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ENERGY, ENVIRONMENT AND CLIMATE CHANGE PROGRAMME

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NIAS Policy Brief

Air Quality, National Standards and Human Health in India

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The Question

A clean air environment is prudent to healthy living. An increase in air pollution beyond a threshold level poses risks to human health. In September 2021, the World Health Organization (WHO) issued its revised Air Quality Guidelines (AQGs). The development of these "global" AQGs was overseen by a steering group led by WHO's European Centre for Environment and Health. The revised AQGs are further tightened as compared to their earlier guidelines (2006) in most cases. For example, WHO has reduced the AQG for Particulate Matter (PM) particles that have an aerodynamic diameter of ≤2.5 microns ($PM_{2.5}$) from 10 micrograms per cubic meter (**µg**/m^3) to 5 **µg**/m^3, and has gone on to say that more than 90% of the global population lives in areas where concentrations exceeded their AQG for long-term exposure to $PM_{2.5}$. The evidence to support this has mostly emerged from research in high-income countries since there are very few studies in developing countries including India that correlate air pollution exposure assessment data with health data to investigate health effects. Therefore, the linkages of air pollution with a range of adverse health outcomes are not as straightforward as commonly perceived. In epidemiological research, an individual or group may exhibit a higher response enhanced responsiveness to an identical level of pollution exposure compared to those who are less susceptible.

Air Quality Standards for a specific pollutant are framed with the basic objective of ensuring that the ambient concentration of the pollutant at or below the standard does not harm public health. In this scenario, the question is whether India's National Ambient Air Quality Standards (NAAQS) notified by MOEFCC in 2009 (Table 1) are adequate and whether the revised WHO guidelines (AQGs) are relevant for India? The natural corollary to this is to identify the policies and actions required to strengthen the science of risk assessment and develop rational estimates of mortality and morbidity attributed to air pollution in India?

The Issue

Various sources of pollution, natural as well as man-made, are responsible for impairing the ambient air quality. While man-made (or anthropogenic) pollution can be controlled, pollution from natural sources that may vary in different climatic zones is almost inevitable. The deterioration of air quality is mainly due to anthropogenic emissions on

Table-1: NAAQS, baseline levels, and background levels of ambient air pollutants in four major metropolitan cities broadly representative of various environmental and climatological conditions in Indian cities

Pollutants	[a]NAAQS	[b]Baseline Levels				[c]Background Level Ranges
		Delhi	Mumbai	Ahmedabad	Pune	
PM_{10} (µg/m3)	100 (24h)	38±8	62±11	65±12	44±9	56-98
$PM_{2.5}$ (µg/m3)	60 (24h)	22±5	33±7	32±7	29±6	34-44
NO_2 (ppb)	43 (24h)	8±3	5±2	6±3	4±1	4-15
Ozone (ppb)	50 (8h)	25±6	21±5	20±5	29±7	20-29
CO (ppb)	1700 (8h)	500±50	600±70	450±50	600±60	780-915
SO_2 (ppb)	30 (24h)	4±2	8±3	7±3	4±2	4-10

[a]***NAAQS***: India's National Ambient Air Quality Standards (MoEFCC, 2009)
[b]***Baseline Levels***: Outdoor pollution levels with negligible local emissions and external intrusions.
[c]***Background Levels***: Outdoor pollution levels with negligible local emissions but including normal external intrusion.

Table-2: Relative share (%) of major sources of emissions[1] in the most harmful pollutant, $PM_{2.5}$.

Source	Delhi	Mumbai	Ahmedabad	Pune
Transport	41.0	31	35.3	40.3
Industry	18.6	13	18.8	21.6
Power	4.9	5.2	5.3	0
Bio-fuel*	3.0	15.5	10.2	11.4
Re-suspended dust	21.5	14.8	19	17.2
Rest others#	11.0	21	11.6	9.6

*Includes- Residential cooking, slum, cow dung, street vendor, household wood burning, etc.
#Includes- MSW plants, brick kiln, open trash burning, crematory, aviation, incense stick, etc.

the ground generated by rapid growth in infrastructure, industries, and transportation associated with economic development and population growth. Table 2 indicates the relative contributions of various major sources to ambient $PM_{2.5}$ pollution in four megacities as per the studies carried out by the SAFAR[1] (System of Air quality and weather Forecasting And Research) programme of the Indian Institute of Tropical Meteorology under the Ministry of Earth Sciences (Govt. of India). Some of the natural sources of air pollution are, organic compounds from plants, sea salt, suspended soils, and clouds of dust (e.g. from the deserts). Other natural sources of air pollution include catastrophic events such as volcanic eruptions, dust storms, forest fires, etc.

The Ambient Air Quality Standards (AAQS) for a specific pollutant is the maximum concentration of that pollutant averaged over a specified duration that is permissible in ambient air without harming human health. The Air Quality Index (AQI) is an extension to the NAAQS and is defined as a unitless number for reporting air quality on a daily basis. India officially released the AQI in 2015 with six categories (Figure 1). However, the quantitative assessment of risk due to air pollution and its variability in different parts of the World requires a more detailed understanding of air pollution as well as human response. Recent studies on the Global Burden of Diseases (GBD) have estimated the exposure to air pollution and its impact on deaths, disease burden, and life expectancy in every state of India along with the associated negative economic impacts. As per these studies, it is estimated that air pollution has caused approximately 1.67 million deaths in India during 2019, of which deaths due to ambient PM pollution contributed about 0.98 million. However, these GBD estimates are derived from global exposure-response functions while the local population in some parts of India may have developed a degree of immunity due to the high baseline levels of specific air pollutants.

India's AQI classification must be in line with the safe limits of ambient air pollutants defined in the NAAQS to

1 Gufran Beig, S. K. Sahu, V. Anand, et al., India's Maiden Air Quality Forecasting Framework for Megacities of Divergent Environments: The SAFAR-Project, Environmental Modelling and Software, 145, https://doi.org/10.1016/j.envsoft.2021.105204, 2021.

avoid any confusion in the minds of the people. As shown in Figure 1, the safe limit is split into 2 categories (Good and Satisfactory) in India's AQI classification, thereby creating some confusion.

The Findings

The term "Baseline level" of a pollutant is defined as the lowest fraction of ambient air pollution naturally present in the atmosphere that remains under photochemical equilibrium without any anthropogenic sources of emission and negligible external intrusions. However, experimental determination of baseline levels is almost impossible in megacities like Delhi, Mumbai, etc., as halting all anthropogenic activities is not feasible . However, this scenario was realized for the first time during the unprecedented Nationwide COVID-19-induced total lockdown scenario for a few weeks starting from 25th March 2020. During the first fortnight of this lockdown, these four megacities in India also experienced stable fair weather conditions that led to minimize all major external sources of air pollution. This rare combination of circumstances enabled researchers from SAFAR to estimate the baseline levels of critical air pollutants in four megacities in India[2,3].

The first experimentally derived baseline levels of major air pollutants, namely, PM_{10}, $PM_{2.5}$, NO_2, Ozone, CO, and SO_2 near the surface in four megacities of India are shown in Table-2[2, 3]. Since there is significant variability in the baseline levels among these four cities, such levels must be determined in different climatic zones. However, as these four cities represent different climatic zones of India, the average baseline level of a particular pollutant measured in these four megacities may broadly be considered as the common baseline level for that pollutant in India. Table 1 also shows the background level of air pollutants which is representative of the level when anthropogenic emissions were negligible (due to the continued nationwide lockdown) but meteorological aspects and external intrusions came into play. The background level for a specific pollutant varies on day to day basis based on weather conditions (rainfall, dust storm, etc.) and long range transport.

Epidemiologists required baseline and background air quality data from the research community to understand the possible adaptive capability of the population to help frame the NAAQS. As shown in Table 1, the background levels of most of the pollutants exceed the corresponding AQG levels in all four cities even though anthropogenic emissions were at a minimum due to the continued nationwide lockdown. Since natural sources are inevitable, the population is likely to become adaptive and develop immunity due to the evolutionary process by which an organism becomes better suited to its habitat in the prevailing natural climate over many generations. As background levels are largely independent of anthropogenic activities, it can be argued that an additional buffer is important for development and economic activities up to a particular threshold level. The determination of this optimized range needs better collaboration between experts in air quality, pulmonology, and exposure science.

Studies related to the impact of ambient air pollution on public health are limited in India. The link between air pollution and health is often determined based on statistical techniques and questionnaire-based surveys carried out among a relatively small group of people in a specific region (and environment). The generalization of results based on such studies may not be appropriate to establish robust linkages between specific levels of ambient air pollution and health impacts in India, for which more extensive research is required. As shown in Table 1, the baseline levels in the four megacities with different climatological conditions are

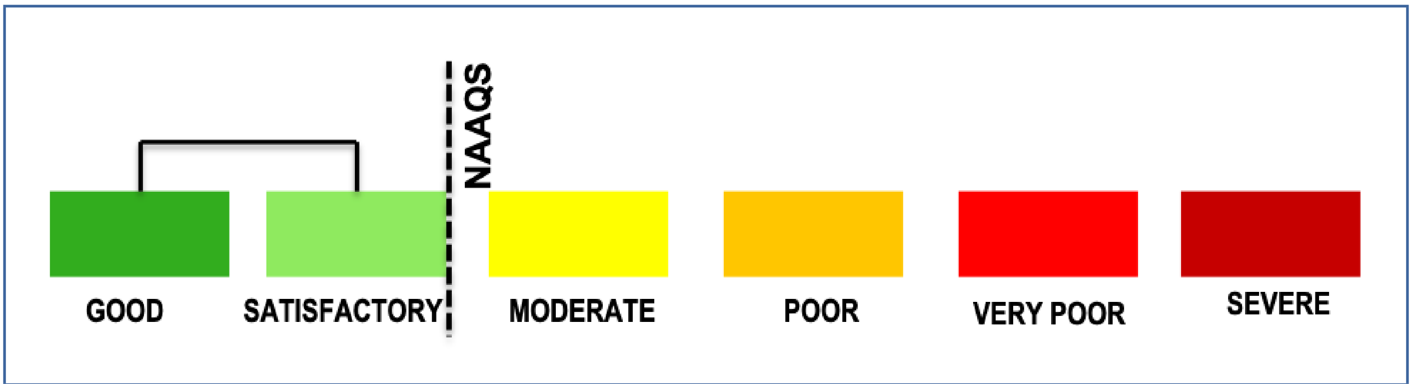

Figure 1: India's National AQI and NAAQS Classification

2 Gufran Beig, M.P. George, S. K. Sahu, et al., Towards baseline air pollution under COVID-19: Implication to chronic health and policy research for Delhi, India, Current Science, 119 (7), 1178-1183, doi: 10.18520/cs/v119/i7/1178-1184, 2020.

3 Gufran Beig, S. Bano, S.K. Sahu, et al., COVID-19 and Environmental-Weather Markers: Unfolding Baseline Levels and Veracity of Linkages in Tropical India, Environmental Research, 191, 110121, https://doi.org/10.1016 /j.envres.2020.110121, 2020.

significantly higher than the WHO's AQGs. Therefore, the air quality guidelines released by WHO are not relevant to India.

The Interventions

The air quality management markers and policies must take into account the human susceptibility to air pollution as a function of demographic or anthropometric characteristics, genetic profile, race and ethnicity, lifestyle, behaviors, socioeconomic position, location of residence, and lastly any natural immunity. The following interventions are proposed:

1. India's current ambient air quality standards appear to be reasonably adequate and the circumstances do not warrant an immediate review of these standards. Two categories of AQI (Good and Satisfactory) can be merged into one class ("Safe") to be in line with India's NAAQS which defines the safe limit for each pollutant.

2. An air quality forecasting framework like SAFAR is crucial to short-term mitigation planning and intervention in advance to avoid severe health impacts. This framework must be rigorously followed along with source-based emission inventory to develop long-term mitigation objectives.

3. The exposure-response function cannot be universal due to the adaptive power of human beings. Therefore, scientific studies must be undertaken to determine the "exposure-response function" and the susceptibility of Indians to different air-pollution related diseases. This needs coordinated national effort among MoES, MoEFCC, and ICMR as well as air pollution and exposure science researchers and various organizations within India.

4. India's national priority must be to implement science-based mitigation activities in all non-attainment cities to achieve the NAAQS, and then extend the same to smaller urban and rural areas which remain largely unexplored.

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