atmosphere (EIA, 2019).

Airborne pollutants can have detrimental impacts on human health, wildlife, and the ecosystem. For instance, being exposed to air pollution has been associated with respiratory conditions like asthma and lung cancer, as well as heart disease, stroke, and various other health issues. Moreover, visibility and damage on crops and other vegetation, diminish visibility, and play a role in contributing to climate change.

Particle size	Penetration degree in human respiratory system
>11 μm	Passage into nostrils and upper respiratory tract
7–11 μm	Passage into nasal cavity
4.7–7 μm	Passage into larynx
3.3–4.7 μm	Passage into trachea-bronchial area
2.1–3.3 μm	Secondary bronchial area passage
1.1–2.1 μm	Terminal bronchial area passage
0.65–1.1 μm	Bronchioles penetrability
0.43–0.65 μm	Alveolar penetrability

Figure 2: Types and sizes of PM

In less developed nations (PM 2017), the issue is exacerbated by high population densities, unregulated urban expansion, and the proliferation of industrialization. Consequently, this results in compromised air quality, particularly in regions marked by social inequalities and a dearth of knowledge regarding sustainable environmental stewardship. The reliance on low-cost fuel sources like wood or solid fuels for household requirements due to limited incomes exposes individuals to subpar, contaminated indoor air. It is noteworthy that globally, three billion individuals rely on these energy sources for their daily heating and culinary needs. (Burden of Disease from Ambient and Household Air Pollution 2017). In less developed nations, it appears that women in households face the greatest susceptibility to developing diseases due to their prolonged exposure to indoor air pollution. China, grappling with swift industrialization and a dense population, stands out among Asian countries contending with severe air pollution (Y 2017). The occurrence of lung cancer mortality in China is linked to fine particles (Y 2017). As previously mentioned, extended exposure relates to harmful impacts on the cardiovascular system. (PM 2017).

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Yet, it is noteworthy that cardiovascular diseases are predominantly observed in affluent, developed nations rather than in low-income, developing countries experiencing high levels of air pollution. (MS 2017). India faces severe air pollution, with hazardous levels of air quality, notably in cities like New Delhi, considered one of the most polluted in the country. Flights to and from New Delhi International Airport frequently face cancellations due to reduced visibility from pollution. Both urban and rural areas in India are affected by pollution, driven by rapid industrialization, urban expansion, and increased use of motorcycles for transportation. However, a significant source of household air pollution in India and Nepal stems from biomass combustion for heating and cooking. There is geographical variation in India, with different indoor air qualities generated in areas with diverse climates, populations, and education levels. North Indian states exhibit higher PM2.5 levels (557–601 μg/m3) compared to Southern States (183–214 μg/m3), possibly due to the colder climate requiring more time spent indoors and increased heating. In India, household air pollution has substantial health impacts, particularly for women and young children who spend extended periods indoors. Chronic obstructive respiratory disease (CORD) and lung cancer are predominantly observed in women, while young children under 5 years old are susceptible to acute lower respiratory disease (Dherani M 2008)

In this current paper, our emphasis lies on examining the origins of environmental pollution concerning public health. We also put forth potential remedies and measures that could be of relevance to environmental policymakers and decision-makers.

Air Pollution impact on micro and macro-Climate

The climate and pollution are closely entwined, with pollution exerting a substantial influence on altering the Earth's climate system. This interplay between the two is intricate, encompassing diverse feedback loops and mechanisms. Here's an exploration of their interconnectedness:

1. **Greenhouse Gas Emissions:** Pollution, especially in the form of greenhouse gas emissions, is a major contributor to climate change. Activities like burning fossil fuels for energy, industrial processes, and deforestation release large amounts of carbon dioxide (CO2), methane (CH4), and other greenhouse gases into the atmosphere. These gases trap heat, creating a "greenhouse effect" that leads to global warming and altered climate patterns.
2. **Airborne Particulates and Aerosols:** Pollutants such as particulate matter and aerosols have a twofold impact on climate. Firstly, they can directly affect the Earth's energy balance by reflecting sunlight back into space, thereby cooling the planet. Secondly, when these particles settle on ice and snow surfaces, they reduce the surface's reflectivity, causing it to absorb more sunlight and accelerate melting.
3. **Feedback Loops:** Pollution can contribute to feedback loops that amplify the effects of climate change. For instance, the melting of polar ice due to higher temperatures releases methane that was previously trapped in ice crystals. Methane is a potent greenhouse gas, so its release intensifies the warming, leading to more ice melt and further methane release.
4. **Ocean Pollution and Acidification:** Pollution, including excess CO2, affects the world's oceans. The oceans absorb a significant portion of atmospheric CO2, leading to ocean acidification. This harms marine ecosystems and the organisms that rely on calcium

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carbonate to build shells and skeletons. Disturbed marine ecosystems can disrupt the ocean's ability to absorb carbon dioxide, further impacting the climate system.

5. **Air Quality and Health Impacts:** Pollutants that are harmful to human health, such as smog and fine particulate matter, are often released alongside greenhouse gases. Policies aimed at reducing these pollutants can inadvertently help mitigate climate change by decreasing the emissions of both harmful pollutants and greenhouse gases.
6. **Urban Heat Island Effect:** Polluted urban areas experience the "urban heat island" effect, where concentrations of pollutants absorb and trap heat, leading to higher local temperatures. This localized warming can disrupt local climate patterns, exacerbating heatwaves and energy demands.
7. **Deforestation and Climate Change:** Pollution from activities like burning forests not only releases carbon stored in trees but also reduces the planet's capacity to absorb carbon dioxide. Forests act as carbon sinks, so their loss contributes to higher atmospheric CO2 levels and accelerates climate change.

Air pollution and climate change share a close connection. Climate change is the flip side of the same coin that diminishes the quality of our planet. (G 2016). Substances like black carbon, methane, tropospheric ozone, and aerosols influence the quantity of incoming sunlight. Consequently, the Earth's temperature rises, leading to the thawing of ice, icebergs, and glaciers.

Many studies, including the work of Nath et al. (2021), have spotlighted the significance of land use and land cover in the context of climate change, particularly in Indian cities. The study by Nath et al. illustrates a swift surge in built-up areas in Guwahati, indicating an overall increase of 103% in land area over the past three decades (1990–2020).

The virus of Chikungunya outbreaks from the Indian Ocean to Europe, as the cases were registered mostly in Italy (Lindh E 2019)and autochthonous cases in France as well. (Calba C 2017)

The relationship between climate and pollution is bidirectional and multifaceted. Pollution contributes to climate change by releasing greenhouse gases, altering energy balance, and affecting feedback mechanisms. Conversely, climate change can influence pollution patterns through shifts in weather, precipitation, and atmospheric circulation. Addressing pollution is a critical component of efforts to mitigate the impacts of climate change and safeguard the planet's ecological balance.

Effects of Air Pollution on Health:

Air pollution comes in two main forms: outdoor pollution, which refers to pollution in the air we breathe, and indoor pollution, which stems from the combustion of household fuels. People exposed to high levels of air pollutants can experience a range of health problems, spanning from mild to severe. These health effects can be divided into short-term and long-term categories, impacting various aspects of well-being.

Extensive research has documented the adverse effects of climate change on human health. These impacts are expected to worsen as climate conditions continue to change, both now and in the future, as indicated by studies conducted by Luber and McGeehin in 2008, Bell et al. in 2018, and Filippelli et al. in 2020. Climate change primarily compromises human health by increasing the frequency and intensity of severe weather events, such as higher temperatures,

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more rainfall, more frequent and severe heatwaves, floods, droughts, strong winds, and landslides, as noted by Orimoloye et al. in 2019.

Changes in temperature and precipitation patterns resulting from climate change lead to severe heatwaves, extreme cold spells, and unpredictable rainfall. These alterations are strongly associated with an upsurge in health-related issues. Additionally, these shifts in climate conditions contribute to the spread of waterborne and airborne infections, diseases transmitted by vectors, malnutrition, an increased occurrence of diarrheal diseases, and a rise in both heat-related illnesses and fatalities, as highlighted in studies by Haines et al. in 2006 and Dutta and Chorsiya in 2013.

As previously discussed in detail, a recent epidemiological investigation conducted by the Harvard School of Public Health has revealed that our understanding of the varying strengths of immediate and long-term impacts remains incomplete, as reported by Kloog in 2013. This is due to differences in epidemiological approaches and inaccuracies in measuring exposure. Innovative methodologies are now being proposed to assess human exposure data more effectively for both short and extended timeframes, as also suggested by Kloog in 2013.

Brief impacts are transient and encompass mild sensations of unease, like eye, nasal, dermal, and throat irritation, accompanied by wheezing, coughing, chest constriction, and respiratory challenges. They can escalate to graver conditions such as asthma, pneumonia, bronchitis, and complications in the lungs and heart. Air pollution's short-term influence can also manifest as headaches, queasiness, and vertigo.

When exposure endures over the long term, these issues can worsen. Prolonged contact with pollutants can detrimentally affect the neurological, reproductive, and respiratory systems, fostering the development of cancer, and in rare instances, even leading to fatalities.

Long-term consequences are enduring, spanning years or an individual's entire lifetime, and can potentially result in mortality. Additionally, the harmful nature of certain air pollutants can also trigger various types of cancer over extended periods. (Nakano T 2013)**.**

As previously mentioned, respiratory ailments are strongly linked to the inhalation of airborne contaminants. These pollutants enter the respiratory pathways and amass within cells. The harm inflicted upon specific cells is intricately tied to the pollutant elements, their origin, and the quantity present. Furthermore, the health consequences are intricately tied to the nation, locality, time of year, and timeframe. Prolonged exposure to pollutants is likely to result in enduring health impacts, influenced by the aforementioned factors.

Particulate Matter (PMs), dust, benzene, and O3 can inflict significant harm on the respiratory system, as indicated by Kurt in 2016. Additionally, there is a heightened risk of developing asthma, which is the most prevalent concern in this regard.

Environmental Justice and Air Pollution

These severe weather conditions have negative implications for public health, potentially resulting in environment loss also. When examining the health impacts associated with extreme heat, it becomes crucial to grasp the effects of rising temperatures on living organisms.

Moreover, the occurrence of heatwaves and recurring weather events provides compelling evidence of climate change's impact on eastern India, as noted by Patil and Deepa in 2007. Specifically, heatwaves in 1998 and 2015 alone resulted in a tragic loss of over 2,000 lives each in India, as documented by Mukherjee and Mishra in 2018. Between 1978 and 1999, approximately 1,625 individuals succumbed to heatwaves, primarily in Rajasthan, followed by

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Bihar, Uttar Pradesh, and Odisha, according to De in 2000. This toll increased significantly to 3,442 heat-related deaths during the period from 1999 to 2003, as reported by Chaudhury et al. in 2000 and the Centres for Disease Control and Prevention in 2006.

A study conducted by Dutta and Chorsiya in 2013 revealed that in 2013 alone, more than 600 people lost their lives due to heatwaves in India, with approximately 1,400 deaths attributed to high ambient temperatures (reaching 50°C) in Andhra Pradesh in 2002. Similarly, a high ambient temperature of 46.8°C in Ahmadabad led to numerous urban residents losing their lives in 2010. Furthermore, heatwaves had a significant impact on states like Rajasthan and Uttarakhand in 2009, as noted by Dutta and Chorsiya in 2013.

Researchers such as Akhtar in 2007, Dholakia et al. in 2015 (for Ahmedabad), Murari K. K. et al. in 2015, and Mazdiyasni et al. in 2017 have investigated the relationship between climate variability and heat-related mortality in India. Predictions suggest that the increasing frequency of hot days and nights from 1951 to 2016 could lead to a fourfold increase by 2050 and a twelvefold increase by 2100, consequently amplifying heat-related mortality, as highlighted by Mukherjee and Mishra in 2018 and Singh C. et al. in 2021.

Climate change is also accountable for triggering various other extreme events, such as droughts, floods, tsunamis, and cyclones, all of which carry adverse implications for human health. Urban droughts and floods, which result from shifts in climate patterns involving either excessive or insufficient rainfall, indirectly impact human well-being. Floods give rise to physical consequences like drowning, hypothermia, and trauma, as documented by Ahern et al. in 2005 and Du et al. in 2010. Severe droughts, leading to food scarcity, have caused a significant number of deaths from starvation in India, as observed by Dutta and Chorsiya in 2013. Similarly, excessive rainfall leading to floods devastates crops, leading to food shortages and subsequently contributing to malnutrition and public health challenges.Malnutrition is a pressing issue in India, with the World Bank's 2009 report on Malnutrition in India indicating that approximately 47% of children are vulnerable to this problem. This issue can also lead to anemia, affecting around 70% of children, 55% of women, and 25% of men in India, as reported by Majra and Gur in 2009. Relation between Air pollution, Health, and EnvironmentStudying the intricate interplay between urban climates, air pollution, and human well-being in cities is a crucial undertaking. Developing nations like India face significant challenges from both air pollution and climate change. The combined effects of weather conditions, climate shifts, heightened air pollution, and the resulting health impacts in India have received limited attention in research (Agarwal et al., 2006; Karar et al., 2006).Climate dynamics play a substantial role in how air pollutants disperse in terms of location and time. Both global warming and stratospheric ozone depletion are pivotal components of climate change. Changes in climate have the potential to influence the levels of air pollutants and facilitate the formation of additional pollutant compounds. Additionally, climatic factors, in conjunction with atmospheric elements, terrain, and urban layouts, collectively determine how pollutants spread, accumulate, and transform in the atmosphere. The spread of these airborne pollutants can lead to respiratory conditions like asthma, emphysema, allergies, and chronic bronchitis (D'Amato et al., 2002).

As per estimates from the World Health Organization (WHO), trends in precipitation and warming driven by human-induced climate change over the past three decades have resulted in an annual toll of 150,000 lives. These climate-related changes have worsened existing human

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health issues, including increased rates of cardiovascular mortality and respiratory illnesses caused by heatwaves and other factors.

Moreover, the intricate interplay between urbanization, climate change, and air pollution operates in a way where specific atmospheric pollutants (aerosols) can magnify climate change through both direct and indirect mechanisms (Ramachandran and Cherian, 2008). These air pollutants not only deteriorate air quality, affecting human health, but also significantly influence the climate by elevating temperatures in the lower and mid-troposphere. This process leads to alterations in sea-land temperature differences, shifts in monsoon patterns, changes in rainfall distribution, reduced solar radiation, and adjustments in cloud properties (Lau et al., 2006; Gautam et al., 2010; Sharma et al., 2014), thereby causing shifts in the frequency of heatwaves, the intensity of storms, and patterns of precipitation.

Global Burden of Air Pollution:

This part uses information to give a big study about how much harm air pollution causes worldwide. It counts how many people die too early, how many years of healthy life are affected, and how much money is spent on health problems from air pollution. It also talks about how some places have more air pollution and worse effects. In 2018, Dr. Tedros Adhanom Ghebreyesus, the leader of WHO, said air pollution is like a hidden health crisis, like how tobacco used to be (WHO 2018)

Despite the challenge of tackling human-caused environmental pollution, a solution may arise through collaboration among authorities, organizations, and medical professionals. Governments should spread information, educate the public, and engage experts to effectively address the problem's emergence.

Implementing source-based technologies to reduce air pollution should be widely adopted in industries and power plants. The Kyoto Protocol of 1997, aiming for over a 5% reduction in GHG emissions by 2012 (123), marked a significant milestone. This was followed by the 2009 Copenhagen summit. (CopenhagenClimate Change Conference (UNFCCC) 2019) and the 2011 Durban summit, which upheld a similar course of action. Many countries ratified the Kyoto Protocol and its subsequent iterations, with China standing out as a prominent supporter of this vital protocol for global environmental and climate "health". China, being a rapidly growing economy, is anticipated to have a substantial GDP by 2050, the proposed dissolution year of the protocol for gas emission reduction.

A more recent and pivotal international accord concerning climate change is the 2015 Paris Agreement established by the United Nations Climate Change Committee (UNFCCC). This pact received widespread ratification from UN member states and European Union countries alike (Paris Climate Change Agreement, 2016) Parties involved should instigate measures and initiatives to enhance various aspects concerning this issue. Strengthening education, training, public awareness, and engagement are among the essential actions to maximize the potential for attaining the targets and objectives related to climate change and environmental pollution (Paris Climate Change Agreement, 2016). While technological advancements have certainly eased our lives, mitigating the harmful impact of gas emissions presents a challenge that requires prudent approaches to limiting their usage.

In summary, a comprehensive global preventative policy must be formulated to combat anthropogenic air pollution as a supplement to effectively addressing the health repercussions

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tied to air pollution. The adoption of sustainable development practices, coupled with insights derived from research, is vital for managing this issue proficiently.

At this juncture, international cooperation encompassing research, development, administrative policies, monitoring, and politics stands as an indispensable facet of effective pollution control. Legislation pertaining to air pollution must be harmonized and revised, and policy makers ought to conceptualize robust tools for environmental and health protection.

2. CONCLUSION

The current assessment underscores elevated levels of air pollution prevalent across numerous major cities in India, surpassing acceptable thresholds. The persistent emissions from both human activities and natural sources lead to heightened concentrations of particulate matter (PM), which in turn have detrimental effects on human health. This accentuates the critical need for ongoing surveillance of air pollutants throughout the Indian subcontinent, employing both direct measurements and satellite data for remote sensing.

The indispensable insights into air quality presented in this review for various Indian megacities offer valuable guidance for tailoring effective mitigation strategies. This involves identifying vulnerable regions within each city. This dataset also serves as a fundamental reference for air quality modelling endeavours, contributing to the prediction of pollution levels. This, in turn, supports preparedness, adaptation, and strategies for curtailing air pollution-linked issues. The considerable disease burden and mortality associated with air pollution in Indian urban canters necessitate comprehensive measures to control pollutant levels nationwide. Notably, the outcomes that depict pollution reduction during the COVID-19 lockdown period suggest the viability of implementing such short-term restrictions to enhance air quality and thereby improve public health across different Indian cities.

Furthermore, as outlined in the review, India, being a developing nation, grapples with adverse health repercussions due to climate change. The country's cities are increasingly exposed to extreme climatic events like heavy precipitation, floods, droughts, and heatwaves, driven by rising temperatures from climate change. Strengthening health surveillance in response to heatwaves, floods, and vector-borne diseases associated with climate change can contribute to addressing imminent health challenges in Indian urban centres. Additionally, the high population density coupled with ongoing urbanization and industrialization amplifies the necessity of factoring in these elements to avert negative health impacts linked to climate change in India. Therefore, the review underscores the significance of adopting mitigation and adaptation strategies to counteract the present and projected effects of climate change on health in Indian cities.

In conclusion, the utilization of advanced technologies such as satellite data integrated with geospatial techniques emerges as a potent tool for monitoring and mapping the spatiotemporal distribution of air pollution and climate change, along with their health implications. Consequently, while prioritizing the development of smart cities in developing nations like India, prudent urban planning and sustainable practices are imperative to establish a resilient urban environment that mitigates adverse health consequences.

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