Centre for Chronic Disease Control

WHO Collaborating Centre for Surveillance, Capacity building and Translational Research in Cardio-Metabolic Diseases

Health Care Without Harm

STRENGTHENING POLLUTION CONTROL BOARDS TO ACHIEVE THE NATIONAL AMBIENT AIR QUALITY STANDARDS IN INDIA

Strengthening Pollution Control Boards to achieve the National Ambient Air Quality Standards in India

November, 2020

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About CCDC

Centre for Chronic Disease Control (CCDC) is a New Delhi based not-for profit organization, established in December 2000. The mission of CCDC is primarily intended to address the growing challenge of chronic diseases, in varied settings of the developing countries through:

- Knowledge generation, which can inform policies and empower programmes for the prevention and control of chronic diseases
- Knowledge translation intended to operationalize research results by bridging the critical gaps between relevant research and effective implementation, through analytic work, capacity building, advocacy and development of educational resources for enhancing the empowerment of people and professionals

CCDC has been recognized as a Scientific and Industrial Research Organization (SIRO) by Department of Scientific & Industrial Research (DSIR), Ministry of Science and Technology, Government of India. It also holds registration under Foreign Contribution (Regulation) Act, 1976. CCDC undertakes clinical research with special emphasis on chronic non-communicable diseases (NCD). Within the spectrum of chronic diseases, our main focus areas are: cardiology, diabetes and metabolic disease, vascular diseases, cancers and mental health. In addition, basic science research in diet/nutrition and cardiac biochemistry are also carried out. The research work at CCDC has produced major insights into the epidemiology, developmental origin, and biomarkers of CVD and diabetes in India; practice patterns on Acute Coronary Syndrome; translation research in CVDs; and development of low-cost combination drugs for primary and secondary prevention of CVDs in South Asia. CCDC holds recognition as a 'Centre of Excellence in Clinical Research' from the Clinical Development Service Agency (CDSA), Department of Biotechnology, Government of India. It is also a WHO Collaborating Centre for Surveillance, Capacity building and Translational Research in Cardio-Metabolic Diseases

About Health Care Without Harm

Health Care Without Harm (HCWH) is an international NGO that seeks to transform health care worldwide so that it reduces its environmental footprint, becomes a community anchor for sustainability and a leader in the global movement for environmental health and justice. Health Care Without Harm has worked for more than two decades with the health care sector to reduce its use of toxic chemicals and generation of waste, while transforming the supply chain and fostering climate action. With offices in the United States, Europe, Asia; a regional team in Latin America; and country-level partnerships with national organizations in Australia, Brazil, China, India, South Africa, and Nepal. Health Care Without Harm is a leader in mobilizing the health care sector to realize this vision. Health Care Without Harm's staff of health professionals, researchers, and advocates work with hospitals, health systems, governments, and international agencies to accelerate health care decarbonization, resilience, and climate policy leadership around the world. As of September 2020 Health Care Without Harm's Global Green and Healthy Hospitals Network has 1,350 institutional members across 72 countries, all working to bring the health sector into the climate movement and expand their healing mission beyond the four walls of their facilities.

Authors of the report

Vidushi Bahuguna,
Senior Research Associate & Program Coordinator (Policy), Centre for Chronic Disease Control (CCDC)

Bhargav Krishna,
Manager (Technical), Centre for Environmental Health (CEH), Public Health Foundation of India (PHFI)

List of Abbreviations

AQCR	-	Air Quality Control Regions
AQFD	-	Ambient Air Quality Framework Directive
AQI	-	Air Quality Index
AQLV	-	Air Quality Limit Values
BS VI	-	Bharat Stage VI
CAA	-	Clean Air Act
CASAC	-	Clean Air Scientific Advisory Committee
CEMS	-	Continuous Emission Monitoring System
CEPI	-	Comprehensive Environmental Protection Index
CNG	-	Compressed natural gas
CO	-	Carbon Monoxide
CPCB	-	Central Pollution Control Board
CPP	-	Clean Power Plan
DALYs	-	Disability-adjusted life-years
DPCC	-	Delhi Pollution Control Committee
EPA	-	Environmental Protection Agency
EPCA	-	Environment Pollution (Prevention & Control) Authority
EU	-	European Union
GDP	-	Gross Domestic Product
GRAP	-	Graded Response Action Plan
IAS	-	Indian Administrative Service
IFS	-	Indian Forest Service
IHME	-	Institute of Health Metrics and Evaluation
IITK	-	Indian Institute of Technology, Kanpur
LPG	-	Liquefied petroleum gas
MoEFCC	-	Ministry of Environment, Forest and Climate Change
MS	-	Member states
NAAQS	-	National Ambient Air Quality Standards
NAMP	-	National Air Quality Monitoring Programme
NCAP	-	National Clean Air Programme
NCR	-	National Capital Region
NEERI	-	National Environmental Engineering Research Institute

NGO	-	Non-governmental organizations
NGT	-	National Green Tribunal
NO_2	-	Nitrogen dioxide
PCC	-	Pollution Control Committee
PIL	-	Public interest litigation
PM	-	Particulate Matter
PMUY	-	Pradhan Mantri Ujjawala Yojna
QALYs	-	Quality-adjusted life years
RSPM	-	Respirable Suspended Particulate Matter
SDG	-	Sustainable Development Goals
SIP	-	State Implementation Plans
SO_2	-	Sulphur dioxide
SoP	-	Standard operating procedure
SPCB	-	State Pollution Control Board
SPM	-	Suspended particulate matter
TPP	-	Thermal power plants
US	-	United States
USEPA	-	United States Environmental Protection Agency
UT	-	Union Territory
WHO	-	World Health Organisation
µg	-	Microgram

Contents

List of Tables

List of Figures

List of Chart and Graphs

Executive Summary

Acute and chronic exposures to air pollution are a leading risk factor for ill health in India, with exposures to Particulate Matter (PM2.5) and Ozone alone contributing to over 1.2 million premature deaths annually. The last three decades of rapid industrialization, increasing urbanization, growing transport fleet, and other factors have contributed to Indian cities becoming some of the most polluted in the world. Simultaneously, rural India is caught in the *chulha trap*, with over two-thirds of rural households depending primarily on polluting fuels such as wood, coal and dung to satisfy their cooking and heating needs. Studies have also shown that this large-scale air pollution not only impacts health and quality of life, but concurrently places a significant economic burden that India can ill afford. As India continues to invest in industrialization with a view to economic growth and poverty alleviation, it is inevitable that air pollution levels will continue to grow as well unless significant actions are taken at a regulatory level.

In an effort to establish minimum acceptable levels for ambient air quality, India established its own National Ambient Air Quality Standards (NAAQS) in line with interim targets suggested by the World Health Organization. Since most regions in India fail to meet the much relaxed national air quality standards compared to the more stringent global ones, the aim of this project was to understand the institutional and informational barriers that are hampering the goal of achieving the NAAQS across the country and provide recommendations to address those.

Primary research for this study was conducted in a purposively selected sample cities in states across the country (Lucknow, Patna, Ranchi, Raipur, Bhubaneswar, Vijayawada, Goa and Mumbai) which were geographically distributed based on a number of criteria as elaborated upon later in the report. Data for this report was collected by conducting qualitative in-depth interviews with members of the Central Pollution Control Board (CPCB) and with members of State Pollution Control Boards (SPCBs). This was done in addition to interviews with other stakeholders ranging from bureaucrats, academics, environmentalists, civil society, etc. to gain a holistic perspective.

This work was supplemented by a secondary literature review.

Our findings reveal several key structural and institutional barriers that are affecting effective implementation of existing regulations, and thereby broader achievement of ambient air quality standards. These include:

Institutional capacity – State pollution control boards have seen an expansion in their scope and scale of their work over the last two decades but neither their budgets nor manpower match the demands that they are met with

Leadership challenges – the leadership of these boards is staffed by civil servants who often lack the domain expertise necessary to effectively deliver on their mandate and are seen primarily as administrative positions

Motivation and accountability – State board officials often have a diminished view of their own role and responsibility. This has shifted their perceived role from that of regulators to technical advisors. Many are also unaware of the full scope of responsibilities accorded to them under existing laws.

Multi-sectorality and bureaucracy – The lack of convergence and coordination between various departments at the State and Central level often mean that Pollution Control Board directives aimed at domains under the control of other departments are left unimplemented. The PCBs themselves are also viewed in some states as a bureaucratic hurdle whose only job is to clear files, and not one that is tasked with a vital role in protecting human health.

Monitoring challenges – While air monitoring is one of the areas of significant growth over the last decade, PCBs often lack the manpower or expertise to actively maintain and calibrate their instruments. Additionally, monitoring is seen as an end in and of itself, rather than as a basis to initiate action.

Understanding of health impacts – The core environmental laws of the country state their *raison d'etre* as protecting human health, but a poor understanding or misinformation dominate the discourse around the epidemiology of air pollution in PCBs. Clarifying these misconceptions is essential if the primary goal of this work is to be realized.

To address these core structural barriers to achieving the NAAQS, we propose that:

- All Governments rapidly address the acute human resource and leadership needs (e.g. through training programs, revising pay structures etc.)
- Strengthen centre-state and inter-departmental interactions
- Expand monitoring capacity to effectively use data for compliance and accountability
- Mobilize significant financial resources to invest in PCBs
- Engage health sector stakeholders
- Strengthen the local evidence base

While recognizing the core structural barriers that are affecting effective implementation of existing regulations, we propose various recommendations that may assist in addressing these barriers to achieving the NAAQS. These actions are essential if the existing legal and regulatory framework for air pollution is to meet its stated goals of improving air quality and protecting human health.

1.0

Introduction

Air pollution has come to be understood as one of the biggest environmental health risk factors of this century. Anthropogenic activities such as rapid industrialisation, unrestricted population growth and increasing urbanisation contribute increasingly concentrated rates of various air pollutants – among these, specifically higher levels of particulate matter (PM10 and PM2.5), sulphur dioxide (SO2), nitrogen oxides (NOx), carbon monoxide (CO) and ozone - leading to not only the degradation of the environment and climate change but also having a debilitating effect on human health (Pant et al., 2016). Simultaneously, over two-thirds of rural Indians caught in the 'chulha trap' use biomass fuels such as wood, twigs, and dung-cake to meet their cooking and heating needs, resulting in smoke-filled homes causing extremely high levels of exposure to residents.

Air pollution is especially severe in many developing parts of the world which also happen to be very fast-growing urban regions contributing higher levels of pollution and are therefore subject to higher exposure. According to the World Health Organization's figures, 97% of the cities in the low- and middle- income countries which have more than 100,000 inhabitants do not meet WHO air quality guidelines (WHO, 2018). In the year 2016, ambient air pollution is estimated to have caused 4.2 million premature deaths worldwide, of which 91% occurred in low and middle-income countries (WHO, 2016).

Air pollution has both acute and chronic effects on human health. With a decline in air quality, especially in the urban areas, there is a higher risk of cardio-vascular diseases, chronic and acute respiratory diseases, lung cancer, chronic bronchitis, acute respiratory infections in children, asthma, low birth and pre-term weight, among others (WHO, 2016). Several studies have established an association between air pollution and health risk from prolonged exposure (Leem J.H, 2006; Pope C.A, 2006, Pope C.A, 2007). This can be especially true in cases of prenatal and early childhood exposure to heavy metals and other toxic substances present in the environment. As per current estimates, ambient and household air pollution together are estimated to cause around 7 million premature deaths each year, globally while in India this figure stands at an astounding 1.2 million deaths (WHO, 2018). Estimates of disability-adjust life years (DALYs) indicate ambient air pollution accounts for 103.1 million life years lost to debilitating illness (Cohen et al., 2017). Just as significant, injury and chronic illness resulting from air pollution contributes to lowered productivity, human rights concerns, and reductions to quality-adjusted life years (QALY) (Chandra, 2015).

India is no exception but is in fact, one of the worst affected countries in the world. The World Health Organization's Ambient Air Pollution database locates 13 of the

Exposure to air pollution is a risk factor for both urban and rural populations. The composite intertwined factors mediating exposure to air pollution toxicants signal towards the need of a multi-faceted approach towards controlling ambient air pollution and reducing exposures at the population level.

top 20 cities globally, with the highest annual levels of PM2.5, in India. The national capital, New Delhi, tops this list. It has been experiencing a steady decline in air quality leading to increased morbidity figures and increased risk of mortality. With relatively weak standards for industrial and transport emissions, and increasing industrialisation across the country, ambient levels of PM2.5 from transport sources alone are expected to double by 2030 if no action is taken. In over half the cities monitored as part of the National Air Quality Monitoring Programme (NAMP), levels of PM10 exceeded the mandated safe levels of 60 µg/m3 (Pant et al., 2018).

Exposure to air pollution is a risk factor for both urban and rural populations. The composite intertwined factors mediating exposure to air pollution toxicants signal towards the need of a multi-faceted approach towards controlling ambient air pollution and reducing exposures at the population level. Another barrier to the formulation of accurate and timely health advisories pertaining to air pollution related health advisories is the lack of uniformity in collection and projection of high-quality data.

The Central Pollution Control Board for instance operates a very limited number of air quality monitoring stations, mostly in large cities making it much harder to understand the nature and patterns of population exposure. Data collected by monitoring stations sporadically distributed across districts, under the State Pollution Control Boards lacks not only in terms of quality but also uniformity, posing major challenges in the way of generalization of this data to the issuance of crucial health advisories. Additionally, most of the data collected by the State Pollution Control Boards are publicly inaccessible.

The need for assessing the health effects of the phenomenon and engaging in capacity building initiatives to handle the projected burden of disease is imperative given the fact that most cities in India routinely exceed the WHO guidelines for safe levels of air quality (especially Particulate Matter) manifold. While there is evidence of rapid technological progress made globally, to address health hazards mediated by air pollution toxicants, gaps are seen to exist in terms of translating this research to changes in health policies and generating public sensitization to the gravity of the issue. This lack of sensitization is seen to directly result in a reluctance to promote and adopt improved energy choices, which could play a pivotal role in reducing emissions.

Exposure to air pollution can also have a long-term effect on productivity in many other ways, such as stunted plant growth hence the productivity of agriculture, affecting physical and mental well-being of human beings, among others. Other severe effects of pollution can be seen in degradation of natural ecosystems where pollutants may deposit on plants or in the soil and water systems. In places such as Mongolia, atmospheric pollutants have turned soils acidic resulting in reducing the productivity of grasslands where pastoral activities are a major occupation (World

Bank and IHME, 2016). A study published by the World Bank in 2016 revealed that air pollution cost India approximately 8% of its GDP or $560 billion in 2013, as a result of lost productivity due to premature mortality and morbidity *(ibid.)*.

Increasingly so, therefore, the effect of exposure to air pollution is being linked not only with health but also on economic growth and development. Air pollution causes illness and premature death while also reducing the quality of life. Therefore, air pollution is not just a health risk but also a growing economic burden. This impact also happens to be the most severe in low- and middle-income countries, disproportionately affecting populations from the lower income groups more than others, thereby, perpetuating already existing inequalities.

This project suggests means to address these gaps using a multi-faceted approach in order to strengthen India's efforts into the global health sector movement against air pollution. The National Ambient Air Quality Standards (NAAQS) provide a legal framework for the control of air pollution and the protection of public health. This study aims to ascertain the effectiveness of existing policies in promoting adherence to air pollution emission standards and the mitigation of hazardous health consequences. There will be a special focus on NAAQS – lacunae in the process of setting up of NAAQS, stack emission standards and the revisions made in 2009. A comprehensive comparison with international best practices, as well as barriers to the adoption of these practices within the Indian setting, will also be analysed. It is imperative to evolve appropriate policies and strategies to strengthen existing regulations, in order to focus on air pollution and health. To address the adverse health impacts of air pollution, current environmental policies and laws need to be examined from a health perspective.

In order to address data collection, uniformity in coverage, and quality and accessibility of data to facilitate timely issuance of crucial health advisories, it is imperative to carry out a comprehensive assessment of the capacity of State Pollution Control Boards (SPCBs). This project aims to carry out this assessment, with a view to work SPCBs into the national effort to collect good quality air pollution data and set up adequately sourced air quality monitoring systems to track progress in adhering to emission standards.

Cross sectoral collaborations will form the cornerstone for the effective implementation of recommendations which are likely to emerge from this initiative. It is therefore essential to collaborate with policy makers engaged in both public and private organizations. This will be done through dissemination workshops, where the policy analysis report will be deliberated upon and disseminated among policy makers.

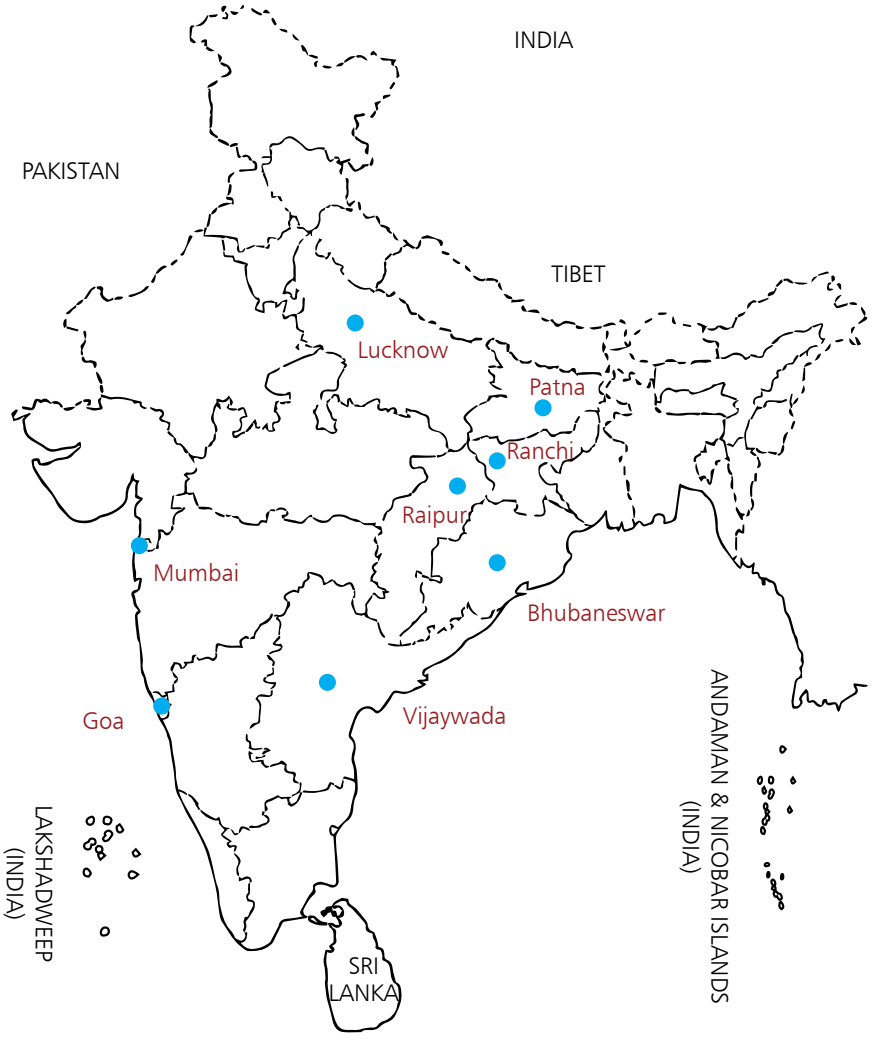
Even though the issue of air pollution has, in the last few years started to gain significance, managing the effects of air pollution and its associated risks on human health has been a formidable challenge for both policy makers and health professionals. Since the adverse effects of air pollution are not limited to human health only, addressing the issue can have significant co-benefits for other policy objectives as well. This is a policy issue for many sectors that generate air pollution and therefore requires the government's focus and policy approach as underlined by the WHO's Health 2020 policy (WHO Regional Office for Europe, 2015).

2.0

Methodology

The aim of this study was to conduct a series of key informant interviews to understand India's roadmap to achieving the National Ambient Air Quality Standards (NAAQS) and the barriers in attaining the same so as to strengthen India's efforts to achieve the Sustainable Development Goals (SDG) target of reducing pollution related diseases by 50%. For this, the objective was

FIGURE 1: Study Sites



to carry out a comprehensive assessment of the capacity of the State Pollution Control Boards (SPCBs) in enforcing regulations, understanding health impacts, driving change and lastly, achieving the NAAQS through a comprehensive action plan.

The study sites were chosen by employing purposive sampling wherein three primary criteria were used, namely, it should be a geographically representative distribution of states across all regions of the country; the distribution should be based on high and low annual average PM2.5 levels in those regions; lastly, states where innovations or new solutions have been implemented so as to improve the air quality of the region would be given priority. Using the above criteria, eight states – Uttar Pradesh, Bihar, Andhra Pradesh, Odisha, Maharashtra, Goa, Jharkhand and Chhattisgarh – were chosen. A point to be noted, is that while initially Gujarat was to be included as part of the study, even after numerous attempts to establish contact with the Gujarat Pollution Control Board to seek an appointment, we were unsuccessful in all our efforts and hence, finally decided to drop the state from the study. The study sites have been represented in the map below.

The participants were requested to provide responses to a series of questions relating to the current process of establishing the National Ambient Air Quality Standards, assessing the capacity of CPCB and the SPCBs in effective implementation of NAAQS and stack emission standards

Data for this report was collected by conducting qualitative in-depth interviews with members of the Central Pollution Control Board (CPCB) and with members of State Pollution Control Boards (SPCBs) of a purposively selected sample of states. This was done in addition to interviews with other stakeholders ranging from bureaucrats, academics, environmentalists, civil society, etc. to gain a holistic perspective. The participants were requested to provide responses to a series of questions relating to the current process of establishing the National Ambient Air Quality Standards, assessing the capacity of CPCB and the SPCBs in effective implementation of NAAQS and stack emission standards, gaps and challenges in the enforcement of existing regulations and industrial emission standards, the importance of a health rationale in the design, implementation and enforcement of energy and environmental policies, among others. A participant information sheet and consent form were provided to the respondents to obtain signed consent prior to the start of the interview.

In addition to the primary research, secondary research was conducted using PubMed as the key source in addition to government reports on relevant matters available on their website or collected during the process of conducting field visits.

3.0

Air Quality in India – History and evolution of policies and actions

Initial awareness around the harmful effects of air pollution arose from the aftermath of the Bhopal gas tragedy, where release in December 1984 of methyl isocyanate from a Union Carbide plant in the city was estimated to have caused the deaths of upward of 3,500 individuals (although estimates[1] vary). The gas leak, considered one of the worst industrial disasters in history, drove a new wave of environmental awareness, not seen since the Chipko movement in the 70s. In 1984, Mahesh Chandra Mehta, a lawyer practising at the Supreme Court of India, filed a public interest litigation (PIL) case at the Supreme Court after witnessing the high levels of air pollution and associated discolouring of the Taj Mahal marbles. The case, and its judgement which banned the use of coal and coke at the surrounding industries, directing them to use natural gas instead, established the principle of absolute liability, which subsequently became the basis of several other cases filed by Mehta and other lawyers at the court (Indiakanoon, n.d.). Judgements in the decade after included directives to the Government to mandate the installation of catalytic converters in vehicles, to expedite the provision of lead-free petrol around the country, to relocate a fertilizer plant that was considered to be located too close to a human habitation, and the closure and relocation of 212 stone crushers from Delhi to a specially identified zone to reduce dust pollution (M. C. Mehta Environmental Foundation, n.d.).

By the late 1990s, Delhi had gained a reputation as one of the most polluted cities in the world, with little action taken to address its notoriety apart from removal of the stone crushing units. Having identified vehicular pollution, particularly from dated and poorly maintained public transport vehicles such as buses and auto-rickshaws, Mehta filed another PIL at the Supreme Court calling for urgent action. In their order, the Court directed the Central and State Governments to expedite the purchase and replacement of polluting diesel buses with those that could run on compressed natural gas (CNG), among other actions related to public transport and associated facilities (Mehta, 2001). While the transition took several years

[1] https://web.archive.org/web/20120518020821/http://www.mp.gov.in/bgtrrdmp/relief.htm

to effectively implement due to many challenges including procurement of the vehicles, and the unpreparedness of the respective line ministries, this action was the first of many taken by the court in its new avatar as an 'Executive Court' (Clean Air Asia, n.d.; Bhatia, 2019). The court, focused primarily on the National Capital Territory of Delhi, subsequently went on to appoint an Amicus Curiae to guide its continued action on air pollution in the capital, and established the Environment Pollution (Prevention & Control) Authority for the National Capital Region (EPCA), also in 1998 (EPCA, 2016). Headed by a former bureaucrat, and comprising environmental scientists and advocates, the EPCA was given responsibility to suggest and direct appropriate actions to State Governments to implement. While EPCA's actions contributed in the next two decades to the banning of the polluting pet coke fuel, and the accelerated transition to Euro VI compliant fuels and engines for vehicles sold in Delhi, there is little else that it has to show for that period of work. In fact, as noted by environmental lawyers, EPCA's sweeping authority was underutilized, and may have in fact stymied potential legal actions by others, since they were the primary authority as established by the Court (Dutta, 2018).

During this period, while progress even if slow was being made in Delhi, there was little happening elsewhere around the country. The CPCB continued to slowly expand its network of manual monitoring stations under the National Air Monitoring Program, slow enough that while Delhi had around a dozen air monitors in 2010, most states did not even have one functional monitor. No cases were filed under the Air Act, nor were factory closures or other actions taken to hold violators accountable. The widespread economic growth India witnessed in these two decades, driven by coal-fired thermal power primarily drawn from central and east-central India, contributed to rising air pollution around the country. In 2009/10, the CPCB also introduced the Comprehensive Environmental Pollution Index (CEPI), aimed at identifying highly polluted areas that could potentially harm human health (CPCB, 2016). When the CEPI was applied, several dozen critically and severely polluted industrial clusters were identified, although little action was taken through either the introduction of more stringent standards, or closure of violating industries. In its 2016 revision, the CPCB downgraded several recognized critically polluted areas, raising questions over the methodology employed and relevance to protecting health (Times of India, 2016).

In 2010, Delhi also hosted the Commonwealth Games, bringing focus once again to its deteriorating air quality. While gains had been made in the early 2000s thanks to the CNG transition, the vehicular population in the city during the interim period had almost doubled, with most consumer choosing polluting but cheaper diesel vehicles due to continued government subsidies (Narain and Krupnick, 2007). While the Government took several actions to counteract the poor air quality during the games, they were later shown to have had little impact. In 2012, the Institute of Health Metrics and Evaluation in collaboration with hundreds of public health scientists around the world published its Global Burden of

In 2012, the Institute of Health Metrics and Evaluation in collaboration with hundreds of public health scientists around the world published its Global Burden of Disease report, which documented the major causes of death and disability in 2010, and their contributory risk factors. This report featured scientific advancements in the estimation of the disease burden attributed to air pollution, and it showed that over 1.5 million deaths in India were attributable to ambient and household air pollution (The Lancet, 2012).

Disease report, which documented the major causes of death and disability in 2010, and their contributory risk factors. This report featured scientific advancements in the estimation of the disease burden attributed to air pollution, and it showed that over 1.5 million deaths in India were attributable to ambient and household air pollution (The Lancet, 2012). Around the same time, the World Health Organization, based on regulatory data collected around the world, released its list of most polluted cities around the world, with Delhi topping the list. The sustained media coverage in subsequent months, including by the international media, led to widespread outcry and calls for action by the Government and Courts (Harris, 2014).

The year after, the Ministry of Health of the Government of India published a report on the health impacts of air pollution, outlining a series of actions that need to be taken to alleviate the associated burden of diseases. While the report's key recommendation on household air pollution regarding the provision of LPG stoves and cylinders to rural households was implemented later as the Pradhan Mantri Ujjwala Yojana, other recommendations on ambient air pollution did not find much resonance (Tripathi and Sagar, 2019). Suo Motu cognizance was taken again by the Supreme Court, and a raft of new PILs were filed, including by a trio of toddlers who called for a ban on the sale of fireworks in the city which caused an annual spike in air pollution in the city (Sikri, 2018). The Supreme Court-established EPCA also worked with air quality experts to address extremes of air pollution in winter, caused by a combination of Diwali, seasonal crop stubble burning in Punjab and Haryana, temperature-related burning of waste for heat in the city, and Delhi's unique meteorological challenges. Comprising a series of actions that are linked to the prevalent air quality, the Graded Response Action Plan (GRAP) was launched in early 2018. Specific actions under the plan, specifically focused on winter air pollution, included shutting down of all construction in the city, closure of thermal power plants in the vicinity, and road rationing to reduce vehicular pollution.

While GRAP has had mixed success, there appears to be at this point in 2020 little momentum for large-scale change in the Government's approach to air pollution. New emissions standards introduced for thermal power plants in 2015 are yet to be implemented, the implementation of Euro VI equivalent BSVI emissions standards for vehicles are likely to be delayed, and there is little appetite for further action in a slowing economy.

3.1 Legislative actions on air pollution and environmental health in India

Though not stringent in implementation, over the course of time, India has developed a broad legislative response to the concerns surrounding air pollution including the Air (Prevention and Control of Pollution) Act, 1981; the Environment Protection (EP) Act, 1986; and the Ozone Depleting substance (Regulation and Control) Rules, 2000. Enacted in 1986, the Environment (Protection) Act greatly enhanced the central government's powers to mitigate concerns of environmental health. Nationwide in scale, this act created the groundwork for improvement in the quality of environment, and furthered the language of emissions standards. Restricted, industry-free zones designated areas that prohibited specific operations or processes. Prevention, control, and abatement powers enhanced the ability of authorities to obtain information, as well granting tools of entry, inspection, and seizure. Environmental laboratories also received specific language in a furtherance of critical analysis and access to sample collection. The EP Act also provides a system of penalties for polluters including financial penalties and imprisonment, while also outlining judicial grievance redressal mechanisms. It also provides for rule-setting on specific pollutants, such as the rules around ozone depleting substances[2].

For the purpose of this study, we focus our attention on the Air Act of 1981 and the revised National Ambient Air Quality Standards in India. A comprehensive legislation, the Air Act established general definitions of air pollution, and set guidelines for the creation of state boards not yet established under the Water Act. In addition, the Act established the governance structure and the enumeration of powers for competent assessment, management and enforcement of air pollution and health standards in the country[3]

The State Pollution Control Boards are conferred with appropriate authority under various legislations to declare air pollution control areas, guide automobile emissions standards, inspect and/or restrict use of specific industrial and manufacturing processes. Other rules endowed board officials with judicial access, or permitted entry and inspection for purposes of data and sample collection. Funding and audit measures provided the financial means for SPCBs, and created provisions allowing CPCB assumption of state-level responsibilities should any local board falter in fulfilment of assigned objectives. A 1987 update to the Air Act offered updated language and assigned new designation to existing state-level entities, thus creating state pollution control boards (SPCB) as they exist today.

Despite these efforts, legislation is only one facet of effective air pollution management and abatement. A significant portion of this study will focus on analysing the division of powers between the centre and the states with regard to the work of improving the quality of air in India. MoEFCC is the nodal agency

[2]http://moef.gov.in

[3]http://www.indiaenvironmentportal.org.in/files/file/air%20act%201981.pdf

responsible for the effective policy-making and implementation of programmes related to the environment in India. Established in 1980 as the Department of Environment, the office evolved to become the Union Ministry of Environment and Forests in 1985 (India National Science Academy, 2001) whose primary concern was the preservation of the nation's natural resources[4]. MoEFCC is responsible for policy development and program promotion designed to educate and assess pollution concerns. Largely responsible for many of the progressive air pollution control movements over the past four decades, MoEFCC addresses widespread concerns with relevant control standards and key legislative action.

Additionally, MoEFCC supports public information programs such as the National Air Quality Index (AQI) (refer to Appendix 1) and the National Ambient Noise Monitoring Network. Divided into six rating categories ranging from Good to Severe, AQI readings utilize corresponding color-codes for convenient recognition of threat levels (CPCB, 2014). This metric represents an effective means by which to communicate air quality status to the public (Table 2). Additional ministry support features focus on CPCB continuous ambient monitoring systems, those covering spaces of primary concern throughout India.

Designed as the technical and multi-disciplinary advisory extension of the MoEFCC, the CPCB was established to advise the Central government on matters of prevention and control of pollution as well as to provide technical assistance and coordinate state-level implementation and enforcement efforts. Internal organization of this office rests on functions of pollution assessment and abatement, technical and administrative assistance efforts, and zonal offices maintained for regional monitoring of areas throughout India. Today, CPCB actions focus on many fronts, from assessment of air quality and epidemiological studies, to emission standards maintenance and forward planning for environmental protection through rule promulgation and legislation[5].

Additional functions under the influence of CPCB include training for pollution control programs for government officers, industry waste treatment professionals, and various non-governmental organizations (NGOs). Mass media and communication efforts foster general awareness in public fora, using print and digital offerings that inform and educate. To that end, significant monitoring projects of the CPCB and SPCBs exist for the benefit of both professional research and public awareness.

The National Air Quality Monitoring Program (NAMP) is a key example of such efforts. NAMP is a nationwide network of 793 manual operating stations covering 344 cities/towns in 29 states and 6 Union Territories within India[6]. Bi-weekly measurements are carried out for four key pollutants, namely SO2, NOx, and PM2.5, PM10. Coordinated national and state-level efforts mobilize equipment

[4]http://moef.gov.in/
[5]https://cpcb.nic.in/
[6]https://cpcb.nic.in/monitoring-network-3/

and personnel in large-scale efforts to sample, analyse, and report on these critical air pollutants data. This is a primary focal point for the introduction and development of targeted interventions, with the data generated from this program used to identify critically polluted areas.

Through continuous monitoring of industrial emissions, CPCB can also identify and target individual industrial polluters. Standards currently in place offer benchmark comparison, through which enforcement measures incorporated in the Environment Act may compel management to adjust manufacturing and waste disposal processes. One example of industry contributions to air pollution arrives in the form of coal-fuelled thermal power plants (TPP). A known fossil fuel that produces significant levels of primary pollutants, government intervention in coal-powered energy production methods could confer significant environmental health benefits. But thermal power emissions enforcement is symptomatic of a broader broken system, with the enforcement of new standards considerably delayed under duress from industry.

Despite the prodigious development of air pollution policy and national office, meaningful change has yet to develop throughout much of India. Multi-faceted issues of governance, rapid and uncontrolled urbanisation, technological inconsistency, and the simple act of living all hinder beneficial movements toward improved environmental health outcomes. Add to this, challenges arise concerning effective program implementation and inconsistent compliance efforts, the result being a lack of progress that fosters premature loss of life.

3.2 Establishment of the NAAQS

The issue of air pollution as a health risk factor gained momentum after three major episodes which took place around the world, namely, Meuse Valley of Belgium in 1930; Donora, Pennsylvania in 1948; and the London smog episode in the year 1952. These events compelled countries in North America and Europe to initiate action through legislative as well as regulatory measures to control and abate air pollution. A number of population-based studies were also taken up around the same time in these countries which confirmed linkages of exposure to air pollution with adverse impacts on health (Pope, 2000; Lave and Seskin, 1970). These episodic events led to the United States Environment Protection Agency (USEPA) making the Clean Air Act while Europe came up with a set of standards for itself to counter the harmful effects of air pollution. Initially the focus of air pollution control and abatement was mostly on the gaseous pollutants. It was, however, the period from 1989 to 1995 in which a series of epidemiological studies documented the role of particulate air pollution as harmful (Pope et al., 1995; Dockery et al., 1993; Schwartz and Dockery, 1992).

While this was the scenario in the developed parts of the world, India was still much behind on assessing and acknowledging air pollution as a threat to human health and humanity. The Indian Parliament paved the way for the establishment of the Central Board for Prevention and Control of Pollution of Water much later

in 1974, thereby, passing the Water (Prevention and Control of Pollution) Act (Water Act, 1974). The Air (Prevention and Control of Pollution) Act was passed by the government in 1981 and the board was renamed Central Pollution Control Board (CPCB), also given the responsibility to improve the quality of air and to prevent, control or abate air pollution in the country (Air Act, 1981).

In pursuance of the Act, the state governments constituted State Pollution Control Boards (SPCB) to exercise power conferred on perform functions under this Act. Thus, while the CPCB was given an advisory role, the SPCBs were entrusted with critical functions. The SPCBs were given the authority to declare air pollution control areas, give instructions for automobile emission standards, or restrict use of specific industrial plants. Each industry in a State or Union Territory is required to interact with its respective State Pollution Control Board (SPCB) or Pollution Control Committee (PCC) in the case of a Union Territory. The SPCB's role broadly is to implement legislation and issue the rules, regulations and notifications that prescribe the emission and effluent standards for air, water and noise pollution.

The Air Act of India was modelled as a response to the 1972 United Nations Conference on the Human Environment, and adapted standards established under the Water (Prevention and Control of Pollution) Act of 1974 (UN, 1973). Under Section 2(a) of the Air Act, 1981 the term 'air pollutant' has been defined as 'any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment'. The next section 2(b) of the Act defines 'air pollution' as 'the presence in the atmosphere of any air pollutant.' The ambient air quality standard was developed as a guideline to regulate the emission of pollutants into the environment as a result of human activity[7].

The Air Act was, therefore, a comprehensive legislation which established general definitions of air pollution, and set guidelines for the creation of state boards not yet established under the Water Act. Additionally, it established central governance, and described enumerated powers for the efficient assessment, management, and enforcement of environmental health standards. The set of standards, thus established, came to be known as the National Ambient Air Quality Standards (NAAQS).

3.3 Revised National Ambient Air Quality Standards

Ambient air quality refers to the condition or quality of air surrounding us in the outdoors. National Ambient Air Quality Standards are the standards for ambient air quality set by the Central Pollution Control Board and are applicable nationwide.

The objectives of air quality standards are:

- To indicate the levels of air quality necessary with an adequate margin of safety to protect the public health, vegetation and property;

[7]https://www.jspcb.nic.in/upload/uploadfiles/files/AirAct.pdf

- To assist in establishing priorities for abatement and control of pollutant level;
- To provide uniform yardstick for assessing air quality at national level;
- To indicate the need and extent of monitoring programme.

On 11th April 1994, the Central Pollution Control Board (CPCB) notified the NAAQS for seven parameters, namely, Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), Carbon Monoxide (CO), Ammonia (NH_3) and Lead (Pb). These were later revised on 14th October 1998 (CPCB, 2006).

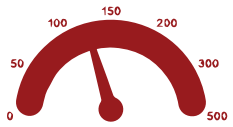
The current National Ambient Air Quality Standards were notified on 18th November 2009 by the Central Pollution Control Board which further lowered the maximum permissible limits for each of the pollutants and made the standards uniform across all states of India.

The current National Ambient Air Quality Standards were notified on 18th November 2009 by the Central Pollution Control Board which further lowered the maximum permissible limits for each of the pollutants and made the standards uniform across all states of India. Before this, the industrial areas were supposed to adhere to less stringent standards as compared to residential areas. Table 1 gives details of the current standards as per the 2009 revision. The changes in the standards according to the 2009 notification included (CPCB, 2009):

I. The new standards were now supposed to be applicable only to two areas: (a) Industrial, Residential, Rural, and other areas, and (b) Ecologically Sensitive Area instead of the previous three: (a) Industrial Area (b) Residential, Rural & other areas (c) Sensitive Area

II. The new parameters include: Particulate matter less than 2.5 µm in size or PM2.5, Ozone, Ammonia, Benzene, Benzo (a) pyrene (BaP), Arsenic (As) and Nickel (Ni).

The notification for the revised NAAQS came after a gap of 15 years and as per the press note released at the time, the review process was an extensive one which included parameters after consultations of the CPCB with the Indian Institute of Technology, Kanpur (IITK). At the time of writing of this report, however, the authors were unable to procure any document or copy of the proceedings of the establishment of these standards despite repeated attempts to do so. Even though, the State Pollution Control Boards (SPCB) are the bodies responsible for the implementation of the NAAQS, on speaking to various officials of the process of revising these standards we believe that there was no participation or involvement of the SPCBs at any stage. In fact, the standards were drawn up based on criteria unknown to anyone, including SPCBs, and the SPCBs were only asked to implement them in their respective states. The general feeling is that this was a top-down approach which has in many ways, created a sense of disengagement of the personnel involved.



Further to the 2009 amendment of the NAAQS, in October 2014, a new National Air Quality Index (AQI) was launched with the purpose of disseminating information on air quality in an easy understandable format.

Following the establishment of these standards, the Ministry developed additional support systems of enforcement such as the National Green Tribunal (NGT) to ensure the effective enforcement of the Standards. The NGT has in the last couple of years, been acting as an independent body working towards environment protection.

In the notification of 2009, while there is an acknowledgement of the fact that Mercury has been left out of the standards, it is said that the research and development in standard setting and standardization is still in progress in other countries hence India has left it out, even though it is of considerable importance. It has now, however, been ten years since this revision happened, during which time countries abroad have not only ratified the Minamata Convention on Mercury but have also included it in their process of measuring air quality standards.

Further to the 2009 amendment of the NAAQS, in October 2014, a new National Air Quality Index (AQI) was launched with the purpose of disseminating information on air quality in an easy understandable format. This index is a weighted average of the pollutants which was earlier limited to three indicators but has now expanded to include five additional parameters. The air quality is, hence, based on eight pollutants which are, PM10, PM2.5, NO_2, SO_2, CO, O_3, NH_3, and Pb for which short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed and the worst reading in these pollutants represents the Air Quality Index for that city.

The AQI in India, launched in October 2014, includes six categories of air quality. These are: Good, Satisfactory, Moderately Polluted, Poor, Very Poor and Severe (Kalra, 2014). Table 2 shows the AQI values and corresponding ambient concentrations (health breakpoints) for the identified eight pollutants.

A comparison of the Indian approach with international best practices is provided in Appendix 2.

3.4 Roles and responsibilities of government bodies responsible for air pollution control

3.4.1 Ministry of Environment, Forest and Climate Change (MOEFCC):

The Water (Prevention and Control of Pollution) Act, 1974 has been enacted under Article 252 of the Constitution and not under Article 248 or 249. Article 248 gives exclusive powers to Parliament to make law with respect to any matter not enumerated in the concurrent or state list while as per Article 249 Parliament shall have power to legislate with respect to a matter in the state list in the national interest. The Ministry of Environment, Forest and Climate Change is also responsible for overseeing and reviewing the draft standards for air pollution (among others) which are developed by the Central Pollution Control Board and submitted for review (Parliament of India, 2008).

3.4.2 Central Pollution Control Board (CPCB):

The Central Pollution Control Board is the apex technical body of the Ministry of Environment and Forests entrusted with the task of abatement and control of pollution in the country. It was initially established under the Water Act of 1974 following which it was also entrusted with the prevention and control of other kinds of pollution and waste management as listed above. The CPCB has been recognized as a scientific and technical organization comprising primarily of engineers and scientists. It receives 100 percent grant-in-aid from the Ministry of Environment and Forests both for plan and non-plan expenditure (Parliament of India, 2008).

Composition of the Board:

According to the Water Act, in order to exercise its powers and discharge its functions, there would be a Central Board to be composed of the following members[8]:

- a full-time Chairman, who would be nominated by the Central Government and would hold special knowledge or practical experience in respect of matters relating to environmental protection or have knowledge and experience in administering institutions dealing with the matters aforesaid;
- such number of officials, not exceeding five, to be nominated by the Central Government to represent the Government;
- such number of persons, not exceeding five, to be nominated by the Central Government, from amongst the members of the State Boards, of whom not exceeding two shall be from amongst the members of the local authorities;
- such number of non-officials, not exceeding three to be nominated by the Central Government, to represent the interest of agriculture, fishery or industry or trade or any other interest which, in the opinion of the Central Government, ought to be represented;
- two persons to represent the companies or corporations owned, controlled or managed by the Central Government, to be nominated by the Government; and
- a full-time Member Secretary, possessing qualifications, knowledge and experience of scientific, engineering or management aspects of pollution control, to be appointed by the Central Government.

The Board is supposed to comprise of 15 members excluding the Chairman and the Member Secretary. Out of these, twelve members are such officials who hold additional charge of the membership of CPCB. Out of the twelve, five officials represent the Government and five persons are nominated from amongst the members of State Boards. All the appointments are made by Government for a term of three years but the Act does provide a clause where the Central Government may remove any member before their term expires.

[8]https://www.indiawaterportal.org/sites/indiawaterportal.org/files/e7402_1.pdf

Roles and responsibilities:

While initially the CPCB was tasked majorly with control and prevention of water pollution, with the legislation for control of air pollution, it was charged with this additional responsibility as well. The Air (Prevention and Control of Pollution) Act 1981 was enacted by the Central Government with the objective of tackling the issue of deteriorating air quality. The Air (Prevention and Control of Pollution) Act 1981 describes the main functions of the Central Pollution Control Board (CPCB) as follows:

- To advise the Central Government on any matter concerning the improvement of the quality the air and the prevention, control and abatement of air pollution;
- To plan and cause to be executed a nation-wide programme for the prevention, control and abatement of air pollution;
- To provide technical assistance and guidance to the State Pollution Control Board, co-ordinate their activities and resolve disputes among them;
- To carry out and sponsor investigations and research related to prevention, control and abatement of air pollution;
- To collect, compile and publish technical and statistical data related to air pollution;
- Plan and organize training of persons engaged in programmes for prevention, control or abatement of water and air pollution;
- Organize through mass media, a comprehensive mass awareness programme on prevention, control or abatement of water and air pollution;
- Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement; Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts;
- Disseminate information in respect of matters relating to water and air pollution and their prevention and control;
- To lay down, modify or annul, in consultation with the State Governments concerned, the standards for stream or well, and lay down standards for the quality of air;
- Perform such other functions as and when prescribed by the Government of India.

The mandate provided to the CPCB under the Air (Prevention and Control of Pollution) Act empowers it to set standards for the quality of air. However, with the enactment of the Environment Protection Act, 1986, the Central Pollution Control Board (CPCB) has been further delegated functions to implement rules framed under the EP Act namely; Hazardous wastes, Bio-medical waste, Municipal solid wastes and Plastics waste. All this, with the limited capacity that it has, proves to be a challenge for the Central and State PCBs to implement.

With respect to air pollution, the Central Pollution Control Board has identified the following main areas for action (Parliament of India, 2008).:

- Monitoring of National Ambient Air Quality Monitoring Programme (NAMP)
- Strengthening of National Ambient Air Quality Monitoring Programme (NAMP)
- Strengthening with respect to number of monitoring stations
- Strengthening with respect to the monitoring of additional pollutants
- Pollution Control Implementation in major polluting industries
- Laboratory Management and Research & Development Activities for prevention and control of pollution
- Development and Review of Effluent/Emission Standards and Guidelines
- Information and Management System
- Non-point source pollution, vehicular pollution

In order to arrest the deterioration in air quality, it is necessary to assess the present and anticipated air pollution through continuous air quality survey/ monitoring. With this in mind, the ambient air quality standards (NAAQS) are pre-requisite for developing programme for effective management of ambient air quality and to reduce the damaging effects of air pollution:

- To indicate the levels of air quality necessary with an adequate margin of safety to protect the public health, vegetation and property;
- To assist in establishing priorities for abatement and control of pollutant level; and
- To provide a uniform yardstick for assessing air quality at national level.

Four pollutants namely, Sulphur dioxide, nitrogen dioxide, respirable suspended particulate matter and suspended particulate matter are being monitored regularly under NAMP. Monitoring of pollutants are carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly for particulate matter) with a frequency of twice a week. Monitoring is being done by CPCB, zonal offices, SPCB/ PCC and NEERI Nagpur, with CPCB acting as coordinator to ensure uniformity and consistency in air quality data. CPCB provides requisite technical and financial supports to the agencies engaged in this work.

3.4.3 State Pollution Control Boards (SPCBs)/ Pollution Control Committees (PCCs):

The State Pollution Control Boards (SPCB) were established in each state to implement the legislations as well as to issue the rules, regulations and notifications thereof which prescribe the standards for emissions and effluents of air, water pollutants and noise levels. In the case of Union Territories (UTs), the Pollution Control Committee (PCC) is responsible for these activities. Therefore, all the industries located or to be located in any State or UT are required to interact with the respective SPCB or PCC as the case may be. The Central Pollution Control Board (CPCB) is the body responsible for coordinating the activities of the SPCBs and PCCs. The composition of the State board is similar to that of the CPCB, with the caveat that certain positions such as that of the Chairman may be part-time as the State deems fit (Parliament of India, 2008).

4.0

Findings – Challenges in implementation of the NAAQS

There are several reasons why the enforcement of regulations has and continues to fall short of the desired levels. These issues range from poor understanding of and enforcement of laws to lack of accountability, from financial challenges of the pollution control boards to a shortage of trained personnel.

The fact that enforcement has been ineffective has led to air pollution and environmental degradation to grow and reach an alarming level. The federal structure of the system with two parallel boards - at the Central and at the States level – has not helped matters much either as the structure has afforded the SPCBs independence and autonomy when convenient, and plausible deniability when not. To ensure compliance by way of inspection, vigilance and sampling fall under the domain of the state boards with the CPCB acting merely as a guiding and coordinating body.

Beyond this, section 5 of the Environment (Protection Act) 1986 states "Notwithstanding anything contained in any other law but subject to the provisions of this Act the Central Government may, in the exercise of its powers and performance of its functions under this Act issue directions in writing to any person, officer or any authority and such person, officer or authority shall be bound to comply with such directions[9]".

A parliamentary standing committee report on the functioning of the pollution control boards also states, "Ministry of Environment and Forests vide its notification dated the 10th July, 2002 delegated its powers conferred upon it under section 5 of the Act to the Chairman, CPCB to issue directions to any industry or any local or other authority for the violation of the standard and rules relating to hazardous waste, bio-medical waste, hazardous chemicals, industrial solid waste, municipal solid waste including plastic (Parliament of India, 2008). But delegation of this power is subject to the condition that it may be revoked if in the opinion of the Central Government such a course of action is necessary in public interest".

[9]https://www.jspcb.nic.in/upload/uploadfiles/files/AirAct.pdf

Hence, even though the Board was created for the express purpose of controlling and abatement of pollution in the country, all the power is mostly concentrated in the hands of the Central Government/ Ministry of Environment, Forests and Climate Change. The SPCBs needs to be given adequate statutory and legal support as well as functional and financial autonomy to be able to discharge their duties with utmost efficiency and effectiveness.

4.1 Institutional capacity:

At the time when the CPCB was established, its role was limited to promoting cleanliness of rivers, streams and wells and later, improving the quality of air. However, in the four decades since its formation, several other functions have been assigned to the Board as well. Some of these functions include the management of industrial pollution, bio medical waste, e-waste, plastic waste, mercury waste, increase in mining activities, Hazardous Waste Management, solid waste management, controlling air pollution, etc. all of which require a stronger regulatory mechanism and further strengthening of the Board specifically in terms of man power and expertise. The Board was not constituted keeping in mind all these other responsibilities that it would have to perform in the years to come and should therefore, be equipped both at the Board and operational levels to handle these functions in a prudent manner.

There has been no proportionate increase in manpower with the expansion of the duties that the Board is required to fulfil at the Centre as well as state level. This was proven during the fieldwork conducted for this study. The percentage of vacant positions was more than 50% in some of the Pollution Control Boards where interviews were conducted. Meagre financial packages provided to staff also prove a stumbling block in attracting and retaining talent.

For the SPCBs, guidelines have been established which require them to inspect pollution levels for the different categories of industries[10]. This is as per the chart below:

CHART 1: Categories of Industries based on Pollution Index score

Category	Description
RED	Industrial sectors with Pollution Index score 60 or above
ORANGE	Industrial sectors with Pollution Index score between 41 and 59
GREEN	Industrial sectors with Pollution Index score between 21 and 40
WHITE	Industrial sectors with Pollution Index score up to 20

[10]https://vikaspedia.in/energy/policy-support/environment-1/environment-ministry-releases-new-categorisation-of-industries

The average inspection per industry, per year, for Maharashtra is 0.3 while for Karnataka it is 0.63 times (Parliament of India, 2008). Even for Gujarat State Pollution Control Board, which was able to inspect all industries in the red category twice every year, it is unlikely that these two inspections are enough to ensure compliance throughout the year.

The regional offices usually have a handful of officials who are tasked with various responsibilities and conducting regular inspections at the industries falls much lower in their list of priorities as that often requires them to travel to far off places. Almost all the State Boards interviewed mentioned shortage of manpower as a concern as to why the adequate number of inspections could not be conducted in a timeframe.

According to the Parliamentary Committee Report, Karnataka State Pollution Control Board and Maharashtra State Pollution Control Board were not able to inspect industries even once in a year. The average inspection per industry, per year, for Maharashtra is 0.3 while for Karnataka it is 0.63 times (Parliament of India, 2008). Even for Gujarat State Pollution Control Board, which was able to inspect all industries in the red category twice every year, it is unlikely that these two inspections are enough to ensure compliance throughout the year. The concern regarding staff issues is a matter which resonates across all PCBs. However, this is specifically true for the technical staff. So, even if the Board in a state may have sophisticated, state-of-the-art equipment to be used to monitor levels of pollution, they do not have enough people who are adequately trained for this work. According to the Parliamentary Standing Committee Report, technical staff comprised only 48% of the total staff at the CPCB in 2004-05 (we were unable to source more recent data in this). Moreover, out of its 236 technical staff only half were in the officer grade. This shortage of technical staff then percolates down to the State Boards where according to some estimates, an average technical person spent 1.77 days to monitor an industry in a year in Gujarat compared to 1.72 days/year in Karnataka and 1.23 days/year in Maharashtra. There is a significant imbalance in the ration of technical and non-technical staff with a high proportion of posts left vacant.

This is of great concern as with each passing year, the number of industries which need monitoring are on the rise. This results in a greater workload for the already thin staff figures and leads to low worker motivation and decreased efficiency. To somewhat balance the paucity of technical staff, Boards tend to hire staff on contractual terms. While this may work in the shorter term, since these employees do not have standard benefits and are on a much lower pay scale, it again results in low worker motivation. Also, the hiring process is lengthy/time consuming i.e., through civil service commission. SPCB should be given some authority to hire the staff with required expertise which is not the case. This will help speed up the recruitment process as well. One of the most important reasons for the ineffective implementation of air quality standards has, therefore, been this shortage of technical and scientific manpower within the central as well as State boards. There is therefore an urgent need for this to be rectified so that adequate numbers can be recruited to carry out the responsibilities designated to the PCBs.

Needless to say, that inadequate funding is a major reason behind the insufficient staff and consequently the infrequent inspections and focus on matters of air pollution control. Also, while technological advancements are desired and need to be adopted, paucity of funds makes this a serious concern.

4.2 Leadership:

Our findings show another prominent feature of the SPCBs around their leadership. This was owing to the fact that the highest authority i.e. the Chairperson was often an official who did not have a scientific or environment background and therefore incapable of fully understanding and dealing with matters pertaining to pollution control, environment, climate change, etc. These are seen as administrative positions rather than technical ones which is the only plausible explanation why they do not have persons with scientific backgrounds holding them. In addition to this, the official almost always holds dual responsibility i.e. they hold multiple portfolios as bureaucrats in the government departments. This effectively reflects the unimportance which is meted out to pollution control in the country and the Board associated with implementing the same.

While there is considerable pressure and workload on an already short-staffed body for pollution control, the matter of the composition of the Board(s) and the qualifications of the Chairperson/Member Secretary leaves this murkier still. The CPCB's composition is dominated by Government representatives and is constituted by the Central Government itself, which conflicts with the expectation of it acting as a watchdog. There are also no prerequisite qualifications which have been set for the various members supposed to become a part of this body but rather just a vague description such as 'having special knowledge or practical experience in respect of matters relating to environmental protection'.

It is important to note that this concern was previously raised by the Parliamentary Committee report of 2008 but even after the significant passage of time, this seems to have remained the same. In its report it was stated that the key posts in both the central as well as the state board were being manned by officers of the Indian Administrative Service or other bureaucrats who 'neither possess the necessary capabilities and expertise in properly managing and planning pollution control activities nor have enough time to pay attention to these activities for obvious reasons' (Parliament of India, 2008). According to a 2001 report submitted by the Supreme Court Monitoring Committee on Hazardous Waste, 77% of Chairpersons and 55% of Member Secretaries across pollution control boards in the country were not qualified enough to hold the post (Parliament of India, 2008). Almost a decade after this report came out, however, the situation seems to persist.

4.3 Lack of motivation and accountability:

Since the functions of a SPCB are highly technical in nature, the staff employed too must have adequate technical knowledge to perform these duties. Although technical and scientific staff are employed in most SPCBs, it was observed that SPCBs are largely dominated by non-technical staff.

It is also believed that firstly, the boards feel they do not have any real authority and therefore do not implement strict action on the industries which are flouting the pollution standards. According to one of our interviewees, these industries are asked to look into the matter of pollution by way of a text message from the board. Even when legal action is taken against outlier polluters, compliance is significantly delayed due to the costs involved in a time-consuming legal process, and existing backlog of cases in civil and criminal courts. This disincentivizes SPCBs from taking legal action, as evident from the limited use of this particular deterrent (Dutta, 2016). Besides, the Boards do not have the legal capacity to pursue the case. This requires a change in regulatory framework so that such non-compliances are disposed quickly and the long legal battles do not serve as incentive to defaulters.

In addition to this, a major hindrance is the role that Board officials often see themselves in. In the words of one respondent, which was reiterated by many, the Board is a 'technical advisory body' which can only advise the government but 'cannot take any action'.

> ***"The duty of the PCB has been diluted from a regulatory body to a facilitating body"***

State boards see themselves as regulatory bodies rather than an authority on controlling pollution levels. Out of the eight State Pollution Control Boards that we visited, none of the respondents interviewed knew how the standards had come about. There was also no clarity or knowledge as to why the standards had been established at a particular level. The process of establishment of these standards was not inclusionary but the State officials were handed the task of implementing the standards. One State Board official aptly described this situation as: *"whatever they give us, we have to follow".*

States were not even provided with standard operating procedures (SoPs) to implement the standards once they came into existence. All of this has created a feeling of detachment from the cause as well as their responsibility.

4.4 Multi-sectorality and bureaucratic challenges:

In addition to the above, a lack of convergence and coordination between departments proves to be a hindrance. Since controlling pollution levels requires consolidated effort and coordination with various other departments, including transport, police and urban local bodies, among others, the Board gets more leeway about the implementation of the standards as it only sees itself as an advisory body.

> ***"The state pollution control boards have to look at water, air, noise pollution as well as biomedical waste management. We directly have no control but can only ask the concerned department or authorities to try and improve upon the mitigation measures. We cannot do it for them."***

"There are no difficulty (in implementation) because we do not have any role, we can only monitor and say that it has gone to 200, we don't have any role to say to transport department, ok it is going to 200, adopt odd even, you know that has to be taken by that department, so we can only make people aware..."

This leads to the question of action plans which have been prepared but not implemented to a great extent. The CPCB came up with a list of 102 non-attainment cities in the country, those which had extremely poor levels of air pollution and the State Pollution Control Board of the state where the cities were situated had to come up with an action plan to address the issue and assign responsibilities to the various departments who would be responsible for the abatement of pollution from their end. While these action plans were prepared and submitted, what is surprising is that most of these plans do not have specific deadlines for the tasks to be completed. Since there are no deadlines for the actions by stakeholder departments, the entire process seems more relaxed than it should be given the grave situation in these non-attainment cities. There is also little in these action plans about coordination mechanisms to ensure tasks are appropriately assigned, with relevant departments taking ownership to address this multi-sectoral issue.

Lastly, in states with large-scale mining or industrial activity, issuing environmental clearances takes precedence over all other work of the State Boards. This then takes time away from all other responsibilities while making sure that there are not very considerable delays in the setting up of industries. This is reflected in the approach of those working at those SPCBs as well, with some noting that they believed the issuance of environmental clearances to be their primary role, with promotion of economic activity a key goal.

4.5 Monitoring-related issues:

In speaking about the role of monitoring as part of their work, interviewees noted that they see this as a primary task. To this end, States deploy their own monitoring networks over and above the CPCB's NAMP and continuous monitors. However, given the challenges with technical capacity cited above, concerns remain regarding the quality and utility of the data generated. For instance, the CPCB's quality assurance and quality control efforts include visits to monitoring stations, review meetings, analytical quality control, and training programmes – few of these tasks are mirrored at the same frequency or efficacy at the State level, with calibration cited as a frequent challenge.

So, while the capacity for real-time and gravimetric monitoring grow year by year across the country, gaps in data collection and erroneous readings due to poor calibration remain, posing an obvious barrier to reliable air quality data for both research and public awareness. For instance, in the case of Delhi, during winter 2015 (characterized by high pollutant concentrations), PM2.5 data was recorded

only 29% of the time across 11 monitors run by the CPCB and DPCC. With an expanding network of air quality monitoring across the country, caution needs to be taken with regard to maintenance of monitoring stations and resulting erroneous data.

Additionally, as noted in earlier sections, the view held by most employees of the SPCBs of own roles within this domain is such that they see monitoring as an end in and of itself, with little need to take action based on the data they collect, unless pressed to do so. To truly address the growing burden of air pollution, there is a need for this mind-set to shift, and to acknowledge that the remit of the SPCBs under the law is actually much larger.

4.6 Understanding of the health impacts:

The Air Act and the EP Act in their preamble mention their raison d'etre as the protection of public health. To ascertain whether this understanding of why the laws exist in the first place exists within SPCBs, we asked interviewees about their understanding of the health impacts of air pollution. While there was some recognition of health impacts across different states, there was heterogeneity in responses, and some misinformation. In a rather startling statement, a respondent casually mentioned how ***"air pollution is not an alarm bell for us yet" and how the "standards are meant for Europeans, not Indians"***, drawing distinctions in physiology that run contrary to established science.

> ***"Now the standard should be different in different countries like in India, if a Britisher(sic) come to Patna and taste the tap water they will suffer from diarrhoea but people in Patna taking same water they are all right because the resistance is high"***

> ***"...see the effect of pollution on health is well documented, I am talking about air pollution, the effect of air pollution is well documented and everybody knows like in winters, whenever the pollution goes up, respiratory problems especially the elderly and the kids get affected, so I don't think you need to [conduct] research to say that pollution is contributing to respiratory health of the urban population. It's an established fact but the only thing is that somehow, we have to bring in all the heads so that they in their spheres can regulate their own activities"***

The heterogeneity in responses showed that while recent epidemiological work has been published in India, and the wide media attention accorded to those studies has raised awareness, there is still work to be done in clarifying misconceptions. That there are no scientists at the Central or State boards trained in public health no doubt also influences this.

5.0 Recommendations

5.1 Addressing Leadership and human resource needs:

Throughout our interview process, and in our review of secondary data, it was revealed that adequate training is not provided to the personnel of Central and State Pollution Control Boards. Considering that controlling pollution is the most important function of CPCB requiring scientific and technical expertise, multi-disciplinary training should be imparted to all personnel. However, this was not reported to be the case. The Parliamentary Committee Report was of the view that creation of trained cadre is required for monitoring and resolving environmental problem (Parliament of India, 2008). This lack of trained manpower affects both day to day functioning and forward planning efforts to address broad-based sectoral issues at a State level. Strengthening manpower at the SPCBs will not only require hiring new resources, but also training existing staff by leveraging institutions such as the Indian Institutes of Technology, NEERI, and others. These in-service training programs would also serve as an incentive for staff both new and existing. Pay structures also need to be revised to align with sectoral norms to ensure that SPCBs are not regularly losing trained manpower to industry and other sectors. The infrastructure of PCBs also needs to be improved along with manpower i.e. facilities such as adequate computers, improved lab facility etc. The instruments used for monitoring are not maintained properly or outdated. Sometimes labs are also not equipped enough to do the necessary analysis.

Additionally, it was clear that the leadership of the SPCBs, namely the Chairman and the Member Secretary, were not in many cases trained in appropriate scientific domains to be able to run these highly technical bodies. Instead, most were either IAS or IFS officers, and many were part-time in these roles, holding other concurrent responsibilities. It is imperative for their effective functioning that States should nominate to these positions, individuals of technical expertise and distinguished service such that effective decision making can be carried out. They should be appointed for a fixed tenure and in full-time roles, with the sword of removal or termination not hanging over their heads. The size of the boards themselves may also be reduced to aid in effective functioning, with preference in membership given to technical experts, as is the international best practice. These moves would ensure that the Boards function effectively as independent agencies, as envisioned in their foundational legislation.

5.2 Strengthening Centre-State interactions:

Till date, we are unaware of a single State government which has implemented more stringent standards for a critically or severely polluted area based on

In spite of recent evidence published on the health effects of air pollution in India, including by the Union Ministry of Health and Family Welfare, there is a high level of scepticism within the regulatory community on the utility of studies where impacts are modelled and not measured.

recommendations from an SPCB. This is partly down to the fact that SPCBs see standards provided to them by the CPCB not as a baseline to be amended as needed, but as the gold standard to be implemented without question. A change in mind-set requires guidance from the CPCB to SPCBs on the contours of their responsibilities, and greater interaction and technical input for States that see a need to implement more stringent standards for specific non-attainment areas.

In the short-term, the lack of technical capacity at the SPCBs can also be addressed by the CPCB providing greater technical input to States, and working with States to foster an effective participatory relationship of learning. Periodic review of actions taken by SPCBs and its effect on reduction of air pollution needs to be monitored and not merely listing the actions taken, but evaluating the effectiveness of such actions.

5.3 Expanding monitoring capacity and utilizing data effectively for compliance:

Current coverage of ambient air quality monitoring is heavily skewed towards tier 1 and 2 cities, with little monitoring happening in the smaller cities, and virtually no monitoring in rural areas. Source apportionment studies conducted over the last few years have shown us that a significant proportion of India's ambient air pollution arises from household sources. Additionally, many large point sources are located in rural areas, with little data available from locations nearby to help local populations understand what they're being exposed to. To paint an accurate picture of the air quality in both rural and urban India, monitoring needs to be rapidly expanded, even more so than envisioned in the NCAP. In the absence of increased monitoring, established methods for predicting localised PM2.5 concentrations based on satellite observations need to be mainstreamed so that those exposed are aware of the dangers of exposure.

Additionally, what data we have also needs to be used more effectively. Currently, CEMS data are not available in the public domain, aside for the Maharashtra star rating program which provides modified data to judge pollution from large point sources. Making these data publicly available would ensure increased accountability for industry, and provide researchers an effective means of estimating the contribution of various sources to ambient air pollution.

5.4 Financial resource mobilization:

Interviewees cited the chronic lack of funding as a major challenge in carrying out their day to day responsibilities, and as a significant hindrance in on-boarding trained personnel. For instance, one interviewee indicated to us that

while allocations had been made for new personnel for their SPCB over 3 years ago, the funds were never released, and their staff strength has stagnated since. Addressing the gap in funding would require States to increase their own earmarked contributions to the SPCB. A proposal from some interviewees was also the introduction of a State or Central pro-rated environmental regulation cess on industrial activity, that would be paid annually and be allocated towards activities of the boards at the State level. This kind of cess is not a new concept and could be a way of raising funds from polluting industry without compromising the integrity of the regulator-industry dynamic.

5.5 Engaging the health community and other stakeholders:

As outlined by our interviewees, there is little engagement with other sectors in their work, least of all with the health sector. Engaging the health sector in their work would help regulators in supplementing their own knowledge gaps regarding the health effects, and potentially lead to joint work with both epidemiological and regulatory relevance. Engaging with other sectors is also crucial, as has been outlined earlier, with bureaucratic bottlenecks stymying action at a State and local level. Addressing this by establishing a multi-sectoral task force at each State headed by the Chief Secretary and convened by the Chairman of the SPCB that would implement the State level action plans, would ensure broad sectoral engagement on important matters of air pollution.

To further support the SPCBs, local institutions could be strengthened to carry out the necessary research, i.e. source apportionment or health studies. Most of the funding goes to central institutes such as IITs, which are overburdened with such studies. This will affect the quality of research. For example, most of the source apportionment studies for cities under NCAP went to central institutes. Rather, local institutes could be identified and strengthened who can carry out the study locally and effectively.

5.6 Strengthening the evidence base:

In spite of recent evidence published on the health effects of air pollution in India, including by the Union Ministry of Health and Family Welfare, there is a high level of scepticism within the regulatory community on the utility of studies where impacts are modelled and not measured. This is being remedied with more recent work led by several teams around the country which aim to plug the gaps in the impacts of long-term exposures on chronic diseases (Arku et al. 2020; Balakrishnan K, 2015; Mandal S, 2020). Addressing these concerns would also require establishing a base of accountability research that examines the effect of regulatory interventions not only on air quality, but on health as well, as these will help build the moral and epidemiological case for effective action.

6.0

Conclusion

In this report we have aimed to capture through key informant interviews and secondary literature reviews the key structural and informational barriers to effectively implementing existing regulations. Implementing these regulations are key to achieving India's goal of achieving the NAAQS. No country has achieved broad-based economic development without investing in the health and well-being of its citizens, and addressing key environmental risk factors forms part of this investment. Regulatory bodies in this regard cannot be seen as hindrances, but rather as enablers to achieving a more sustainable future. Our recommendations outlined above capture what our interviewees see as the key challenges that need to be addressed if we are to set India on this more sustainable development path. Addressing these recommendations, coupled with effective and coordinated policymaking across domains, enshrined in a culture of accountability will ensure that future generations will not have to deal with the persistent threat of ambient air pollution.

Appendix 1

Purpose of an ambient air quality index:

In a research paper by Ott (1978), the objectives served by having an Air Quality Index have been listed as follows:

I. **Resource Allocation:** To assist administrators in allocating funds and determining priorities. Enable evaluation of trade-offs involved in alternative air pollution control strategies.

II. **Ranking of Locations:** To assist in comparing air quality conditions at different locations/cities. Thus, pointing out areas and frequencies of potential hazards.

III. **Enforcement of Standards:** To determine extent to which the legislative standards and existing criteria are being adhered. Also helps in identifying faulty standards and inadequate monitoring programs.

IV. **Trend Analysis:** To determine change in air quality (degradation or improvement) which have occurred over a specified period. This enables forecasting of air quality (i.e., tracking the behaviour of pollutants in air) and plan pollution control measures.

V. **Public Information:** To inform the public about environmental conditions (state of environment). It's useful for people who suffer from illness aggravated or caused by air pollution. Thus, it enables them to modify their daily activities at times when they are informed of high pollution levels.

VI. **Scientific Research:** As a means for reducing a large set of data to a comprehendible form that gives better insight to the researcher while conducting a study of some environmental phenomena. This enables more objective determination of the contribution of individual pollutants and sources to overall air quality. Such tools become more useful when used in conjunction with other sources such as local emission surveys.

Appendix 2

Comparison with international best practices

In a comparison of international standards, valuable insight arrives from air quality legislation that actively engages effort at all levels of society. National planning and resource management synthesizes with state-level implementation and compliance measures, in turn maintaining local efforts while encouraging and supporting community development. No less essential is the presence of environmental justice standards, where even a single individual may petition for redress of environmental harms. For this discussion, air quality standards in the United States (U.S.) and supranational efforts by the European Union (EU) will combine to provide one perspective on largely successful air pollution mitigation strategies.

For this discussion, valuable comparisons highlight both research-informed policymaking and the evaluative change process following enactment of air quality legislation. Both U.S. and EU leaders are similar in experience when managing air quality networks incorporating these factors. Additionally, there are comparisons of both economic resources and technological standing that describe a difference between these programs when compared to those developing, for example, in China and India (Kuklinska et al. 2015). Opportunity exists for the exchange of extensive experience and guidance, describing potentials for long-term pollution reduction and air quality improvement.

Strategies for air pollution control in the modern times, began in the United States in 1955 with the establishment of the Air Pollution Control Act. This movement established resources for research, training and technical assistance for an initial period of five years (Stern, 1982). Extension of this research in 1960 led to the 1963 incorporation of the U.S. Clean Air Act (CAA). This critical legislation not only defined NAAQS for the country, but also through subsequent amendments in 1977, 1979 & 1990, defined air pollution standards for years to come (Kuklinska et al. 2015). Additional legislation followed in the 1965 Motor Vehicle Protection Act, as well the 1967 Air Quality Act. The creation of the U.S. Environmental Protection Agency in 1970 established a federal body that was tasked with both implementation and enforcement of pollution control legislation.

In the European Union (EU), efforts to curb air pollution began only in 1980 and included a series of directives that established air quality limit and guidance

values, as well describing specific language on various air pollutants such as Pb, NO2, and industrial emissions (Kuklinska et al., 2015). Development progressed throughout the decade, arriving in 1992 with directives concerning air pollution by O3. These efforts mirrored by the 1990 amendments to the Clean Air Act (CAA) of the US, enacted to mitigate concerns brought about by acid rain and atmospheric O3 depletion. Development in the next few years led to adoption in 1996 of the Ambient Air Quality Framework Directive (AQFD), an agenda that established guiding principles for ambient air quality management not dissimilar to NAAQS (Wettestad & Farmer, 2003). Further refinement arrived via directives which provided AQFD updates, establishing additional limitations on primary air pollutants. Continuing through 2008, these directives came as a result of updated research data and requests from EU member nations.

Around the same time, the U.S. continued efforts toward improved air quality. EPA guidance implemented new rules, legislators explored cap-and-trade emissions options first implemented in the previous decade, and in 2015 new environmental standards defined the Clean Power Plan (CPP). CPP requires submission of state-level planning for carbon emissions reductions resulting from fossil-fuelled power plants, facing recent concerns surrounding global climate change (Federal Register, 2019). Similar efforts by the EU arrived in the 2013 adoption of the Clean Air Policy Package, an ambitious document that provided research-based updates to many previous standards, and also set new overarching goals for clean air throughout Europe (European Commission, 2013).

Many standards created by U.S. and EU efforts are similar in nature. Generally, any differences tend to focus on specific air quality limits, implementation practices, or interactions with various member states. For example, AQFD and subsequent directives establish air quality limit values (AQLV) similar in nature to U.S. NAAQS. Differences exist based on concentrations of primary pollutants, or pollution zones defined in part by geographic or population features. Variances occur in incremental exposure limits over time, and EU standards are generally more restrictive when compared to U.S. measures, aligning more closely with WHO recommendations (Kuklinska et al., 2015).

Implementation efforts in EU member states (MS) and U.S. state-level interactions are defined through AQFD and CAA standards, respectively. States and MS are tasked with assuring air quality standards within geographical borders and across specific zones. U.S. states, metropolitan areas, or multi-state groups may all have federal designation under air quality control regions (AQCR), whereas zones within MS are more typically defined by air quality limit values (AQLV) associated with population areas greater than 250,000 (DG Environment, 2004). MS are offered a more relaxed description of implementation, where a certain amount of control is maintained by nations working in concert with EU standards. Alternatively, U.S. protocol is more restrictive, and revolves around state

implementation plans (SIP) that describe either attainment of standards with associated maintenance, or non-attainment coupled with response mechanisms. In either case, SIPs must go through a process of assessment and approval according to EPA rules and standards established under the CAA.

Key to this discussion is the resultant process of accountability that results from the interactions between distinct governing bodies. In both U.S. and EU standards, implementation and correctional planning involves significant documentation and integrated data. This comprises description of pollutants and emission events, the duration of release, and information regarding zone type. Additionally, source data and continued monitoring are used in strategy development, and ultimately describes the various combination of federal, state, or local resources necessary to successfully implement an updated SIP (Colburn, Hausauer, & James, 2012).

What is also notable is that states and MS both are permitted to implement more stringent local standards based on specific air quality concerns. A primary example of this exists in U.S. vehicle emissions policy. EPA rules and standards apply nationwide for all types of motorized vehicles, and impose production requirements and certification before vehicles are placed on the market. Based on resultant pollution arising from traffic congestion around major metropolitan areas, California implemented significant vehicle emission legislation at the state level, sanctioned through an inclusion granted by the CAA. The success of these more stringent requirements has since encouraged twelve other U.S. states to follow suit, forming a state-level coalition that includes more than 130 million residents who represent one-third of the current vehicle market in the U.S.

While policies for protecting the quality of air are much similar in the US and the EU, the differences arise primarily in the implementation and management. The U.S monitors information on six 'criteria air pollutants' (SO_2, NO_2, particulate matter (PM_{10}, $PM_{2.5}$), CO, O_3, Pb) while in the EU there is a larger number of compounds monitored than those listed in the WHO recommendations. The Clean Air Act in the US requires the Environment Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS). Two types of Ambient Air Quality Standards are identified in the Clean Air Act: Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly and Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. In addition to the above, in the U.S., air pollution management is implemented through a combination of the air quality standard and the emission standard strategies, whereas in the EU emission standards, emission taxation, and cost–benefit analysis have been used (Kuklinska et al, 2015).

Table 4 has been reproduced from Kuklinska et al, 2015 which draws a comparison between the air quality guidelines in the US and EU with those recommended by the WHO. According to the US EPA, integrated science assessments are conducted periodically to evaluate the 'scientific literature on the potential human health and welfare effects associated with ambient exposures to particulate matter (EPA, 2009). In addition to this, technical and policy assessments on the adequacy of the current standards and the appropriateness of plausible alternatives inform decision-making. An independent science advisory committee called the Clean Air Scientific Advisory Committee (CASAC) is responsible for the review of the proposed air quality standards and criteria. With the process for the establishment of the current standards in the US and the EU laid out above, we shall steer the discussion to the case of India. In so far as secondary literature as well as our research explains, there is no record at hand of how the air quality levels are established for the country. In the case of India, the CPCB should follow a similar procedure with a process transparent in manner, in reality, we were unable to find how this actually works.

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Tables

TABLE 1: National Ambient Air Quality Standards[11]

Pollutant	Time-weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Area (notified by Central Government)
Sulphur Dioxide (SO_2), µg/m3	Annual* 24 hours**	50 80	20 80
Nitrogen Dioxide (NO_2), µg/m3	Annual* 24 hours**	40 80	30 80
Particulate Matter (size less than 10 µm) or PM10 µg/m3	Annual* 24 hours**	60 100	60 100
Particulate Matter (size less than 2.5 µm) or PM2.5µg/m3	Annual* 24 hours**	40 60	40 60
Ozone (O_3) µg/m3	8hours* 1 hour**	100 180	100 180
Lead (Pb) µg/m3	Annual* 24 hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m3	8 hours* 1 hour**	02 04	02 04
Ammonia (NH_3) µg/m3	Annual* 24 hours**	100 400	100 400

[11] http://cpcb.nic.in/National_Ambient_Air_Quality_Standards.php

Pollutant	Time-weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Area (notified by Central Government)
Benzene (C6H6) µg/m3	Annual*	5	5
Benzo(a)Pyrene (BaP)-particulate phase only, ng/m3	Annual*	1	1
Arsenic (As), ng/m3	Annual*	6	60
Nickel (Ni), ng/m3	Annual*	20	20

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Source: National Ambient Air Quality Standards, Central Pollution Control Board Notification in the Gazette of India, Extraordinary, New Delhi, 18th November, 2009

TABLE 2: National Air Quality Index [12]

AQI Category, Pollutants and Health Breakpoints								
AQI Category (Range)	Categories for the various readings of the pollutant based on the health breakpoints or health impacts							
	PM10 24-hr	PM2.5 24-hr	NO2 24-hr	O3 8-hr	CO 8-hr (mg/m3)	SO2 24-hr	NH3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5 –1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

TABLE 3: National Air Quality Index and Associated Health Impacts [13]

AQI	Associated Health Impacts
Good(0–50)	Minimal Impact
Satisfactory (51–100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101–200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201–300)	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease
Very Poor (301–400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401–500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

[12] http://www.cpcb.nic.in/About_AQI.pdf
[13] http://www.cpcb.nic.in/About_AQI.pdf

TABLE 4: Comparison across EU, US and WHO standards [14]

Pollutant/ Averaging Time	EU (AQS, 2011)	U.S. (U.S. EPA, 2012a)	WHO (WHO, 2006)
SO2	ppb	ppb	ppb
1 hour mean	134	75	-
3 hour mean	-	500	-
24 hour mean	47	140	8
Annual mean	-	30	-
NO2	ppb	ppb	ppb
1 hour mean	105	100	106
24 hour mean	-	-	-
Annual mean	21	53	21
PM10	µg/m3	µg/m3	µg/m3
24 hour mean	50	150	50
Annual mean	40	-	20
PM2.5	µg/m3	µg/m3	µg/m3
24 hour mean	-	35	25
Annual mean	25	15	10
CO	ppb	ppb	ppb
8 hour mean	9 000	9 000	-
1 hour mean	-	35 000	-
Ozone	ppb	ppb	ppb
8 hour mean	40	75	50
1 hour mean	-	120	-
Benzene	µg/m3	µg/m3	µg/m3
Annual	5	-	-
Lead	µg/m3	µg/m3	µg/m3
Annual	0 5	0.15	-
PAH	µg/m3	µg/m3	µg/m3
Benzo[a]pyrene	0.001	-	-

[14] http://www.cpcb.nic.in/FINAL-REPORT_AQI_.pdf


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