Air Quality Index and Its Effects on Human Health

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***Abstract*—Air pollution is a major environmental problem in India which has gradual health effect on the local public all over the world. The Air Quality Index (AQI) is a standardized tool used to communicate to the public how polluted the air currently is or how polluted it is forecast to become. This paper focuses on the Air Quality framework, pollutant categories, calculation methods, and the documented impacts of air pollution on human health. It also discusses vulnerable populations, health outcomes associated with various AQI levels, and policy implications.**

***Index Terms*—Air Pollution, human health, pollutant, AQI levels, Policy implications**

I. INTRODUCTION

Air quality significantly affects environmental sustainability and human health. With rapid urbanization, industrialization, Vehicular emissions, airborne pollutants have increased in many regions, elevating health risks. The Air Quality Index (AQI) was developed as a simplified indicator to reflect daily air quality and its potential health effects. Understanding AQI and its health correlations helps individuals and policymakers mitigate adverse outcomes.

The Air Quality Index (AQI) is a standardized system used by government agencies to communicate how polluted the air currently is or how polluted it is forecast to become. It focuses on health affects we may experience within a few hours or days after breathing polluted air. It operates on a standardized scale where higher values indicate poorer air quality and greater public health risks.

II. OBJECTIVES

1.To know about Air quality Index (AQI).
2.To know effects of polluted air on human health.

Principal pollutants measured under Air quality Index (AQI) are given below with their health effects.

PARTICULATE MATTER (PM2.5 & PM10)- Tiny particles are generated from the process of combustion, chemical reactions and dust. It can penetrate deep into lungs and bloodstream, causing respiratory and cardiovascular issues.

OZONE (O_3)- this is ground-level ozone which is a secondary pollutant formed by chemical reactions in sunlight. It causes breathing difficulty, aggravates asthma, reduces lung function.

NITROGEN DIOXIDE (NO_2)- It is emitted from vehicles and industrial processes. It irritates airways, contributes to bronchitis and lung disease.

SULPHUR DIOXIDE (SO_2)- SO_2 generated in the process of fossil fuels burning with sulphur content (e.g., coal). It causes respiratory symptoms and aggravate existing heart disease.

CARBON MONOXIDE (CO)- CO is a colourless gas generated from incomplete combustion process. It decreases oxygen delivery in the body; It is unsafe for cardiovascular patients.

Gradually these gases affect important body system like respiratory system, Cardiovascular system and has systematic effects. In respiratory system pollutants cause inflammation of airways, increase susceptibility to infections which includes more chances of bronchitis and pneumonia. Long term exposure can reduce lung function. In case of Cardiovascular system Particulate matter can enter in the blood circulation, increases risk of heart attacks and strokes. Chronic exposure to these gases may cause the diabetes, cancer, and adverse pregnancy outcomes.

Vulnerable Population includes Children which has developing lungs and higher breathing rates. Elderly people whose having weaker immune and respiratory system are more prone to get effects like asthma. People who are already eth pre-existing diseases are more prone for these problems as well as pregnant women are at higher risks of adverse birth outcomes.

Several research findings epidemiological studies link AQI and pollutants with health outcomes. It has short term as well as long term effects. Short term effects show increased hospital admissions for respiratory symptoms on high-AQI days, elevations in asthma attacks following ozone and PM peaks. Long term effects show Persistent exposure to PM2.5 is linked to chronic bronchitis and premature mortality. Longitudinal studies link with the air pollution with reduced life expectancy. Air pollution is estimated to contribute to millions of premature deaths globally each year, primarily through ischemic heart disease, stroke, chronic obstructive pulmonary disease (COPD) and lung cancer.

Mumbai's air quality dropped to the 'poor' category on Sunday 7th December 2025 morning, even as the city witnessed clear, sunny weather with smog, according to real-time air quality monitoring data updated at 8.30 am. As per aqi.in, the Air Quality Index (AQI) stood at 194, placing it within the poor range. Other pollutants, including carbon monoxide at 254 parts per billion, nitrogen dioxide at 17 ppb, ozone at 12 ppb and sulphur dioxide at 6 ppb, remained within controlled limits. However, high particulate matter alone is sufficient to cause breathing discomfort and eye irritation. (1)

AQI VALUES ARE TYPICALLY CLASSIFIED INTO CATEGORIES, IT MAY VARY SLIGHTLY BY COUNTRY.

AQI Range	Air Quality	Health Implication
0–50	Good	Minimal risk
51–100	Moderate	Sensitive groups may be affected
101–150	Unhealthy for sensitive groups	Asthmatics, children, elderly
151–200	Unhealthy	Increased health effects
201–300	Very Unhealthy	Serious effects across population
301–500	Hazardous	Health warnings of emergency conditions

Source-(https://www.airnow.gov/aqi/aqi)

III. MITIGATION AND PUBLIC HEALTH POLICIES

A. EMISSION CONTROL (INDUSTRIAL & VEHICULAR EMISSION CONTROL)

1.Air pollution is a major environmental and public health challenge in India, especially in urban and industrial regions. Effective control of AQI requires integrated actions at governmental, industrial, community, and individual levels**.**

2.Ministry of Environment, Forest and Climate Change launched National Air Quality Index (AQI) an initiative under 'Swachh Bharat' which has 'One Number- One Colour-One Description' for the common man to judge the air quality within his vicinity on October 2014 Air pollution has been a matter of environmental and health concerns, particularly in urban areas.

Under this program Central Pollution Control Board along with State Pollution Control Boards has been operating National Air Monitoring Program (NAMP) covering 240 cities of the country. In addition, continuous monitoring systems that provide data on near real-time basis are also installed in a few cities.

3.National Clean Air Programme (NCAP, 2019)-The National Clean Air Programme (NCAP), launched by

India's Ministry of Environment in January 2019, is a national strategy to combat air pollution by reducing particulate matter (PM) levels in 131 "non-attainment" cities, initially aiming for a 20-30% cut by 2024 and later revised to a 40% reduction by 2026, using city-specific action plans, performance-linked funding, and monitoring via the PRANA Portal (Portal for Regulation of Air-Pollution in Non-Attainment cities).This program has goal to Reduce PM10 and PM2.5 concentrations by 20-30% by 2024 (revised to 40% by 2026) compared to 2017 levels in 131 identified cities. It addressing air pollution in cities that consistently exceed National Ambient Air Quality Standards (NAAQS). (2)

B. TRANSITION TO CLEANER ENERGY AND FUEL STANDARDS

1. Implementation of BS-VI emission norms (2020): The Bharat Stage VI (BS-VI) emission norms, fully implemented in India from April 1, 2020, cover several key aspects to drastically reduce vehicular pollution. The norms aim to align Indian standards with global benchmarks (Euro 6 equivalent) and involve significant changes in fuel quality, engine technology, and testing procedures.

It mandated stricter emission controls, requiring cleaner fuel (10 ppm sulphur) and advanced tech like Diesel Particulate Filter (DPF)/ Selective Catalytic Reduction **(**SCR) in vehicles to significantly cut pollutants like NOx and PM, aligning with global benchmarks Euro-6 equivalent standards and making vehicles more expensive but cleaner. Two-wheelers had to transition from carburetted engines to more precise fuel injection systems. It Applies to all categories of cars, two-wheelers, three-wheelers, and heavy-duty vehicles. BS-VI gives stricter emission limits for Particulate matter i.e. 4.5 mg/km for both diesel and petrol direct-injection vehicles, Nitrogen oxide limits are reduced to ~60 mg/km for petrol vehicles (from ~80 mg/km) and ~80 mg/km for diesel vehicles and Hydrocarbons (HC) and Carbon Monoxide (CO) limits for these pollutants are also made more stringent. (3)

2. Air (Prevention and Control of Pollution) Act, 1981- The Air (Prevention and Control of Pollution) Act was enacted in 1981 and amended in 1987 to provide for the prevention, control and abatement of air pollution in India. Air (Prevention and Control of Pollution) Act, 1981, mandates strict guidelines for industries in India, primarily requiring Consent to Operate from State Pollution Control Boards (SPCBs), prohibiting excess emissions, allowing inspection/sampling, and enabling Boards to issue directions, even for closure, if standards (like NAAQS) are violated, with stricter penalties and provisions to curb pollution. Key requirements include getting consent before setting up/operating, providing facilities for sample collection, adhering to emission standards, and compliance with CPCB/SPCB directives, with amendments broadening scope to all industries. (4)

3. Graded Response Action Plan (GRAP): The GRAP is a pre-emptive and emergency framework designed to control and reduce air pollution levels in the Delhi-NCR region. It is an Emergency measures in Delhi–NCR during severe pollution episodes. A Graded Response Action Plan (GRAP) is a set of emergency measures implemented in India's Delhi-NCR region to combat severe air pollution, triggered by the Air Quality Index (AQI) reaching different pollution levels (Poor, Very Poor, Severe, Severe+) activating specific actions like restricting vehicles, banning construction, and closing schools to systematically reduce emissions and protect public health, coordinated by the Commission for Air Quality Management (CAQM) Delhi's Air Quality Index (AQI) reaching the 'Poor' category prompted the Commission for Air Quality Management (CAQM) to invoke Stage-I of the Graded Response Action Plan (GRAP) across the National Capital Region (NCR) to prevent further deterioration in air quality. (5)

C. REAL TIME MONITORING AND ALERTS- Public Air Quality Index (AQI) forecasts are crucial tools that enable vulnerable populations to make informed decisions and take preventive actions to protect their health when air pollution levels are high. (6)

Air quality apps and alerts provide crucial information to help you decide on outdoor activities, especially if you have health concerns. Such apps have key features like Real -time AQI data and forecasts, Interactive maps displaying pollutant concentrations, notification for air quality alerts, personalised health recommendations which has integration with smart home devices. (7)

D.URBAN PLANNING-

In urban planning green spaces and pollution reducing infrastructure play a important role to improve air quality, they acts like a natural filters which absorb pollutants like Particulate Matter, NO_2, releasing oxygen, reducing urban heat, managing airflow. Roadside tree, green parks are effective in reducing impact of air pollution. (8)

IV. CONCLUSION

The AQI is an important means for linking air quality measurements to potential health effects. High levels of air pollutants pose significant risks, particularly to vulnerable groups like patients having lung issues, children, pregnant women etc. Effective policy, strict rules and regulation, Good urban planning and awareness in public can diminish exposure and improve public health outcomes.

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