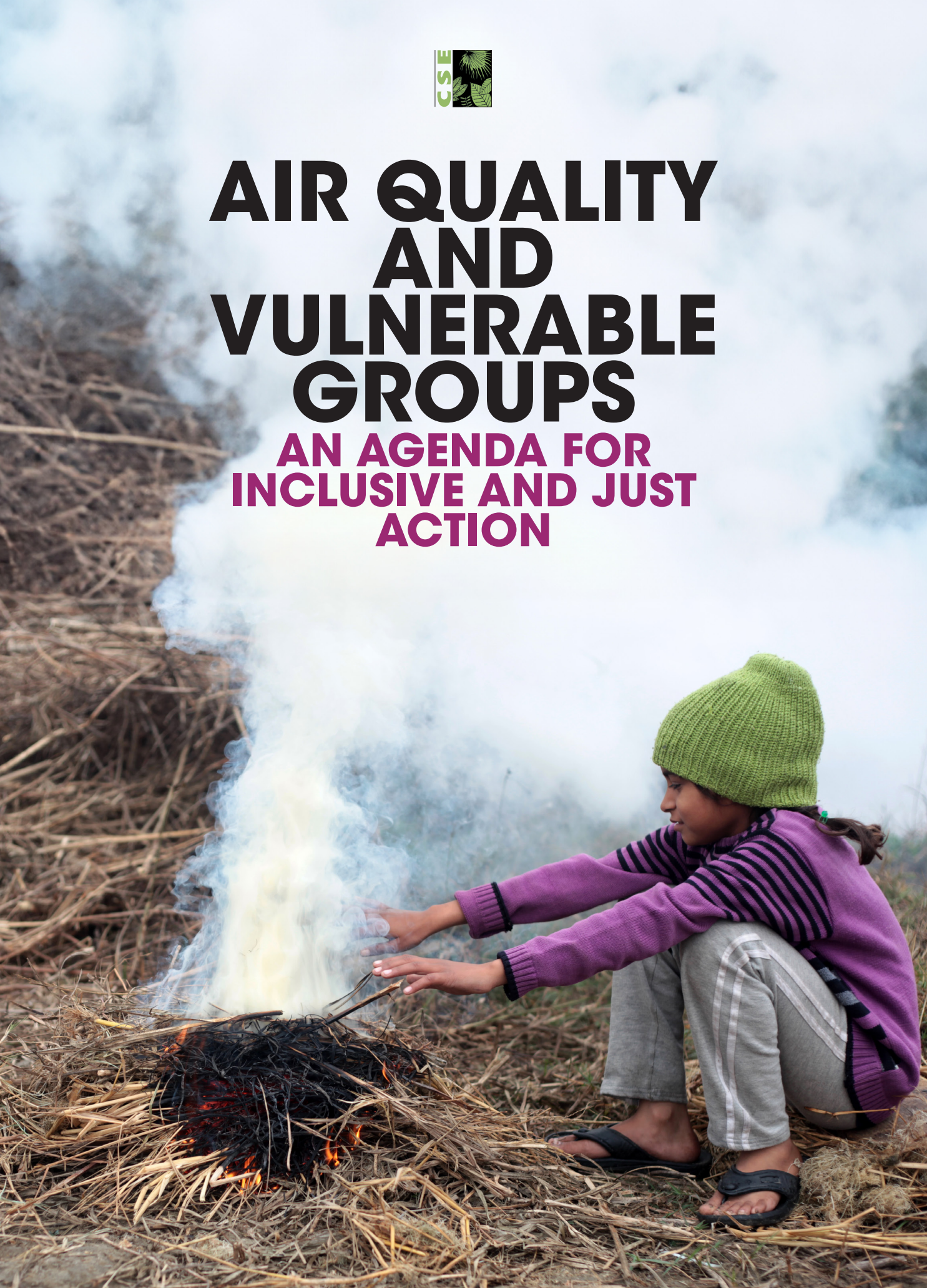
AIR QUALITY AND VULNERABLE GROUPS

AN AGENDA FOR INCLUSIVE AND JUST ACTION



AIR QUALITY AND VULNERABLE GROUPS

AN AGENDA FOR INCLUSIVE AND JUST ACTION

Authors: Anumita Roychowdhury and Kalyani Tembhe

Lead Research: Kalyani Tembhe

Editor: Archana Shankar

Cover: Ajit Bajaj

Layout: Kirpal Singh

Graphics: Vineet Tripathi

Production: Rakesh Shrivastava and Gundhar Das

The Centre for Science and Environment is grateful to the Swedish International Development Cooperation Agency (Sida) for their institutional support.

Citation: Anumita Roychowdhury and Kalyani Tembhe 2024, *Air Quality and Vulnerable Groups: An Agenda for Inclusive and Just Action*, Centre for Science and Environment, New Delhi

Published by
Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi 110 062
Phone: 91-11-40616000
Fax: 91-11-29955879
E-mail: cse@cseindia.org
Website: www.cseindia.org

Contents

The spotlight

Air pollution is a public health crisis. Health Effect Institute's (HEI) most recent and comprehensive global overview the *State of Global Air 2024* shows that as many as 8.1 million deaths related to air pollution occur worldwide annually, of which about 2.1 million deaths are reported in India.[1] This tally is increasing every year.

Even though the challenge of air pollution and associated health risks span across the developed and the developing world, the developing Global South, with its enormous development burden, is at high risk. The problem has not gone away in developed regions either. Meeting clean-air targets to protect public health remains a challenge across all regions. While the scale and speed of technology, design and energy solutions have to gather momentum, the growing body of scientific knowledge and real-world experiences are increasingly pointing towards another dimension of this challenge, which is the inequity of this crisis.

Already mounting evidence on health impact of air pollution have unmasked the human face of this crisis. But there is now growing recognition that it is not enough to only address techno-centric solutions to improve ambient air quality to protect all. It is also critical to understand the patterns of inequitable exposures of individuals and groups to toxic risks. Understanding the unique vulnerabilities of communities influenced by a wide range of socio-economic conditions and marginalization is important as this iniquitous exposure aggravates the health risks of these communities.

Traditionally, the health impacts of air pollution have been understood in terms of the relation between dose and response at an undifferentiated population scale. But over the years, more nuanced approaches have evolved to investigate the modifiers and specific impacts on groups differentiated by age, gender, socio-economic and nutritional status, and a range of other factors that define the vulnerabilities and underpin marginalization.

Such evidences make it clear that the health risk is not uniform for everyone. The unique disadvantages of a community or a section of population can enhance the public health risks that need special attention and mitigation.

Although the science has become more compelling on this issue, and a lot more evidence is available, the policies have not evolved adequately to integrate this

new insight and address the specific risks to communities and reorient the clean air action.

However, there is a change in this direction more in the Global North where scientific evidences combined with mobilization of communities on their specific risks have led to significant policy-level changes to integrate what is now popularly known as 'environmental justice' programmes. This is more noticeable in the US and the UK, among others. Even though there have been significant improvements in air quality in the developed North, disparities in community-level exposure have persisted due to local conditions aggravating the public health risks in several subregions.

This learning curve has become crucial for India and the developing South, where economic growth is expected to increase the pollution curve while the coping of marginalized communities bearing iniquitous exposure remain weak. If environmental justice programmes are not integrated with clean air policies early on, deaths and illness may take unacceptable proportions at enormous social and economic costs.

This issue is highly relevant to India. While the high pollution levels have persisted across several regions, social inequities, occupational outdoor exposure, indoor pollution, geographical disadvantages and poverty impacts have compounded the health risks from air pollution, eroding welfare gains.

There is yet another dimension to this challenge. Disadvantaged communities are not only at higher health risks from air pollution, but they also bear the brunt of iniquitous air pollution control measures. This is a double jeopardy. As the equity indicators have not been adequately integrated with air pollution control policies, often the vulnerable groups fall victim to the pollution-control efforts and are adversely impacted.

Air pollution control measures may adversely impact the livelihood, jobs and economic wellbeing of certain communities. Polluting activities get pushed to the backyards of cities where disadvantaged and marginalized groups mostly live or are employed. In the absence of adequate safeguards, this increases their toxic exposures and livelihood crisis.

It is from this perspective that the Centre for Science and Environment (CSE) has carried out this review to understand this challenge and the global approaches to addressing equity-based air pollution control policies and programmes and how India can address this.

At a time when the National Clean Air Programme (NCAP) is being redesigned and the clean air action plans in cities and states are getting revised, it is necessary to assess this dimension to mainstream these indicators to maximize the welfare impacts of air pollution control. NCAP needs to integrate exposure-based health evidence for multi-sector action and ensure deep cuts in exposures from key sources of pollution in all situations and areas where vulnerable communities are exposed.

NCAP needs to become more community-centric so that it can be more participatory in prevention, control and mitigation measures. In fact, the NCAP policy has taken on board the principle of providing communities with the knowledge and tools to take action and help improve their local air quality. It states, 'problem areas can easily be identified and monitored using citizen science methods, empowering communities, and reducing the risks of exposure to air pollution'.

However, while NCAP provides the lever to involve communities, the scope is still very narrowly defined. It is still seen as the public's prerogative to become more involved in reducing local air pollution impacts in their communities. Extensive awareness and outreach programmes for various stakeholder groups need to be taken up on a priority basis in non-attainment cities. Building public awareness will be vital in supporting implementation of NCAP. This is seen as an advocacy and information, education and communication strategy.

However, the agenda for inclusive and 'just' clean air action is a much broader concept that seeks to address unequal distribution of health and environmental risks in the population due to air pollution. This prism of policymaking is still very nebulous in India. But globally, considerable action is underway in different regions to integrate and implement what is commonly known as the environmental justice programme to strengthen air quality management. This has attained more momentum in the global North especially in the US, where substantial improvement in air quality over the decades has also exposed the vulnerability of sections of the population with lower socio-economic status and other inherent disadvantages.

This assessment has therefore highlighted the differentiated risks in the Indian context and how this needs to inform policy action going forward. Unless the risks to all vulnerable groups are mitigated, the disproportionately high health cost burden cannot be addressed effectively.

Key highlights

The identification of groups that are more vulnerable to air pollution is understood from the emerging research that has exposed a wide range of vulnerabilities of population based on age, gender, socio-economic and nutritional status, occupational exposure and proximity to pollution sources. While susceptibility due to age and gender is widely accepted and has been part of the policy focus globally, the environment justice programmes by their very nature are more related to structural inequalities in society

Growing evidence on overall vulnerability in India: There is stark evidence from the global and Indian research that indicate very high risk to children and foetus in India. This manifests as a massive disease burden for infants, children and adolescents, which lasts a lifetime. Children of poorer households are more at risk.

Women, especially those of marginalized and poor households, without access to clean cooking energy are especially susceptible to a plethora of diseases that also harm children. Exposure of pregnant women to toxic air pollutants compromises the health and development of the foetus. India has considerable disparity in gender-based air-pollution exposure. Women's pre-existing poor nourishment, especially from poor and marginalized households, pose greater threat to their respiratory, cardiovascular and reproductive health.

On the other hand, older people are more susceptible as they have more underlying health conditions including hypertension, diabetes, and heart disease, and slower metabolic rates. Lifetime exposure increase risks further. The mortality and morbidity risks for an ageing population are worsened by air pollution.

Socio-economic inequity and vulnerability to air pollution risks: Marginalized and poor communities face disproportionate impacts of health burden due to their weak health status, nutritional deficiency, weak coping capacity and high exposure levels. While this connection has been made very strongly in the global literature, there is also a growing body of evidence in India. Low-income households face an order of magnitude higher mortality risks. The World Health Organization (WHO) observes that although all populations are affected by air pollution, the distribution of burden of consequent ill-health is inequitable. The poor and disempowered and those living near roads or industrial sites are often exposed to high level of air pollution, especially in cities.[2]

The review shows that the informal settlements are located largely in marginalized areas around the urban periphery and also in close proximity to pollution sources

like industries, waste dumps, heavily trafficked highways etc. A 2022 World Bank study found that about one in ten people exposed to unsafe levels of air pollution live in extreme poverty. This increases severe health risks compared to higher income households.[3] This is a matter of serious concern, given the burgeoning population in informal settlements with growing urbanization.

High economic burden on low-income groups: The economic cost to the economy due to the air pollution-related disease burden is quite heavy in India. This is evident from the comprehensive estimate of disease burden attributable to air pollution and its economic impact in Indian states as published in the Lancet Planetary Health journal in 2019.[4] However, the impact is disproportionate on lower-income groups. This disproportionate exposure also increases 'out-of-pocket' expenses related to health in poorer households. Such costs, especially those associated with air pollution-related non-communicable diseases, can be catastrophic and push already vulnerable households further below the poverty line.

Low-income groups are also more occupationally exposed to outdoor air pollution: Most exposed are those who have to work outdoors or in close proximity to specific pollution-generating industrial processes. There is now a growing body of evidence that shows how informal-sector workers and outdoor workers, including waste pickers, municipal sweepers, security guards, construction workers and vendors, among others, are at serious health risk.

Poor and informal sector workers are victim of air pollution control measures and not-in-my-backyard syndrome: In several cities of India, air pollution measures have begun to gather momentum. These include targeted fleet renewal, clean fuel substitution, removal of para transit from city centres, relocation of polluting industries, setting up of waste-to-energy plants for remediation of waste close to habitation, temporary ban on construction and truck movement and more.

While the objective is to reduce emissions and clean up the ambient air, which is needed, these mitigation measures are not co-joined with the environmental justice principles and indicators to reduce adverse impacts of these measures on vulnerable groups. These measures, sometime drastic in nature, lead to job losses and livelihood disruptions. Relocation policies often shift polluting industries to areas with weaker enforcement, which further increases exposure risks for these communities. This further adds to their economic distress.

The bigger worry is 'middle-class environmentalism' in cities that are obsessed with the 'not-in-my-backyard' syndrome and push problems to urban peripheries

or ignore low-income neighbourhoods instead of catalysing systemic solutions. This tendency also brings in biases in mitigation measures that may disrupt the lives and livelihoods more. For instance, in Delhi, it is easier to stop trucks and construction than impose restrictions on cars and create space for buses during pollution episodes during winter. Such gentrification of air pollution solutions may impede rolling out of more holistic solutions. Some solutions may even lock in funds that do not equitably address the exposure risk of all, including vulnerable communities. The clean-up action has to become more inclusive, otherwise vulnerable groups that are often the majority may lack the power to negotiate solutions that will reduce their risks.

Structural inequality and air pollution: Global experience and the environmental justice policies are increasingly pointing towards the inequity due to inherent social and economic backwardness and social structures that either cause or aggravates the already existing disparity. Integrating some of these indicators may help to improve investment patterns to maximize welfare health gains by targeting the most vulnerable and targeted communities.

Judicial interventions and environmental justice: India may not have specific environmental justice laws like those enacted in the US or other countries, but there are legal instruments with legal provisions, policies and a series of judicial decisions that have taken on board the environmental justice principles and protection of environmental rights.

The public interest litigation related to air pollution has consistently upheld and aimed at ensuring environmental protection and the right to life. These include Article 48A, Article 21 and Article 51A(g) of the Indian Constitution.[5] Article 21 provides the right to life and personal liberty, which courts have construed to include the right to a clean and healthy environment. This approach has resulted in numerous historic decisions in which courts intervened to protect the environment and promote environmental justice. Article 48A requires the protection and improvement of the environment. This article is a directive concept of state policy that requires the state to work to maintain and improve the environment, as well as to safeguard forests and wildlife. Article 51A(g) highlights citizens' roles in environmental conservation and sustainable development, and each citizen is responsible for contributing to the protection and enhancement of the environment, supporting environmental justice at the grassroots level. Together, these constitutional provisions create a framework for environmental governance in India and can be leveraged to achieve environmental justice by balancing environmental conservation with developmental needs while safeguarding the rights of citizens.

The legislative process for the vulnerable: There are environmental legislations that outline the role of the executive like the Environment (Protection) Act, 1986, and the Air (Prevention and Control of Pollution) Act, 1981, which have a few provisions to reduce air pollution exposure of the inequitably impacted population.

These have provided for public participation provisions, compliance monitoring and legal remedies that contribute to ensuring environmental justice indirectly by enabling pollution-exposure assessment and participation of the vulnerable population and penalizing violators.

However, due to a lack of proper guidelines and mandates, the application of these provisions, concerning justice principles, is left at the discretion of the enforcer and the polluters.

Under the 'polluter pays' principle, the offending industry might just find paying the fine levied more economically reasonable than mitigating the emissions. This adds to the burden of pollution exposure of the socioeconomically marginalized community.

On the other hand, India's Environmental Impact Assessment (EIA) process does not explicitly include provisions labelled as 'environmental justice'. However, the EIA notification issued by the Ministry of Environment, Forest and Climate Change (MoEFCC) outlines several mechanisms that indirectly contribute to promoting environmental justice. These seek that the interests of affected communities are adequately addressed while granting environmental clearance. If used and amended correctly, the EIA can become one of the levers for promoting environmental justice.

Moreover, public hearings and consultations conducted to provide affected communities with an opportunity to express their concerns, opinions and grievances regarding the proposed project is also a related mechanism. This, however, does not currently work efficiently and effectively as the communities are not adequately empowered or informed to participate effectively. The data generation on impact of the proposed project are not well understood at the community level. Relaxation on public consultation and data accessibility undermine the potential of EIA to enable environment justice.

Reinventing the National Clean Air Programme: The National Clean Air Programme (NCAP) has been reformed incrementally and is expected to be further redefined in the next phase. This reformation is an opportunity to integrate the inclusive approach within the environmental justice framework.

NCAP requires identification of pollution hotspots and prioritization of actions in areas with high levels of air pollution, including urban areas with dense populations and industrial zones. Though this provision within NCAP does not directly hint at environmental justice, it indirectly aims at alleviating the disproportionate exposure faced by communities in the pollution hotspots. NCAP also emphasizes the importance of inclusive stakeholder engagement, including participation from affected communities, civil society organizations and local authorities. This participatory approach can be leveraged to address the concerns and perspectives of marginalized communities if an explicit provision can be included in the planning and implementation of air quality improvement measures.

NCAP includes provisions for conducting health impact assessments to evaluate the adverse health effects of air pollution on certain vulnerable populations, including children, the elderly, and individuals with pre-existing health conditions. Moreover, NCAP emphasizes the importance of robust air quality monitoring and reporting systems to track progress towards air quality-improvement goals. By providing transparent and accessible air-quality data, NCAP enables communities to hold authorities accountable for addressing air pollution and ensuring environmental justice. The NCAP programme also includes initiatives aimed at building the capacity of local authorities and communities to address air pollution effectively. This includes raising awareness about the health impacts of air pollution, providing training on air quality monitoring and management, and empowering communities to take action to improve local air quality.

Global learning curve

The environmental justice movement has taken a more definitive shape in the US, and has shaped and influenced the air-quality laws and policies quite significantly. There are important takeaways for policy and rule-making from this experience.

Grassroots movements catalysed legal reforms: The environmental justice movement in the US has its genesis in the grassroots movements stemming from protests against the inequity of environmental protection primarily in communities dominated by people of colour during the late 1960s. This drew attention to the disproportionately high health risk for these communities. Several of these movements were triggered by the unfairly located landfill sites for waste dumping – close to these communities. Some of these centred on the iconic protest against the polychlorinated biphenyl (PCB) landfill in Warren County in North Carolina, and the selection of neighbourhoods of the coloured population for dumping of toxic waste.

This had triggered a spate of movements during the 1990s. Some of the impactful movements include West Harlem Environmental Action (WE ACT), which worked towards empowering local communities; Indigenous Environmental Network; Southwest Network for Environmental and Economic Justice (SNEEJ) that was formed in Albuquerque, New Mexico; Congressional Black Caucus, a coalition of academics, social scientists and political activists; and National Black Environmental Justice, among others. These movements raised their voices against the health disparity in disadvantaged communities.[6]

These movements led to the government agencies, including the US Environmental Protection Agency (EPA), to investigate the problem and generate evidence. One of the early assessments by the United States General Accounting Office (GAO) in 1987 found that three out of four hazardous landfills were located in communities where Black Americans constituted at least 26 per cent of the population, with low income levels.

These movements have led to a series of regulatory and legal reforms that enabled grassroots solutions. For instance, Warren County in North Carolina could eventually get federal support to remediate the PCB landfill.

Regulatory action on environmental justice

The regulatory action that followed to create the framework for environmental justice legislation in the USA are founded on three key pillars—Title VI of the Civil Rights Act of 1964, Executive Order 12898, and the California Assembly Bill 617 (AB 617). All these legal provisions have developed and evolved over time, fostered by emerging research showing inequitable air-pollution exposure borne by vulnerable and marginalized communities, grassroots-level activism led by these communities, and increasing community awareness.

Title VI of the Civil Rights Act of 1964 does not directly address air pollution and the corresponding environmental injustice, but it has laid a foundation by ensuring that inequitable exposure cannot be intentionally incorporated into federal activities. It legally prohibits federally funded activities from discriminating based on race, colour or national origin. If discrimination is alleged, individuals can file suit in the federal court or a complaint with the federal agency providing funds for the programme or activity in question. This provision gives marginalized communities a well-defined legal avenue to voice their concerns.

EO 12898, although not a statute or law, introduced the impact assessment of federal activities on marginalized communities into the federal decision-making

process. Provisions like the Public Participation Committee, Title VI of the Civil Rights Act Committee, and focus groups on marginalized communities have provided platforms for these communities to learn about the impacts of proposed federal activities and participate in their assessment.

While Title VI of the Civil Rights Act and EO 12898 emerged as pioneers in environmental justice legislation, California's AB 617 established a framework that allows marginalized communities to participate not just in assessments but also in the governance of air pollution action plans. The governance structure includes the California Air Resources Board, Local Air Districts, and Community Steering Committees, which consist of stakeholders from communities unfairly exposed to air pollution. The experiences in the USA and the evolution of its environmental justice legislation underscore the importance of involving marginalized communities in the governance of air pollution control actions and fund disbursements.

Evolution of regulatory tools

As the legal framework evolved and got stronger, enabling regulatory tools also evolved to operationalize the environmental justice programme.

In the EPA, the Environmental Equity Workgroup created the report *Environmental Equity: Reducing Risk for All Communities* that eventually led to the establishment of the Office of Environmental Justice in 1994.[7] From 2001 onwards, new rules came that required statutory and regulatory authorities of the EPA to address justice issues, especially through the permit systems enshrined in a range of legislations, including the Clean Air Act; Clean Water Act; Safe Drinking Water Act; Resource Conservation and Recovery Act; and Marine Protection, Research, and Sanctuaries Act etc. [8]

This also helped to strengthen the science behind the air-quality-management strategies. The EPA adopted the Framework for Cumulative Risk Assessment to conduct and evaluate cumulative risk assessment.

The EPA began to develop the Environment Justice (EJ) Action Plan to identify measurable commitments for environmental justice priorities, 2004 onwards. Further, to enable the process, EPA developed toolkits for assessing potential of environmental injustice to prevent such occurrence. Subsequently, Plan EJ 2014 evolved to provide a roadmap to integrate environmental justice in all programmes, policies and activities.[9]

This led to the EJ 2020 Action Agenda that is a strategic plan to deepen environmental justice practice to improve health and environment of the 'over-burdened' communities and demonstrate progress in priority areas. [10]

Environment justice for co-benefit of climate and health benefits: The environment justice programme is expected to get stronger in the US post enactment of the Inflation Reduction Action (IRA) 2022, which is the single largest investment plan in the US history for energy transition to meet the goals of net zero economy by 2050. The IRA has created a dedicated Environment and Climate Justice Programme under the Clean Air Act, Section 138, and provides funding for environmental justice activities to benefit overburdened communities. In fact, the EPA has created an EPA-IRA Disadvantaged Communities Map to identify potential communities for implementation of this programme.[11]

There is a recognition of the fact that just action complements and enables the transition needed for clean air and climate. Some of the recent action taken to address local justice issues have supported energy transition measures. Some of these include cancellation of the Keystone XL tar sands pipeline in Nebraska that would have damaged farmlands, stoppage of fracked gas export terminals proposed in Texas; accelerated action to address methane emissions from the oil and gas industry; action to close and clean up oil drills in the neighbourhoods of California and also enable just transition for the workers. It is this complementarity of environment justice and environment action that is an important learning curve for all.

Other regions: The environmental justice movement is not so well structured in other regions of the world though a lot of this discourse and public action occur under the sustainability programmes.

In Western Europe, environment justice largely driven by the civil society is an academic discourse. Disadvantaged group-led movements are comparatively more limited than in the US. However, there are several instances of how the governments have integrated environmental justice indictors in planning and programmes.

Governmental interest is growing in Germany and France. It is evident that there are several public financed programmes that have integrated environmental justice indicators. For instance, in Berlin, environmental justice analysis has been carried out and integrated into spatial planning of the city. Otherwise, the Federal Environment Agency promotes such projects. Otherwise, in most cases, justice

issues are addressed through grassroots, academic and political discourse related to disproportionate health burden. The United Kingdom has also witnessed interest in inequality and environmental injustice from time to time. In European cities, the environment justice programme is largely taking shape through citizen science programmes based on sensor-based monitoring of the exposure patterns of targeted groups such as schoolchildren and parents. The BreatheLife campaign in London to get ultra-low emission zones expanded is another such example.

In the Global South, especially in the countries of Africa, the challenges are severalfold higher. While the vulnerability due to age, gender and socio-economic status is enormous, air-quality management approaches have not evolved adequately to address the range of these risks. Air-quality monitoring is extremely limited and the communities do not have adequate access to information and data to understand the risks and their exposures to local sources of pollution.

Increasingly, international support is flowing in to set up sensor-based monitoring systems to generate data. This is expected to lead to more refinement of policies and strategies.

The next steps

Need framework for operationalizing environmental justice approaches: The environmental legislations and regulations as well as judicial interventions in air-pollution-related public-interest litigation have already laid down the foundation for just action to address the special risks to disadvantaged communities. However, specific policies, programmes and schemes despite taking on board the inclusive and equity principles do not get translated into specific operational framework for explicit implementation strategies.

Simultaneously, the Ministry of Environment, Forest, and Climate Change (MoEFCC) has adopted a framework for framing climate action plans in states. This framework includes livelihood impacts assessment, adaptation measures for vulnerable communities, and provisions for skill development to minimize livelihood disruptions. For clean air action, this framework needs to be sufficiently developed.

Integrate equity framework with NCAP programme: The NCAP programme needs further reform to make more explicit provisions on integration of tools and indicators that align with vulnerability assessment of communities that are disproportionately exposed to air pollution and live in close proximity to polluting sources. It must also provide for integration of indicators of impact assessment

of infrastructure and industrial projects on communities and seek adequate safeguards and protection, and calibrate all mitigation measures to minimize livelihood disruption. NCAP has already provided sector-wise indicators to cities to report progress across key sectors of pollution. These need to include equity indicators as well.

Under the NCAP programme, cities are required to plan and report progress based on pre-defined indicators in different sectors of pollution. These indicators need to be re-oriented to account for differentiated impacts on different communities and mitigation. Even without this intended design, several strategies are included in clean air action plans that are delivering on environmental justice programme. Nearly all strategies identified for clean fuel transition in industry, transport, households, need to be calibrated based on equity action. The national programme Ujjwala, to expand community access to LPG to replace solid fuels for cooking, and complementary state government policies are some such examples.

Develop regulatory tools to address vulnerability and refine action plans accordingly: The current policy approaches have not adopted any clear definition of vulnerability and the vulnerable to address disproportionately higher impacts on these groups for remedial action. The current provisions are discretionary in nature. A well-defined criteria and tool for equity impacts need to be mainstreamed into programme design, impact assessments, clearances and approval, and permit schemes, among others. NCAP as well as sectoral policies need to include the full range of vulnerability, including children, women, the elderly across all socio-economic groups, as well as disadvantaged communities. It is necessary to integrate these indicators early on to ensure equitably distributed welfare gains from the clean air action and reduce the overall disease burden.

The air legislations need to include exposure management in addition to improvement in ambient air quality to strengthen community-based approaches: The current limitation of the air quality management approach is the singular focus on ambient air quality in the Air Act, 1981. There is no explicit focus on 'exposure' that determines the health risk faced by communities. The only policy recognition has come from the Ministry of Health and Family Welfare's 2015 *Report of the Steering Committee on Air Pollution and Health-Related Issues*, which states that it is more important to know how close people are to the pollution source, what are they inhaling, and how much time they are spending close to the pollution source than what occurs generally in the air that is influenced by climate and weather.[12] Ambient concentrations do not always well represent human exposures and cannot indicate exposure and health outcome.

Innovate and strengthen air-quality monitoring to map out exposure patterns of communities for remedial action: Even though the air quality monitoring network is expanding steadily across the country, there are still large data shadow areas in the several regions, including cities. It is often not possible to generate data on the exposure levels of the communities in the vicinity of pollution sources or in urban peripheries etc. In fact this is one of the lessons from the US where regulatory monitoring covers only 20 per cent of their counties. As a result, there is not enough information on exposure patterns of a large number of communities.

Therefore, in India as well, multidimensional monitoring is needed to get indicative data for dispersed polluted industrial zones, areas of power generation, congestion hotspots, highway traffic, waste dumpsites and waste-to-energy plants, slums and squatter settlements, unauthorized colonies outside the municipal limits, and sensitive areas including schools, hospitals and old-age homes, among others.

As it is very expensive to expand regulatory monitors so widely, it is necessary to leverage satellite data and sensor network to generate the targeted data on exposure patterns to refine the action strategies. The Central Pollution Control Board has supported initiatives on satellite-based air-quality monitoring. It has also stated in a 2022 directive that sensor-based monitoring can be applied to assess local exposures in pollution hotspots but not for regulatory compliance. Civil society groups and academia have begun to assess air quality based on satellite data and sensor-based networks. This needs to be planned better from the perspective of community exposure mapping.

Strengthen hyper local hotspot action along with city/region-wide systemic changes under NCAP to address vulnerable groups: Under the NCAP programme the cities designated as non-attainment have been mandated to identify and implement hotspot action plan to address local pollution. But there is no policy to combine the pattern of exposures of the local communities as a criteria to define hotspot action. These hotspots include industrial areas, high traffic areas, highways, densely populated residential neighbourhoods, and low-income neighbourhoods. While mapping the pollution sources, which include road dust, construction sites, traffic congestion, and open burning of waste etc., indicates the nature of exposure of the local communities, the nature of their vulnerability, coping capacity and the expected local benefits are not included. Communities living near highly toxic landfills are often not included in these hotspot action plans. This will require supportive surveys to refine action. Moreover, several sources such as traffic congestion cannot be solved only with local traffic engineering solutions. They require more systemic action for real impacts.

Sectoral strategies need to account for the impact on vulnerable communities: Not only exposure and disproportionate health risk to the vulnerable communities need to be assessed; equally important to assess is the impact of sectoral policy measures for pollution control on vulnerable communities with very weak coping capacity. The sectoral action designed for reducing overall air pollution are also linked with jobs and livelihoods of the vulnerable communities. Higher economic cost of regulatory compliance or relocation of polluting activities/industries can directly impact the earning and jobs and cause displacement. Such impacts will have to be accounted for and safeguards need to be built in the policy measures.

In the industrial sector, air-pollution-control measures require effective emissions control systems, clean fuels, siting policy to keep them away from the habitat, and strong compliance framework. There are pollution-control strategies for critically polluted areas. Even siting policies have been adopted for industrial locations. These need to be planned through the prism of impacts on communities that determine the health and welfare risks.

Moreover, during pollution episodes in winter, non-compliant industries are shut down. Most of these are small and medium industries (MSMEs) that employ vulnerable groups, including informal workers. Stronger compliance requirements, transition to clean fuels and technologies and any relocation can impact the jobs and livelihoods in these units. Air-pollution-control policies need to integrate the safeguards and several enablers to support innovative approaches to minimize dislocation.

Already small step are being taken towards cluster development approaches to allow development of common infrastructure for MSMEs. Sharing of assets such as common boilers equipped with emission-control systems and access to clean and affordable fuels are being developed in several states to reduce the burden of compliance on each unit and enhance productivity and competitiveness of the industry. Similarly, through the aggregation model, innovation, skill building and market-access strategies are being facilitated.

On the other hand, economic instruments such as interest subvention, subsidies and tax incentives can be designed to reduce the cost of finance and transition. Environmental safeguards can be further scaled up and supported to improve the occupational health and safety of the workers. The overall efforts to reduce pollution in MSME clusters can also reduce environmental risks for the communities living in close proximity.

Integrate equity benchmarks in infrastructure projects for pollution control: Multisector clean air action requires infrastructure development to enable sustainable choices for the larger population. But the planning and design of the new infrastructure or urban renewal may not have adequate safeguards to protect vulnerable communities. This is evident in the infrastructure plans in the transport sector. Currently, all clean air action plans have included affordable zero-emission travel modes, including walking and cycling. These are the modes of the urban poor that are also part of the solution to air pollution. But this needs to be mainstreamed as a mode of choice for higher income groups. But the infrastructure projects to enable mass-scale walking and cycling are often neglected in the planning and execution of clean air action plans.

Similarly, several steps are being taken to scale up formal and modern public transport systems like metro and modern bus systems to clean air and climate action. However, public transport services are not being planned and deployed equitably and affordably. A 2018 study by CSE found that globally, spending more than 10-15 per cent of household income on transportation is considered unaffordable. The lowest 20 per cent of households typically spend no more than 10 per cent of their income on transport. Nearly one-third of Delhi's population—34 per cent—is excluded from basic non-ac bus services, highlighting a significant gap in access to affordable public transportation.[13] Higher spending on transport leads to lower spending on housing, health and education, and hampers inclusive growth. However, several state governments do come up with policies to keep bus fares free for targeted groups like women. But there is no strategy to develop a sustainable financing model—a funding strategy for viability gas funding, tax reforms, revenue generation from other sources, etc. at the state level. Innovative strategies for the long term are needed for affordability and sustainability of the public transport system.

On other hand, development and modernization of the public transport infrastructure—metro, bus rapid transit systems etc.—can also push the poor out of the city and disrupt their livelihood, increase travel distances and costs of living. An early study by the Transportation Research & Injury Prevention Programme (TRIPP) found that the Delhi Metro had displaced slums. For the majority of relocated households, cycling and bus distances had increased by several kilometres as had the journey time.[14] Similarly, the average distance to services and number of trips had also increased. This had led to a decline in the share of walking and cycling for the community.[15] Yet another study by the Ahmedabad-based Centre

for Environment Planning & Technology (CEPT) shows that the share of transport cost in the household budget increased significantly for the bottom 50 per cent of the population, and that on education and health had stagnated. The BRT in Ahmedabad had displaced nearly 2,000 vendors.[16]

This further aggravates the structural inequity that weakens the coping capacity of the communities. Pro-poor mobility and housing need to be aligned with air-pollution control measures to allow diverse livelihood choices and make the labour market efficient.

Several transportation policies have taken shape that if implemented properly can address inclusive planning. For instance, the Transit Oriented Development Policy requires compact urban form near transit nodes that includes mixed use and mixed income development with improved accessibility. Institutional measures are needed for efficient delivery. National and state-level policies need to be sensitized for pro-poor planning

Waste management to de-risk communities: Waste management requires to address inequalities in exposures of different communities. Currently, the 'not-in-my-backyard' syndrome is hampering spatial planning for decentralized waste management in neighbourhoods as the higher income groups tend to push such activities to back alleys of cities. At the same time, cities desperate to dispose of their waste are indiscriminately setting up waste-to-energy plants in densely populated neighbourhoods and also the neighbourhoods of vulnerable communities. While safe siting policies are being disregarded, the advanced level of emissions control systems and compliance required in such plants are also not addressed adequately.

However, robust and well-funded waste management policies and programmes like the national Swachh Bharat Sarvekshan are in place to mandate the cities to achieve 100 per cent waste collection, segregation, material recovery, diversion of fresh waste from dump sites and remediation of at least 80 per cent of the legacy waste. While this has created conditions for reduced waste-related risks, overall the programme is still not nuanced enough to ensure that specially exposed groups, especially those communities that live on the marginal lands close to the dump sites are addressed. Therefore, evolving clean air action plans need to address the disproportionate distribution of inequities in population and further fine tune the interventions.

Generate data on local sources of pollution and exposure risks to increase community awareness and participation: Along with the identification of the vulnerable communities that disproportionately bear air pollution exposure, an understanding of what causes this disparity is required to devise an effective legal and implementation framework. All the regulations related to environment impact assessment and public participation requirements for meaningful action need to be leveraged.

1
EQUITY IMPACTS OF AIR POLLUTION IN INDIA

HIGHPOINTS

Vulnerability varies by age, gender, socio-economic status, and proximity to pollution, disproportionately affecting disadvantaged groups.

While the impact of air pollution on vulnerable groups is disproportionately high, the mitigation efforts – without adequate safeguards - may also hurt the livelihood of the vulnerable groups.

Monetary burden of health impacts associated with air pollution can lead to very high out-of-pocket expenses for a large group of vulnerable residents.

There is mounting evidence from several studies in different regions indicating disproportionate impacts of air pollution on vulnerable groups. There is no one absolute definition of vulnerable population. Several attributes are considered to define vulnerability and susceptibility to air-pollution-related risks. These include age, gender, socio-economic inequalities, nutritional status, occupational exposures and geographical location that determines proximity of the communities to pollution sources.

It is now quite widely understood that children, the elderly and women, especially pregnant women across all socio-economic groups, and socially disadvantaged communities are disproportionately impacted by air pollution. It is necessary to understand the nature of these widely different risks.

1.1 Children and air pollution

Globally, combined exposure to outdoor and household particulate matter pollution is estimated to have contributed to nearly 500,000 infant deaths in their first month of life in 2019. Around 116,000—or 23 per cent—of these newborn were in India, according to the recent estimates in the *State of Global Air, 2020* report.[1] This means one of every fourth newborn deaths due to air pollution was in India. In fact, country-level analysis of the death burden due to air pollution shows that a newborn dies in the country from health concerns associated with air pollution once every five minutes.

There are strong evidences to show that children and foetuses are vulnerable to toxic air. This toxic journey starts from the womb. When an expectant mother is exposed to polluted air during pregnancy, the foetus is at serious risk. The risk manifests itself in the massive disease burden for infants, children and adolescents, which lasts a lifetime. India has one of the highest tally of child deaths due to air pollution. The problem has reached scary proportions in the Global South, with India bearing the infamy of accounting for a quarter of the global infant deaths—within a month of birth. Mounting local and global evidence and well-decoded science define the biological pathways through which pollutants enter bodies and mutate organs. These estimates consider not just lower-respiratory infections affecting children but also a much broader set of health impacts.[2, 3] And children of poorer households are more at risk. Foetuses exposed to toxins in the womb may have lower chances of survival.

Exposure to toxins also predisposes foetuses to a range of diseases later in life, including endocrine and metabolic disorders and diabetes.[4] If air pollution affects the mother's respiratory health, oxygen and nutrient delivery to the foetus can be

reduced. Impaired lung development in-utero increases the risk of airway diseases. Scientists explain that particulate matter can cause maternal inflammatory response, reduce maternal immunity and increase the risk of infection and poor neurological development.[5,6,7] Exposure to toxins also leads to stillbirth, preterm birth and low birthweight.[8] Pre-term babies or babies born born with low weight are more vulnerable and cannot cope with the risk of lower respiratory infections, diarrhoeal diseases, brain damage and inflammation, blood disorders and jaundice. In children under the age of five years, exposures to polluted air pose grievous risks. It affects brain and neurological development, lung function and can cause obesity. Neurological disorders include attention deficit hyperactivity, lower intelligence and impaired neurological development.[9,10,11,12]

Even at a lower level of exposure children can develop lasting deficits in lung function, making them vulnerable to chronic lung disease in adulthood, affecting their quality of life. Poor understanding of this evidence breeds policy complacency and scepticism. Powerful evidence is also mounting on infant deaths, acute respiratory infection, stunting, childhood anaemia, allergic rhinitis and neuro-developmental outcomes. Cohort groups of mothers and babies have been tracked to find link between exposure during pregnancy and low birthweight in households that use solid fuels for cooking. Air pollution and its impacts on children are gravest violations of their right to a liveable and viable future.

According to a review conducted by the Collaboration for Air Pollution and Health Effect Research, India (Capher India), a national research network focused on air pollution and health effects steered by All India Institute of Medical Science (AIIMS), New Delhi, and the Indian Institute of Technology (IIT) Delhi, air pollution is the third leading risk factor for deaths in under-five children in the country. For children under the age of 14 years, it is the second leading risk factor for deaths.[13] The policy brief, which reviewed key Indian studies on the issue, estimated that since 2010, Delhi, Punjab and Haryana have seen the highest percentage of deaths in under-five children related to outdoor $PM_{2.5}$ exposures.

Clean air action is about inter-generational equity. Evidence is stark on infant deaths during the first month of life due to lower respiratory infections, low birth weight and preterm births affected by air pollution. Foetal exposure to pollutants is on the rise, as many harmful substances can easily pass through the placenta. Children are especially at risk because their respiratory systems are still developing; they breathe at twice the rate of adults, inhaling more air for their body size. Furthermore, their immature immune systems hinder their ability to cope with these exposures.[14]

1.2 Women and indoor air pollution

Several epidemiological studies are available in India that bear out special vulnerability of poor and marginalized women to household air pollution. This is one of the direct manifestations of poverty and lack of access to clean cooking energy. The first ever 'mother–child' cohort study was carried out by Kalpana Balakrishnan and her team of Sri Ram Medical College, Chennai. [15] They followed the cohort over time to investigate the link between exposure to $PM_{2.5}$ during pregnancy and low birthweight in an integrated rural-urban setting. This shows that a 10 $\mu g/m^3$ increase in exposure to $PM_{2.5}$ during pregnancy can decrease birthweight by 4 g, lead to a 2 per cent increase in the prevalence of low birth weight and cause a 70 g decrease in birthweight in households using solid fuels.[16]

According to the *State of Global Air, 2019* report,[17] India has reduced its proportion of households cooking with solid fuels from 76 per cent in 2005 to 60 per cent in 2017 due to improved access to liquefied petroleum gas. Yet solid fuel use remains high among the lower income groups. This still accounts for about two-thirds of the $PM_{2.5}$-related neonatal disease burden.

India also has a considerable gender-based air pollution exposure disparity. Due to unequal access to basic social goods, mortality is worsened when women have a lower socio-economic status. Moreover, women from the lower income class use traditional indoor stoves for cooking and heating with very poor ventilation, especially in urban areas. These are fueled by biomass and produce carbon monoxide, hydrocarbons and particulate matter and account for nearly 24 per cent of ambient air pollution from $PM_{2.5}$.

These women are disproportionately exposed to indoor air pollution and due to their pre-existing poor nourishment, face greater threat to their respiratory, cardiovascular and reproductive health.

1.3 The elderly and air pollution

It is now widely understood that older people are more susceptible to environmental risk factors because with age they have more underlying health conditions, including hypertension, diabetes, heart disease and slower metabolic rates. In fact, with age, air pollution can further aggravate heart disease, stroke and lung diseases, including chronic obstructive pulmonary disease and asthma and diabetes. The elderly are also more vulnerable to weakened immunity, neurological disorders including Parkinson's disease and Alzheimer's, and a range of compromised mental health problems. These require increased healthcare, emergency hospital admission, and increased cost of medication.

Ageing also means long-term and lifetime exposures to air pollution, with a range of health outcomes. Global evidence indicates that countries with large and ageing population have higher level of deaths and illness due to air pollution. India is moving in that direction of demographic transition. The combination of a very large population, ageing population and socio-economic disadvantages make the risk even more daunting.

1.4. Low-income groups and air pollution

The disproportionate impact of health burden on the poor is significantly more pronounced due to their weak health status, nutritional deficiency, weak coping capacity and high exposure levels. Even though evidence on health impact on low-income groups have begun to emerge, this has not been well investigated or integrated in policies.

There is a sprinkling of studies in India and these definitely point towards the special vulnerability of the low-income groups and the associated health inequity.

A 2021 Yale University study found that the mortality risk from indirect sources falls disproportionately on lower-income households in India. This suggests that industry-wide pollution controls can reduce inequity in the impacts of ambient air pollution. However, as low-income households face an order of magnitude higher mortality risks from indoor air pollution, clean cooking fuels remain the most effective way to reduce the number of premature deaths from air pollution in India.[18]

A 2023 global study, *Global Air Pollution Exposure and Poverty,* published in Nature Sustainability found that about 716 million of the world's lowest income people (living on less than US S1.90 per day) live in areas with unsafe levels of air pollution. Air pollution levels are particularly high in lower-middle-income countries, where polluting industries and technologies dominate.[19] This study shows that high-income Indian households contribute maximum to the outdoor air pollution due to emissions from manufacturing, transport and products they consume. But low-income households are nine times more vulnerable to premature deaths than the high income counterparts.

A 2022 World Bank study reiterates that about one in ten people exposed to unsafe levels of air pollution live in extreme poverty. For the extreme poor, the air pollution level means increased severe health risks compared to higher income households. The effect of air pollution is aggravated by the poverty and inadequate access to health care.[20]

A very serious concern that has been indicated in a few studies is the cancer risk among the marginalized. The end point of all toxic risk is cancer. A very early survey conducted by the Department of Preventive Oncology, Tata Memorial Centre, Mumbai about two decades ago had found high incidence of cancer in the slum areas and air pollution was envisaged as one the probable contributory factors.[21] The implication of this for the poor is ominous. In fact, in the early years the Harvard Centre for Cancer Prevention, USA, found a larger occurrence of lung cancer among the poor. The American Cancer Society had issued a report to the nation that highlighted the key issues related to the cancer risk among the poor, including the magnitude of suffering, high healthcare cost, access to healthcare and health insurance, and lack of awareness.

With a very large urban population and dominance of urban poor, this can emerge as a serious public health agenda. The urban landscape in India is dominated by the informal settlements where the marginalized communities and poor live. As per one CSE estimate, at least one in every six urban Indians resides in informal settlements. Moreover, six in 10 persons in informal settlements live in close proximity to unsanitary drains and every sixth persons lacks access to treated water as per the assessment based on Census 2011.[22] These bring out the compromised coping capacity during illness.

Further review has found close proximity of informal settlements to pollution hotspots prone to waste dumpsites, open burning, traffic choke points, small-scale construction sites and informal industrial units. In fact, some indicative vulnerability mapping by an ongoing CSE study in a few cities such as Jaipur and Kolkata found that the overlaps between pollution hotspots, heat hotspots, flood hotspots and location of the informal settlements.

This is a serious matter, given the burgeoning population in informal settlements with growing urbanization. It is estimated that while urban population increased by 32 per cent, population in informal settlements increased by 131 per cent during 2001–11. About 11 out of 47 cities with more than million population have on an average as much as 30 per cent of the population living in informal settlements. This population may double in the coming years.

The enormity of this problem also emerges from the fact that most of the informal settlements are located and are growing in marginalized areas around the urban periphery that are least serviced and remain mostly outside the orbit of municipal services, transport connectivity and healthcare services. For a long time, even the housing policies focussed on relocation and resettlement of the informal settlements

from the city centre, which has further compounded the disadvantages. Recent policies on public housing schemes are now also focusing on in-situ development with amenities inside the cities.

The World Health Organization (WHO) observes that although all populations are affected by air pollution, the distribution of burden of consequent ill-health is inequitable. The poor and disempowered and those living near roads or industrial sites are often exposed to high levels of air pollution and this is worsening in cities.[23]

Economic burden on low income groups due to air pollution

Overall economic cost to the economy due to the air-pollution-related disease burden is fairly high in India. In fact, a comprehensive estimate of disease burden attributable to air pollution and its economic impact in states of India in 2019 published in the *Lancet Planetary Health* bears this out.[24] This brings out the economic impact of health loss due to air pollution in Indian states. The economic loss due to loss of productivity, deaths and illness from air pollution was estimated to be 1.4 per cent of the GDP in 2019, equivalent to Rs 2,60,000 crores (US $36.8 billion). The economic loss as a percentage of the state GDP is higher for the northern and central Indian states, with the highest for Uttar Pradesh (2.2 per cent) and Bihar (2 per cent of GDP).

The impact is disproportionate on lower income groups. A study conducted in Mumbai shows that the estimated monetary burden of health impacts associated with air pollution in Mumbai includes out-of-pocket expenses of city residents. These expenses form a sizable proportion of the annual income of individuals, particularly those belonging to poor households. This makes healthcare unaffordable for poor households.[25] Similar evidences have emerged in other cities as well.

What is more worrying is that a great part of the health impact related to air pollution includes the non-communicable disease (NCDs) burden. This has enormous cost implications in terms of healthcare. It increases out-of-pocket expenses as well as catastrophic health expenditure in NDC- affected households. A study published in the journal *PLOS one* in 2021 shows that the mean expenditure by NCD-affected households in public hospitals is more than twice as compared to non-NCD households. The study found a significant relationship between catastrophic health expenditure and residence, caste, religion, household size, and economic status of households.[26]

Overall, it is evident that when out-of-pocket expense related to health increases in a household, poor households try to protect their expenditure on food, but reduce

the expenditure on education, fuels, and other consumable items.[27] This may get more skewed with increased toxic risk from air pollution.

1.5. Outdoor pollution sources, locational disadvantages and vulnerable groups

Most exposed are those who have to work outdoors or in close proximity to specific pollution-generating activities and industrial processes. This is yet another dimension of vulnerability. Evidence has emerged on the vulnerability of informal workers to outdoor air pollution and extreme weather events. International Labour Organisation has always highlighted the risk of occupationally exposed groups to a range of environmental risk factors. This matter has become the focus of new investigations in India as well.

A 2022 study by the Chintan Environmental Research and Action Group[28] assessed the relationship between the respiratory illness of low-income, outdoor workers, including waste pickers, municipal sweepers and security guards. They investigated the socio-demographic characteristics, lifestyle, knowledge on air pollution and health issues experienced by workers. They also examined the respiratory health in terms of pulmonary function and assessed the relationship between the incidence of respiratory illness and socio-demographic and working environment factors.

This study was conducted at selected locations in Delhi.[29] Waste pickers in Bhalaswa landfill, Ghazipur landfill, Mahipalpur and Vivekanand Camp and municipal sweepers of South Delhi Municipal Corporation (SDMC), New Delhi Municipal Council (NDMC) and East Delhi Municipal Corporation (EDMC), New Delhi Municipal Corporation (NDMC) and Khan Market were studied. The study specifically reviewed security guards in Safdarjang Hospital, CAG building, ITO, Reliance Building, Chandni Chowk etc. For comparison, it considered a control group in several neighbourhoods of central Delhi, and carried out pulmonary function or respiratory function and spirometer tests among these groups.

The study showed that among waste pickers, air-pollution-related illness dominated at 86 per cent. The lung function among waste pickers was significantly lower compared to other groups. The severity of obstruction and restriction impairments for waste pickers can be as high as 57 per cent. Female waste pickers are 3.9 times more likely to have respiratory illness.

Among the municipal sweepers, 97 per cent of the participants were exposed to air pollution during their jobs while 37 per cent did not have enough protection from the cold during winter. Approximately 23 per cent reported major illnesses such

as fever, headache and blood pressure in the preceding one year. Only 11 per cent, however, visited hospitals for treatment. Female sweepers were approximately six times more likely to have respiratory illnesses.

Among the security guards, about 45 per cent faced health issues such as cough, sore throat, burning sensation in eyes, headache etc. About 86 per cent had abnormal lung function.

Another study published in *Environmental Science and Pollution Research Journal* in 2022, which focussed on auto-rickshaw drivers, street vendors and sweepers, found that most of those surveyed complained of headaches/giddiness, nausea, and muscular cramps. Auto-rickshaw drivers reported the highest prevalence of ophthalmic symptoms, including eye redness and eye irritation due to exposure to vehicular pollution. Vendors reported a higher prevalence of headaches and eye redness due to increased exposure to vehicular emissions. The majority of auto-rickshaw drivers, vendors and sweepers believed that air quality was impacting their health. Most of them had restricted lung function.[30]

An earlier study by the National Chittaranjan Cancer Research Institute in Kolkata had generated evidence to show more pronounced evidence of biomarkers of air pollution exposure such as heightened level of alveolar macrophages in the sputum among the taxi drivers in Kolkata.[31]

Construction sites in cities can be a significant source of exposures. A review by CSE showed that key sources of dust in construction sites include sand, grit, conveyor system, truck movement, soil excavation, site clearance, material handling and storage, bulldozers, crane, crushers, piling, building demolition, and concrete batching.[32] Every stage of construction can be a source of toxic dust. This can exist as silica dust from sand, stone, rock, sandstone, brick, concrete and mortar that contains crystalline silica. Dust from masonry work, tunnelling, road milling and mixing of cement and concrete can affect workers. Mining dust from cutting and drilling can have adverse impacts. Other sources include stone crushing dust while making aggregates, stone polishing dust and wood dust. Demolition of old buildings have more lead and asbestos that are highly toxic. Serious health risks are associated with construction-waste-related particles, which cause lung cancer, silicosis, chronic obstructive pulmonary disease and asthma.[33]

In fact, a 2023 global study on exposures of construction workers in construction sites brings out the pattern of exposures in different phases of construction. For example, workers engaged in pit-bottom operations in building foundations; steel bar processing in the main structure; and plastering, masonry, and

putty workers engaged in installation and decoration are at the highest risk in construction sites.[34]

A survey carried out by the Help Delhi Breathe and Mahila Housing Trust in Delhi found that informal workers, especially those who live close to the landfill sites, face very high exposure. Unfavourable working conditions, harsh climatic conditions like extreme cold winter or heatwaves, unsafe work sites and inequity compound the problem. Informal workers who work in polluting industries or in construction sites face the challenge of job loss if clean air action is directed at the polluting activities and industries.

These snapshots of evidence help to establish a range of risks from outdoor air pollution, and locational disadvantage of where these communities live.

Adverse impact of air pollution control measures on marginalized groups

Public and policy responses to air pollution crisis as well as court directives have triggered a range of interventions in several cities, including Delhi, Kolkata, Mumbai and others to help achieve energy and technology transition in industry and transport, accelerate fleet renewal, relocate polluting industries and remediate waste, among others, to clean up the ambient air.

While these measures are needed to control air pollution, if implemented without considering mitigation measures to reduce adverse impacts on the vulnerable groups, including low-income groups, they can compound not only economic hardship but also make these groups more vulnerable to toxic risks.

This is evident from the way polluting industries have been relocated and shifted out of cities, para-transit vehicles like auto-rickshaws have been restricted from operating in city centres, and pollution emergency measures requiring temporary shutdown of industries, construction and truck operations during winter.

These measures destabilize and dislocate informal daily wage workers as they lose their earnings as a result of these interventions. Also relocation of industry erodes livelihood base as these are often done without any welfare safeguards for workers. Moreover, the polluting activities are shifted to areas that have weaker enforcement measures, which increases the local exposures further. Moreover, the problem compounds further when all polluting activities get pushed to where marginalized people live—the backyards of the cities.

A few studies have evaluated some of the pollution-control measures that have been implemented in Delhi from the equity perspective. The measures investigated include relocation of polluting industries and industrial zoning carried out to move industrial units from non-confirming areas to designated industrial estates. These were largely driven by location policies without adequate safeguards or proper rehabilitation policies and programmes. All hazardous industries were stopped from functioning in Delhi way back in the late 1990s. This triggered policy debate around how environmental security and livelihood security need to be balanced in mitigation policies.[35]

There are more illustrative cases. **I**n the mid-2000s, the Mumbai Metropolitan Region Development Authority (MMRDA) relocated numerous families from various slum areas of Mumbai to the neighborhoods of Mahul and Ambapada Industrial Zone to facilitate urban infrastructure projects. The families were placed in an area dominated by heavy industry—chemical factories, oil refineries and petrochemical storage units. Environmental assessments showed that pollutant levels in Mahul often exceed permissible limits. The air is heavy with volatile organic compounds, sulphur dioxide, nitrogen oxides and particulate matter. This increased the disease burden including respiratory diseases, skin conditions, and other health issues and also increased cancer risk.[36]

The National Green Tribunal issued an order mandating a comprehensive review and monitoring of the air quality in Mahul by Maharashtra Pollution Control Board (MPCB), and enforcing stringent emission controls on industrial units in the area.[37] The order also directed MPCB to take immediate measures to mitigate the health risks faced by residents, including relocating those willing to move to safer locations. The Bombay High Court, in parallel proceedings, echoed these concerns and directed the state government to expedite the relocation process for the affected families. The court highlighted the inadequacy of initial resettlement planning and underscored the need for urgent remedial action.

In Lavaj Khar, a case similar to Mahul, the residents were resettled in a polluted industrial zone as part of the Lavasa Lake City project. The new location was close to industrial areas, leading to significant air and water pollution issues. The community faced various health problems, including respiratory ailments and skin diseases, prompting legal and activist interventions.

At one level, public-health protection requires that exposure of the larger population to sources of toxic emissions be reduced. Simultaneously, it is also necessary to mitigate the risks faced by vulnerable population from certain larger welfare interventions.

As policies have not yet been able to find the balance between the two, this has triggered a serious concern around 'middle-class and elitist environmentalism'. It is believed that this exclusive focus is leading to more gentrification of air pollution solutions and urban spaces, marginalizing the needs of the disadvantaged and the poor in cities. As the neighbourhoods of the middle class are cleaned up, the vulnerable poor or slums are pushed to the polluted backyards of the cities. Or, several solutions lock in funds that do not equitably address the exposure risk of the vulnerable communities. The poor and the displaced do not find livelihoods and shelter in cities. It has also been pointed out by experts that the judicial interventions have compromised the negotiation ability of the affected workers as well.[38]

The clean-up act is seen more as a social privilege as inclusive indicators are not integrated to minimize the adverse and disproportionate impacts on the lower income and marginalized groups. This is considered ecological and social injustice.

1.6 Structural inequality and air pollution

The emerging evidence points towards inequity due to economic backwardness that is inherent social structure making it difficult for the vulnerable groups to negotiate solutions for themselves. This inequity can be associated with social caste structures.

There is a study that has mapped the air pollution exposure disparity in rural parts of India and found a strong correlation between the exposure distribution and socio-economic status.[39] Integrating some of these indicators may help to improve investment patterns to maximize welfare and health gains by targeting the most vulnerable and targeted communities. As already seen, there are evidences on location of polluting industries and power plants that are more heavily concentrated in poor, socially disadvantaged villages.[40]

One of the studies conducted in Saharanpur district of Uttar Pradesh with an urban and rural context,[41] shows that there are greater contribution-exposure gaps between socio-economic classes. Rural areas account for 68 per cent of annual premature deaths. Low-socioeconomic-status groups suffer 6 per cent, 7 per cent, 7 per cent and 26 per cent higher premature mortality from $PM_{2.5}$ exposure due to industries, domestic cooking fuel burning, open waste burning and transportation, respectively, compared to their contribution to air pollution. Most disability-adjusted life years (DALYs) in the research domain are found in worker groups with lower socio-economic status.

2

REGULATORY FRAMEWORK FOR INCLUSIVE CLEAN AIR ACTION IN INDIA

HIGHPOINTS

NCAP prioritizes pollution hotspots, indirectly addressing community risk, but requires explicit planning focus.

NCAP has provisions for conducting health impact assessments of adverse health effects of air pollution on vulnerable populations, including children, the elderly, and individuals with pre-existing health conditions. Take this forward.

NCAP's provision for stakeholder engagement offers opportunities to incorporate marginalized communities' concerns in air quality management. Thus, opportunity exists.

The National Clean Air Programme (NCAP) has been reformed incrementally and is expected to be further redefined in the coming years. This is an opportunity to integrate the inclusive approach within the environmental justice framework.

Even though there aren't specific environmental justice laws, there are various legal provisions, policies and judicial decisions that have underscored the environmental justice principles and protection of environmental rights.

In public interest litigation (PIL) cases on air pollution, the judiciary has upheld the Constitutional provisions aimed at ensuring environmental protection and the right to life. These include Article 48A, Article 21 and Article 51A(g) of the Indian Constitution.[1] Article 21 guarantees the right to life and personal liberty, which has been interpreted by courts to include the right to a clean and healthy environment. The judiciary has interpreted this article expansively to include the right to a clean and healthy environment as an integral part of the right to life. This interpretation has led to numerous landmark judgments where courts have intervened to protect the environment and ensure environmental justice. Through Article 21, citizens have the right to approach the courts to seek relief against environmental degradation or violations that threaten their right to a healthy environment.

Additionally, Article 48A mandates the protection and improvement of the environment. This article is a directive principle of state policy, which mandates that the State shall endeavour to protect and improve the environment and to safeguard forests and wildlife. It emphasizes the duty of the state to ensure environmental protection as part of its governance responsibilities. While directive principles are not enforceable by courts, they serve as guiding principles for the state in policymaking and legislation. Article 48A underscores the importance of environmental conservation and sustainable development in the national agenda.

While Articles 21 and 48A protect the environmental rights of the citizen, Article 51A(g) of the Indian Constitution outlines the fundamental duties of the citizen towards the environment. It states that every citizen of India must protect and improve the natural environment, including forests, lakes, rivers, and wildlife, and to have compassion for living creatures. Article 51A(g) emphasizes the role of citizens in environmental conservation and sustainable development and places a responsibility on every citizen to contribute to the protection and enhancement of the environment, thereby promoting environmental justice at the grassroots level. Together, these constitutional provisions create a framework for environmental

PUBLIC INTEREST LITIGATIONS PROTECTING COMMUNITY INTERESTS

Throughout the 1980s, the judiciary of India assumed a critical role in enforcing rights beyond the purview of statutory law yet within the constitutional mandate, notably through the advocacy of Public Interest Litigation (PIL). Public Interest Litigation (PIL) emerged in India as a mechanism to provide access to justice for marginalized and disadvantaged communities and to address systemic issues affecting the public interest.

The Supreme Court of India, through its judgments, liberalized the traditional rules of locus standi (standing to sue) to allow any person or organization acting in the public interest to approach the courts directly. This departure from the traditional adversarial litigation model enabled PIL to be filed by public-spirited individuals, social activists, and non-governmental organizations (NGOs) on behalf of marginalized or vulnerable groups who lacked the means to access justice.

The utilization of PIL in interpreting the constitutional provisions of Articles 48A, 51A (g), and 21 of the Indian Constitution has brought about a substantial shift in India's environmental landscape.

The following judgments illustrate how the Indian judiciary has utilized constitutional provisions such as Article 21, Article 48A, and Article 51A(g) to address air pollution and ensure environmental justice by issuing directives to control emissions, enforce pollution norms, and protect the right to a clean and healthy environment.

M.C. Mehta v. Union of India (1987): This case addressed the issue of air pollution in Delhi caused by industries emitting harmful gases. The Supreme Court, invoking Article 21, directed the closure of industries violating pollution norms and ordered the implementation of measures to improve air quality, emphasizing the right to a clean and healthy environment as part of the right to life. The court also directed the enforcement of emission standards for vehicles, the introduction of cleaner fuels, and the implementation of measures such as the conversion of public transport vehicles to compressed natural gas (CNG). These directives were based on Article 21 and the duty of the state under Article 48A to protect and improve the environment.

Delhi Rozi-Roti Adhikar Abhiyan v. Union of India & Ors. (2015): This PIL was filed by a coalition of civil society organizations representing marginalized communities, including informal workers and slum dwellers, in Delhi. The petition sought measures to address air pollution and its impact on the livelihoods and health of vulnerable populations, including access to clean cooking fuels and improved air quality monitoring in slum areas.

Virender Singh & Ors. v. Union of India & Ors. (2019): This PIL was filed in the Punjab and Haryana High Court by farmers and residents of rural areas affected by air pollution from stubble burning in Punjab and Haryana. The petition sought directions to government authorities to address air pollution caused by stubble burning and protect the health and livelihoods of marginalized agricultural communities.

governance in India. While Article 48A guides the state in formulating policies and laws related to environmental protection, Article 21 ensures that individuals have the right to a clean and healthy environment and can seek legal recourse in case of violations. Article 51A(g) reinforces the notion that environmental protection is not only the responsibility of the state but also the duty of every citizen. This combined approach helps in achieving environmental justice by balancing environmental conservation with developmental needs while safeguarding the rights of citizens.

2.1 Environmental legislations and equity framework

Apart from the constitutional provisions mentioned above, environmental legislations like the Environment (Protection) Act, 1986, and the Air (Prevention and Control of Pollution) Act, 1981 also have a few provisions within their framework to reduce air pollution exposure of the inequitably impacted population.

The Air (Prevention and Control of Pollution) Act, 1981, through its regulatory framework, pollution-control measures, public-participation provisions, compliance monitoring and legal remedies contributes to ensuring environmental justice indirectly by aiding pollution exposure assessment and participation of the vulnerable population and further enforcing the penalties on the violators.[2]

The Air Act has measures that can aid public participation in the formulation and implementation of pollution control measures. Section 21 of the Air Act, which empowers the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) to take measures for the prevention, control, and abatement of air pollution, indirectly provides avenues for public involvement. These boards often conduct public hearings, seek public comments on proposed regulations, and may involve the public in the monitoring and reporting of air quality data.

While the Air Act of 1981 does not have explicit provisions akin to modern environmental legislation that mandates public participation, the establishment of the boards (that typically include representatives from various stakeholders, including government agencies, industry, environmental organizations, and sometimes members of the public) and their functions create mechanisms through which public involvement can occur in matters related to air pollution control and management.

Along with having provisions for public participation, the Air Act also provides for legal remedies and penalties for non-compliance with pollution-control measures. It allows affected individuals and communities to seek recourse through courts in case of environmental violations. By providing avenues for legal redress, the Act empowers citizens to protect their right to a clean and healthy environment. Hence, even though the Air Act does not have any explicit environmental justice mandate, it has some provisions within its framework that follow the principles of environmental justice and can act as a policy lever to further the environmental justice legalese.

However, due to a lack of proper guidelines and mandates, the application of these provisions, concerning justice principles, is left to the discretion of the enforcer and the polluters.

Under the polluter pays principle, the offending industry might just find paying the fine levied more economically reasonable than mitigating the emissions. Such loopholes potentially add to the burden of the pollution exposure of the socioeconomically marginalized community due to their lack of either awareness or political clout to contest effectively.

Another similar Act that entails ensuring a clean environment for the people by empowering the central government to take measures to protect and improve the environment is the Environment (Protection) Act, 1986. Even though most of the provisions within the ambit of the Environment Act that resemble the principle of environmental justice are similar to that of the Air Act, the mandate for Environment Impact Assessment (EIA) is noteworthy.[3]

India's Environmental Impact Assessment (EIA) process for industries does not explicitly include provisions labelled as 'environmental justice'. However, the EIA notification issued by MoEFCC outlines several mechanisms that indirectly contribute to promoting environmental justice. These mechanisms aim to ensure that environmental concerns and the interests of affected communities are adequately addressed in the process of granting environmental clearance to industrial projects.

If used and amended correctly, EIA can become a lever for promoting environmental justice as it mandates assessing the impact of all the pollution-generating development projects like thermal power plants, mining etc. on the neighbouring environment and population as a part of the environment clearance procedure.

The state governments assess the environmental effects before project approval, often involving public consultation. Public hearings and consultations are conducted to provide affected communities with an opportunity to express their concerns, opinions and grievances regarding the proposed project. Along with a role in the overall decision-making process, EIA equips the stakeholders with comprehensive information on the environmental, social and economic impacts of proposed projects. This provision to include communities and stakeholders in decision-making gives them a medium to voice their concerns regarding potential project impacts, both environmental and socio-economic.

The environment impact checklist of EIA sometimes includes, socio-economic aspects, along with environmental aspects. In certain cases, the EIA notification requires the preparation of a Social Impact Assessment (SIA) report to assess

the potential social implications of industrial projects on local communities. It requires collecting data on whether and how a proposed project will change the neighbourhood demographic structure, the current social infrastructure around the project and the potential impacts on the local communities.

The SIA evaluates the socio-economic characteristics of affected communities, identifies potential impacts on livelihoods, access to resources and social infrastructure, and proposes measures to mitigate adverse effects to aid in addressing socio-economic inequalities caused or aggravated by proposed projects. If collected correctly and diligently, this information will help the vulnerable stakeholders make informed choices that weigh the long-term implications of development on both the environment and communities.

Moreover, with a wider view, the EIA legislation of 2006 has the potential to address environmental injustices by ensuring fair distribution of project burdens and benefits across society. It prompts decision-makers to consider potential disproportionate impacts on vulnerable or marginalized communities, thereby promoting equity in decision-making processes.

There have been ongoing debates and critiques regarding the effectiveness of the EIA process in ensuring genuine participation and protecting the rights of marginalized communities. While the flexibility of the 2006 legislature was a provision to integrate the new sciences and requirements, it seems to have been exploited to undermine the entire purpose of EIA.

The EIA 2006 Notification defined the sectors and projects that require to go through the process of public hearing or public consultation to acquire project approval and appraisal. It had outlined the entire procedure of both public hearing and public consultation.

Public consultation is a broader process of engagement with stakeholders throughout the EIA process, aiming to gather input and feedback on the proposed project. Public hearings, on the other hand, are specific events within the public consultation process where stakeholders have the opportunity to provide oral testimony and express their views on the project before a designated authority.

There were certain sectors, like the ones pertaining to ‘national defence’ that were exempt from public consultation. However, over the years the list of exempt sectors and industries has only increased. In July 2023, the Ministry issued a

notification exempting all the standalone re-rolling units or cold rolling units with valid Consent to Establish and Consent to Operate from the requirement of public consultation during its Terms of Reference (ToR) application provided the application is made within a year of the notification.[4]

In October 2021, the ministry issued an office memorandum permitting a 20 per cent increase in production for mining operations of minor minerals such as iron, manganese, bauxite and limestone, based solely on public consultation.[5]

Furthermore, the public hearing process for legacy mining projects granted environmental clearance under the 1994 EIA notification was further relaxed.[6] These projects are now only required to undergo public consultation rather than following the entire public hearing process outlined in the 2006 EIA notification.

Relaxation on public consultation and data accessibility will not only further undermine the potential of EIA to enable environmental justice but also obfuscate the basic principle behind EIA—protection of people and environment and a participatory justice that gives voice to the voiceless.

2.2. National Clean Air Programme and equity

The NCAP includes provisions aimed at addressing air pollution and its adverse impacts. It is broadly designed to improve the ambient air quality. However, as stated earlier, one of the requirements of the NCAP programme is the identification of pollution hotspots and prioritization of actions in areas with high levels of air pollution. Though this provision does not directly hint at environmental justice, this provision created the opportunity to alleviate the disproportionate exposure faced by communities in the pollution hotspots.

NCAP emphasizes the importance of inclusive stakeholder engagement, including participation from affected communities, civil society organizations and local authorities. This participatory approach can be leveraged to integrate the concerns and perspectives of marginalized communities in the planning and implementation of air quality improvement measures.

The NCAP programme also includes initiatives aimed at building the capacity of local authorities and communities to address air pollution effectively. This includes raising awareness about the health impacts of air pollution, providing training on air quality monitoring and management and empowering communities to take action to improve local air quality.

NCAP includes provisions for conducting health impact assessments to evaluate the adverse health effects of air pollution on vulnerable populations, including children, the elderly, and individuals with pre-existing health conditions.

Moreover, NCAP seeks robust air-quality monitoring and reporting systems to track progress towards air quality improvement goals by providing transparent and accessible air quality data.

The NCAP programme needs further reform to make more explicit provisions on integration of tools and indicators that align with vulnerability assessment of communities that are disproportionately exposed to air pollution and live in close proximity to polluting sources. It must also provide for integration of indicators of impact assessment of infrastructure and industrial projects on communities and seek adequate safeguards and protection, calibrate all mitigation measures to minimise livelihood disruption. Already NCAP has provided sector-wise indicators to cities to report progress across key sectors of pollution. These need to include equity indicators as well.

3
THE MISSING LINKS

HIGHPOINTS

Ambient air quality data and pollution source assessment do not fully capture the exposure and health risks for vulnerable groups.

Air quality management must integrate community-specific risks to better reflect disparities in exposure.

Hyper local hotspot action plans under NCAP need to carry out exposure mapping of vulnerable groups for community-focused actions.

3.1 Need framework for operationalizing environmental justice approaches

Even though there are Constitutional provisions that recognize the universal and fundamental rights to life, and there are environmental legislations with provisions to protect all environment and improve air quality, there is no clear mechanism and framework to identify and remedy the challenges and impacts that are unique to the specific communities and vulnerable groups.

The current policy approaches have not adopted a clear definition of vulnerability or the vulnerable. The policy also lacks a clear pathway of assessing disproportionately higher impacts on these groups to enable targeted remedial action. The strategy for implementation is left at the discretion of the policy and implementing agencies that has no clarity about the application of the criteria.

It is also evident globally that there is still quite a bit of ambiguity in defining vulnerable groups for policymaking and this can be subjective and discretionary. It is also limited by the research methods applied to assess the impacts. There is no cohesive definition yet and the vulnerability is largely understood in relation to the control groups assumed for comparison. In the Global North, such terms are broadly used to refer to the 'minority' or 'low income' or an ambiguous reference to 'disparate impact'. This makes data collection and classification challenging.

3.2 Air quality monitoring not yet oriented to capture community-specific exposure risk

Currently, the air-quality monitoring network is limited, and there are large data-shadow areas in regions and cities of India. As of October 2023, there are 931 manual stations under the National Ambient Air Quality Monitoring Programme; 516 are real-time Continuous Ambient Air Quality Monitoring (CAAQM) stations. Of these, 512 manual stations and 344 CAAQM stations are in National Clean Air Programme (NCAP) cities.

But there are a large tracts of land and population that are not covered by the monitoring network. While this is not a constraint to scale up clean air action across the regions, there is still inadequate understanding of the spatial profile of air quality impacts on vulnerable communities. This could be widely dispersed as polluted industrial zones and areas of power generation; congestion hotspots; highway traffic; waste dumpsites and waste-to-energy plants; slums and squatter settlements; unauthorized colonies outside the municipal governance; and sensitive areas, including schools, hospitals and old age homes, among others.

It is not cost effective to expand regulatory monitoring to cover all data-shadow areas and where most vulnerable communities live. It is necessary to adopt alternative monitoring methods including satellite- based monitoring and sensor-based monitoring for a multi-dimensional approach. The Central Pollution Control Board has permitted sensor-based monitoring for monitoring of pollution hotspots but not for regulatory compliance. Similarly, it is possible to do granular mapping of areas with the help of satellite data. It is necessary to provide air-quality data to communities to understand the risks and action.

3.3 Hyperlocal hotspot action under NCAP needs to be leveraged

Under the NCAP programme, the cities designated as non-attainment have been mandated to identify and implement hotspot action plan to address local pollution. These are currently defined based on dispersed pollution sources like waste burning, road dust, construction etc. But there is no policy to combine the pattern of exposures of the local communities as a criteria to define hotspot action. This approach needs to be redefined for local action and for protection of targeted communities close to the pollution sources.

To illustrate the point, about 13 hotspots—which subsequently increased to 18—were originally identified in Delhi. These include industrial areas like Okhla Phase 2, Dwarka, Ashok Vihar, Bawana, Narela, Mundka, Punjabi Bagh, Wazirpur, Rohini, Vivek Vihar, Jehangirpuri and Mayapuri; high-traffic nodes like Anand Vihar (including Mandoli), Shadipur, ITO; and residential and recreational areas including R.K. Puram, Mandir Marg, Nehru Nagar, Patparganj, Sonia Vihar, Dhyan Chand Stadium, and Moti Bagh.

The hotspot plans of these areas show mapping of sources like road dust, construction sites, traffic congestion and open burning of waste. But these plans have not indicated the nature of exposure of the local communities, nature of their vulnerability and coping capacity, or the expected local benefits from clean air action. In fact, due to data gaps, communities who live near highly toxic landfills do not usually get included in these plans. There is considerable scope of reframing the hotspot action to make it more community oriented.

However, some of the action taken in terms of controlling open burning of plastic waste in Mundka area in 2018 have the potential to reduce toxic exposure of the local workers and communities. It is also important to note that some exposures related to traffic congestion and waste burning may not be possible to address locally and may require city-wide systemic intervention.

3.4 Need to broaden the focus from ambient air quality to exposure risk

The current limitation of the air quality management approach is the singular focus on ambient air quality in the Air Act, 1981. There is no legal recognition of 'exposure' that determines the health risk that communities face due to close and direct exposures to pollution sources. The only policy mandate has come from the 2015 Report of the Steering Committee on Air Pollution and Health Related Issues of the Union Ministry of Health and Family Welfare. This has stated that it is more important to know how close people are to the pollution source, what they are inhaling, how much time they are spending close to the pollution source than what occurs generally in the air that is influenced by climate and weather. It is necessary to shift from concentration management to exposure management. Ambient concentrations do not always well represent human exposures and are not a good surrogate for total air pollution risk as this cannot indicate exposure and health outcome.

This principle will have to be integrated in the framework of NCAP and clean air action plans of the cities, states and regions, and needs to be leveraged to make local action more community oriented.

3.5 Sectoral strategies need to account for the impact on vulnerable communities

Often sectoral policy measures for pollution control can impact vulnerable communities adversely and can be in conflict with the welfare interest of the community. The sectoral action for pollution mitigation can lead to job losses and livelihood disruption. Higher economic cost of regulatory compliance or relocation of polluting activities/industries can directly impact livelihoods and cause displacement. However, these impacts are usually not accounted for to which leads to weak policy safeguards.

In the industrial sector, air-pollution-control measures require effective emissions-control systems, clean fuels, siting policy to keep them away from the habitat, and strong compliance framework. There are pollution-control strategies for critically polluted areas. Even siting policies have been adopted for industrial locations. These need to be planned through the prism of impacts on communities that determines the health and welfare risks.

Moreover, during pollution episodes in winter, non-compliant industries are shut down. Most of these are small and medium industries (MSMEs) that employ vulnerable groups, including informal workers. This will require different kind of

assessment to design solutions in a way that it enables sustainable transition in the MSME sector and also mitigates pollution and health risk.

There is already considerable conversation around the aggregated approach that can help to reduce the economic burden on the MSMEs. For instance, policies are integrating the requirements of cluster development to allow development of common infrastructure for MSMEs. Asset sharing like common boilers equipped with emissions control systems and access to clean and affordable fuels are being developed in several states to reduce the burden of compliance on each unit and also enhance productivity and competitiveness of the industry. Similarly, through the aggregation model, innovation and skill building, and market-access strategies are being facilitated.

Economic instruments like interest subvention, subsidies and tax incentives can be designed to reduce the cost of finance and transition. Environmental safeguards can be further scaled up and supported to improve the occupational health and safety of workers. The overall efforts to reduce pollution in MSME clusters can also reduce environmental risks for communities living in close proximity.

On the other hand, from the perspective of exposure management, it is also necessary to ensure high-degree pollution control and compliance in the industrial belt. There are several cases in which big industries have been found to be polluting and non-compliant, increasing local health risks. For instance, serious concerns over emissions and effluent from the Sterlite copper plant in Thoothukudi, Tamil Nadu, triggered widespread local protests. In 2018, the Tamil Nadu government ordered the closure of the Sterlite copper plant. The closure order was supported by findings from the Tamil Nadu Pollution Control Board (TNPCB), which highlighted significant environmental violations. In parallel, NGT ordered an independent assessment of the environmental impact of the plant's operations and mandated a review of its compliance with environmental norms before considering any reopening of the facility. This highlights the role of public participation in the environmental decision-making processes.

In the industrial belt of Chhattisgarh, particularly around Korba and Raigarh, heavy industries such as coal mining, power plants and steel manufacturing have caused significant air and water pollution. The local tribal and rural communities, dependent on agriculture and local natural resources, have been severely affected by the pollution, leading to health issues and loss of livelihoods.

The tannery industry in Kanpur has affected communities, especially those involved in fishing and agriculture, who have faced severe health issues and

economic losses. These cases underscore the critical role of regulatory steps to address equity impacts.

These evidences can inform implementation strategies. The EIA framework needs to be reformed to prevent it from becoming a perfunctory checklist. The flexibility of the provision can be utilized to promulgate more effective socio-economic assessments and stakeholder participation. The recent slew of industrial exempts from public hearings is going against the principle of environmental justice. But, while the rule allows additions to the list of exempt sectors, it also allows the reduction to the list.

3.6 Integrate equity benchmarks in infrastructure projects for pollution control

Multisector clean air action requires infrastructure development to enable sustainable choices for the larger population. But the planning and design of the new infrastructure or urban renewal may not have adequate safeguards to protect vulnerable communities. This is evident in the infrastructure plans in the transport sector. Currently, all clean air action plans have included affordable zero-emission travel modes, including walking and cycling. These are the modes of the urban poor, which are also part of the solution to air pollution. But this needs to be mainstreamed as a mode of choice for higher-income groups. But the infrastructure projects to enable mass-scale walking and cycling are often neglected in the planning and execution of clean air action plans.

Similarly, several steps are being taken to scale up formal and modern public transport systems like metro and modern bus systems to clean air and climate action. But public transport services are not being planned and deployed equitably and affordably. A 2018 study by CSE found that globally, spending more than 10-15 per cent of household income on transportation is considered unaffordable. The lowest 20 per cent of households typically spend no more than 10 per cent of their income on transport. Nearly one-third, or 34 per cent of Delhi's population is excluded from basic non-ac bus services, highlighting a significant gap in access to affordable public transportation.[ref] Higher spending on transport leads to lower spending on housing, health and education and hampers inclusive growth. Several state governments, however, do come up with policies to keep bus fares free for targeted groups like women. But there is no strategy to develop sustainable financing model—funding strategy for viability gas funding, tax reforms, revenue generation from other sources, etc. at the state level. Innovative strategies for the long term are needed for affordability and sustainability of the public transport system.

On other hand, development and modernization of public transport infrastructure—metro, bus rapid transit systems etc.—can also push the poor out of the city and disrupt their livelihood, increase travel distances and costs of living. An early study by the TRIPP found that the Delhi Metro had displaced slums. For the majority of the relocated households, cycling and bus distances had increased by several kilometres as had the journey time.[2] Similarly, average distances to services and number of trips had had also increased. This had let to the decline in the share of walking and cycling for the community.[3] Yet another study by CEPT shows that the share of transport cost in the household budget increased significantly for the bottom 50 per cent of the population, and that on education and health had stagnated due to the BRT metro project. Along with this, the BRT Ahmedabad had also displaced nearly 2,000 vendors.[4]

This further aggravates the structural inequity that weakens the coping capacity of communities. Pro-poor mobility and housing needs to be aligned with air-pollution-control measures to allow diverse livelihood choices and make the labour market efficient.

Several transportation policies have taken shape, which if implemented properly, can address inclusive planning. For instance, the Transit Oriented Development Policy requires compact urban form near transit nodes that include mixed-use and mixed-income development with improved accessibility. Institutional measures for efficient delivery are needed. National and state-level policies for pro-poor planning need to be sensitized

3.7 Waste management to de-risk communities

Waste management requires inequalities in exposures of different communities be addressed. Currently, the 'not-in-my-backyard' syndrome is hampering spatial planning for decentralized waste management in neighbourhoods as the higher income groups tend to push such activities to back alleys of cities. At the same time, cities desperate to dispose of their waste are indiscriminately setting up waste-to-energy plants in densely populated neighbourhoods and also the neighbourhoods of vulnerable communities. While safe siting policies are being disregarded, the level of advanced emissions control systems and compliance required in such plants are also not addressed adequately.

However, robust and well-funded waste management policies and programmes such as the national Swachh Bharat Sarvekshan are in place to mandate the cities to achieve 100 per cent waste collection, segregation, material recovery, diversion of fresh waste from dumpsites and remediation of at least 80 per cent of the legacy

waste. While this has created conditions for reducing waste-related risks, the overall the programme is still not nuanced enough to ensure that specially exposed groups, especially communities that live on marginal lands close to dumpsites, are addressed. Therefore, the evolving clean air action plans need to address the disproportionate distribution of inequities in population and further fine tune the interventions.

Therefore, the evolving clean air action plans need to address the disproportionate distribution of inequities in population and further fine tune the interventions.

4
GLOBAL LEARNING CURVE

HIGHPOINTS

The US environmental justice movement has shaped air-quality laws through recognition of disproportionate pollution exposure.

The US Federal agency resources and technical assistance programmes are focused to address disproportionately high and adverse health outcomes among communities;

In Europe, citizen science campaigns have helped to understand exposure of vulnerable groups such as children, and this has become the basis of engagement between environmental protection agencies and local communities to improve air quality.

Even though significant improvement in ambient air quality has been noted over the decades in the Global North, the problem remains unresolved. The air pollution risk is changing its character. While overall ambient concentration of pollution has improved, the specific exposures to communities have remained disproportionately unequal. These concerns fuelled by grassroots campaigns and the substantial body of scientific evidence have propelled policies to address the specific needs of the communities to address their exposures and ensure environmental justice. This framework has advanced the most in the US. There is a global learning curve that needs to be tapped to inform the local policies.

4.1 Environmental justice movement and regulations in the US

The genesis of the environmental justice regulations in the US

The US has taken the lead to institutionalize inequitable patterns of environmentalism and environmental policies. The environmental justice movement in the country traces its roots to Title VI of the Civil Rights Act of 1964,[1, 2] which prohibits unjustified discrimination against an individual based on their race, colour or national origin, and requires the recipients of federal funding to operate their programmes in a non-discriminatory manner.[3]

The early environmental movement, initially defined as 'environmental racism', concentrated on the unequal distribution of environmental liabilities on a social and spatial scale frequently overlooked by the mainstream environmental movement. The environmental justice movement dates back to the 1970s when the activism of disadvantaged communities drew attention to the inequitable siting of hazardous waste facilities in their neighbourhoods (see *Figure 1: Timeline of Environment Justice benchmark events leading Executive Order 12898).*

The initial benchmark events that sparked attention towards the issue proved pivotal in laying the foundation of environmental justice. The 1982 wave of grassroots protests against the placement of a PCB (polychlorinated biphenyls) landfill in a predominantly African-American neighbourhood in Warren County, North Carolina, sparked a public discussion about 'environmental racism', which served as the impetus for two significant studies that would help establish the environmental justice movement.

Both the researchers, the US General Accounting Office (1983) and the United Church of Christ (1987), came to the same conclusion that race was the single most significant factor in determining the placement of hazardous waste

facilities, confirming patterns of environmental injustice previously apparent to inhabitants in contaminated zones. The movement expanded and became more institutionalized during the ensuing years as a result of numerous new studies substantiating the connections between minority groups, institutional authority and environmental dangers, in addition to other social stressors (see *Figure 1: Timeline of Environment Justice benchmark events leading Executive Order 12898)*

Despite the growing activism and emergence of environmental justice groups, very little was happening in Congress to instil environmental justice measures in federal and local activities. Following this, in 1994, President Bill Clinton issued an Executive Order (EO) that established environmental justice as a top federal objective. The Executive Order stated that every federal agency 'shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations'.[4] Following this directive, at their discretion, federal agencies started to take environmental justice into account when implementing and evaluating policy.

Unlike Title VI of the Civil Rights Act, an Executive Order is not a law or a statute. It is general guidance for federal bureaucratic action. It directs how federal agencies can put efforts to ensure non-discrimination in federal programmes and give underserved communities more access to information and opportunities to participate (see *Table 1: Comparison between Title VI of the Civil Rights Act and EO 12898*).

Taking lessons from California's AB 617, community representation in decision-making is as important as ensuring that polluting firms do not get an upper hand when decisions are being taken. Any perfunctory efforts will delay if not hinder the actual progress.

Executive Order 12898: The beginning

Executive Order 12898 was signed in 1994 to analyse the environmental impact a given federal activity would have on a historically disadvantaged community. Under EO 12898, agencies are tasked with taking into account how a new regulation would affect environmental justice, provided such considerations are pertinent to the rulemaking.

Figure 1

Timeline of Environment Justice benchmark events leading Executive Order 12898

FEBRUARY 11, 1968

Memphis Sanitation Strike

The Memphis Sanitation Strike was an action taken against unfair treatment and environmental justice concerns in Memphis, Tennessee. The strike advocated for fair pay and better working conditions for Memphis garbage-workers. It was the first time African-Americans mobilized a national, broad-based group to oppose environmental injustices.

DECEMBER 1979

Bean v Southwestern Waste Management Corp. and the Formation of NECAG

The African-American home owners in Houston, Texas formed the Northeast Community Action Group (NECAG) to prevent the proposed Whispering Pines Sanitary Landfill from being situated within 1,500 feet of a nearby public school (and within 2 miles of six schools) and filed a class action law suit. Bean v. Southwestern Waste Management, Inc. was the first in the United States to charge environmental discrimination in waste facility siting under civil rights laws. While the lawsuit ultimately failed to prevent the landfill's construction, it sent a strong message to environmental justice cases across the country.

SEPTEMBER 1982

Sit-in against Warren County, NC PCB landfill

A non violent sit-in protest against a polychlorinated biphenyl (PCB) land fill in Warren County, North Carolina, was the second time African Americans mobilized a national, broad-based group. Over 500 environmentalists and civil rights activists were arrested, but the protest failed to stop construction. This event is widely regarded as the impetus for the Environmental Justice Movement.

1983

General Accounting office conducts study

The United States General Accounting Office (GAO) conducted the study *Siting of Hazardous Waste Land fills and Their Correlation with Racial and Economic Status of Surrounding Communities* in response to the 1982 Warren County sit-in. The study instigated the environmental justice movement and provided empirical support for claims of environmental racism.

1987

Toxic waste in the United States

The United Church of Christ Commission released their study *Toxic waste in the United States* where in they examined the statistical relationship between the location of a hazardous waste sites and the racial/socioeconomic composition of the host community. The study was first national-level study to address the interrelation between race and environmental actions. Although residents' socioeconomic status appeared to play an important role in the location of hazardous waste sites, the study found that race was the most significant factor among the variables examined.

Source: Compiled by CSE from the EPA website

1988

West Harlem environmental action

The West Harlem Environmental Action Committee (WE ACT) was established to address the ongoing concerns about the North River Sewage Treatment Plant's poor management, the construction of the sixth bus depot across from a school, and a large housing development - all in a densely populated and heavily trafficked area.

APRIL 1990

Congressional Black Caucus meets with EPA officials

The congressional black caucus met with the EPA officials to discuss the higher environmental risk faced by the low income and minority population and alleged that the EPA was not addressing the community's grievances and needs.

JULY 1990

Environmental equity workgroup

The EPA administrator created the environmental equity workgroup to address the allegations placed by the Black caucus.

OCTOBER 1990

Dumping in the Dixie

Dr Robert Bullard's book *Dumping in Dixie* was the first to document environmental in justice in the United States. Bullard's book tells the stories of five communities of colour working to secure their right to live in a healthy environment.

OCTOBER 1991

First National People of Color Environmental leadership summit

In Washington, D.C., the first National People of Color Environmental Leadership Summit was held. Several hundred people, including Native Americans, African-Americans, Latinos, and Asia-Pacific Islanders, attended and adopted the 17 Principles of Environmental Justice as a comprehensive platform for a national and international movement of all people.

NOVEMBER 1992

Office of Environmental Equity is established

Based on the recommendations from the Environmental Equity group, the Office of Environmental Equity was established; which later became the Office of Environmental Justice in1994.

1994

Environmental justice small grant program

The Environmental Justice Small Grants Program was established to provide financial assistance to eligible organizations to help them form collaborative partnerships, identify local environmental and/or public health issues, envision solutions, and empower the community through education, training, and outreach.

SEPTEMBER 1993

National Environmental Justice Council was created

The then EPA administrator created a federal advisory council, the National Environmental Justice Council (NEJAC) to hold public meetings regarding environmental justice issues across the nation.

FEBRUARY 11, 1994

Executive Order 12898

President Bill Clinton signed Executive Order 12898, Federal Actions to address environmental justice in minority populations and low-income populations, to ensure environmental protection for all communities and direct federal attention to the environmental and human health problems of minority and low-income groups.

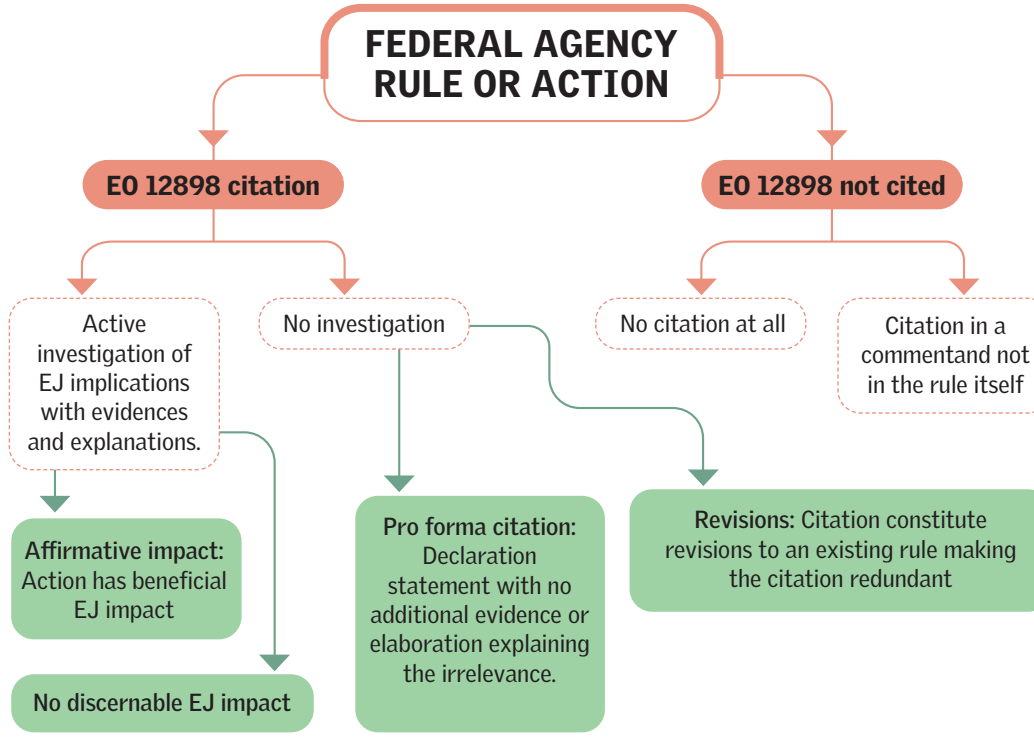
Table 1: Comparison between Title VI of the Civil Rights Act and EO 12898

Aspects of the authorities	Title VI of the Civil Rights Act of 1964	Executive Order 12898
What is the authority?	A Federal statute enacted as part of the Civil Rights Act of 1964	A Presidential executive order signed in 1994. It is not a statute or law.
What does it say?	Prohibits discrimination on the basis of race, colour and national origin in programmes and activities receiving federal financial assistance.	Directs all Federal agencies to integrate environmental justice as a part of their mission by identifying and addressing disproportionate human health or environmental impacts of their programs, policies, and activities on minority and low-income populations.
What is the purpose?	Title VI was designed to ensure that federal funds are not being used for discriminatory purposes.	EO 12898 was issued to: Promote nondiscrimination in Federal programmes disproportionately affecting human health and the environment Provide underserved communities access to public information on, and an opportunity for public participation in, matters relating to human health or the environment.
Who is covered?	Title VI applies to recipients of federal financial assistance.	EO 12898 applies to designated Federal agencies.
What is required?	Title VI requires recipients of federal financial assistance to not discriminate on the basis of race, colour, or national origin. Title VI requires federal agencies to monitor their recipients and ensure their compliance with the Statute	EO 12898 requires Federal agencies to create environmental justice strategies. Pursuant to the 2011 Memorandum of Agreement on Environmental Justice, 17 Federal agencies agreed to issue an annual implementation progress report on environmental justice.
How is it enforced?	Individuals alleging intentional discrimination may file suit in federal court or a complaint with the federal agency providing funds for the program or activity at issue. If a program or activity has a discriminatory effect, individuals may file an administrative complaint with the federal funding agency. An individual cannot file a suit in federal court to address discriminatory impacts of a recipient's activities. Additionally, federal agencies have the authority to conduct compliance reviews of recipients to ensure their activities do not violate Title VI.	EO 12898 is a Presidential Order and is not enforceable in the courts and it does not create any rights, benefits, or trust responsibilities enforceable against the United States. To accomplish the goals of E.O. 12898, a Federal agency may implement policies that affect their funding activity. Agencies may also utilize their authority under various laws such as the Clean Air Act, National Environmental Policy Act, and the Fair Housing Act to achieve the goals of the Executive Order.

Note: The table was taken directly from the source

Source: US Environmental Protection Agency 2014. Title VI and Executive Order 12898 Comparison. Accessed at https://www.epa.gov/sites/default/files/2015-02/documents/title-vi-ej-comparison.pdf

Figure 2: Categories of citations of the EO 12898 in Federal rules or actions



Note: EJ—Environmental Justice; EO—Executive Order

Source: Compiled by CSE. Colin Provost, Brian J. Gerber 2019. Political control and policy-making uncertainty in executive orders: the implementation of environmental justice policy. Journal of Public Policy. Cambridge University Press.

This obligation, however, does not necessarily have force because an agency may mention the order but still believe it has no bearing on the rule's actual provisions. Agencies occasionally neglect to acknowledge the Executive Order (EO) as opposed to citing it as not relevant to the rule. Hence, determining the substance of EO 12898 citations aids in explaining the actual impact of President Clinton's initiative to take environmental justice (EJ) into account.

There are six categories under which the citations of the EO can fall. Beneficial environmental justice (EJ) impact, no environmental justice impact or no impact with evidence, irrelevant without giving evidence, no citation, citation in the revision of an existing rule, citation in a comment and not the actual rule (see *Figure 2: Categories of citations of the EO 12898 in Federal rules or actions*).

To facilitate the active involvement of all the federal agencies and to execute the Order, the EO established a federal environmental justice (EJ) inter-agency working group (EJ IWG). The working group provides a forum for the federal

agencies to implement the environmental justice agenda as a collective measure along with assisting the communities in their environmental justice activities.

The EPA Administrator serves as the chair of the EJ IWG, which consists of 17 Federal agencies as well as White House offices. The administrator can establish other committees as needed to carry out the Order's requirements.

The group itself is made up of the leaders of relevant federal agencies and departments like the Departments of Defense, Health and Human Services, Housing and Urban Development, Labor, Agriculture, Transportation, Justice, Interior, Commerce, Energy, and various divisions of the Executive Office of the President (see *Figure 3: EJ IWG Governance structure 2020*)

In 2011, the White House, the EPA, and 16 other agencies restructured the Interagency Working Group and signed a memorandum of understanding, pledging to prioritize EJ. The MOU acted as a formal agreement amongst Federal agencies to renew their commitment to addressing environmental justice in a more collaborative, all-encompassing, and effective manner.

The MoU also adopted a charter that describes the EJ IWG's governance structure and key areas. Additionally, it clarifies additional commitments made by member agencies and expands the EJ IWG to include more agencies (see *Figure 3: EJ IWG governance structure 2020*)

Each federal agency participating in the EJ IWG has an environmental justice strategy outlining how it intends to incorporate environmental justice into its various initiatives. These tactics offer a road map for putting plans into action for establishing quantifiable and doable goals.

Along with this, the member agencies develop an 'Annual Implementation Progress Report' to document the success of the strategy. These reports outline significant accomplishments for each fiscal year and make agency evaluation easier so that efforts to advance environmental justice can continue to be strengthened.

The task of the working group is to aid the federal agencies to identify the areas with potential environmental justice concerns and help them to coordinate the environmental justice measures, research and, data collection. The working group assesses the environmental justice proposals submitted by the agencies. Along with the proposal, agencies also submit a list of initiatives to solve the issues that were discovered during the proposal drafting process.

Figure 3: EJ IWG governance structure 2020

Note: EPA—US Environmental Protection Agency; DOJ—U.S. Department of Justice; HUD— US Department of Housing and Urban Development; HHS—US Department of Health and Human Services; USDA—US Department of Agriculture; DOT—US Department of Transportation; GSA—U.S. General Services Administration; DOI—US Department of the Interior; DOE—US Department of Energy; NPS—US National Park Service; DHS—US Department of Homeland Security; FEMA—US Federal Emergency Management Agency
Source: Compiled by CSE from the EPA website

Under the ambit of the EO, the agencies are expected to conduct their programmes in a manner that does not disqualify people from participation, deny them benefits, or treat them unfairly because of their race, colour or place of birth. Wherever feasible, agencies are urged to evaluate cumulative hazard exposure.

The agencies are expected to collect data on race and economic status. Agency heads are in charge of monitoring EO 12898 compliance.

The Clean Air Act and Environmental Justice

The Clean Air Act (CAA), signed by Congress in 1970, was designed to protect public health and welfare from various types of air pollution caused by a wide range of pollution sources. The CAA last amended and enacted by Congress in 1990, establishes the Environmental Protection Agency's (EPA) responsibilities for protecting and improving the nation's air quality. Like other laws passed by Congress, the Act was codified as Title 42, Chapter 85 of the United States Code.[5]

The CAA and its accompanying laws have greatly improved air quality by many different standards. Notwithstanding this accomplishment, local air quality issues can persist despite seemingly thorough rules due to flaws in the three key CAA components.

The CAA and its later revisions (CAAA) incorporate a system of health-based National Ambient Air Quality Standards (NAAQS).[6] A network of monitoring stations that detect average air pollution concentrations at 'representative' sites is used to evaluate compliance with these criteria. However, due to the sparseness of the regulatory-grade network, certain neighbourhoods in places that the Environmental Protection Agency (EPA) considers to be in 'attainment' (also known as compliance) frequently experience pollution levels over the legal limit.[7]

The EPA's limited power to enforce compliance with air quality regulations is another flaw in the NAAQS scheme. Although placing various punishments on states is the most efficient way to bring a region into compliance, this option is rarely used. Progress is typically instead encouraged through more subtle means, such as financial incentives, stricter permitting, and technical support.[8] Bringing polluted areas up to par can take decades due to the gradual nature of this procedure.

The permitting and regulatory provision is another area with shortcomings. The majority of stationary source emissions are permitted primarily prospectively, using engineering estimates or emissions factors. EPA has limited regulatory

authority to regularly monitor emissions or impacts on air quality from a facility once it has been permitted, with the notable exception of power plants.

The evidence thus points to the possibility that large industrial sources like oil refineries have emissions in reality that are several orders of magnitude higher than those allowed by the air quality permit. Regulators may not be able to evaluate the concerns of locals who can smell the chemicals and frequently have respiratory issues if they just use engineering-based emissions criteria. Regulators and community members have limited power to impose limits on new stationary ambient exposure and emissions monitoring requirements once a permit has been granted.

The third group of CAAA rules addresses mobile sources. The primary sources of hotspot pollution are heavy-duty trucks, freight transportation and passenger vehicles. The CAA mandates inspection and maintenance (I&M) of some types of current vehicles in NAAQS non-attainment zones and gives the EPA the authority to set emission criteria for new mobile sources. With one major exception, California is allowed to set vehicle-emission standards that are stricter than EPA's if EPA grants a 'waiver', after which other states can follow California's lead.

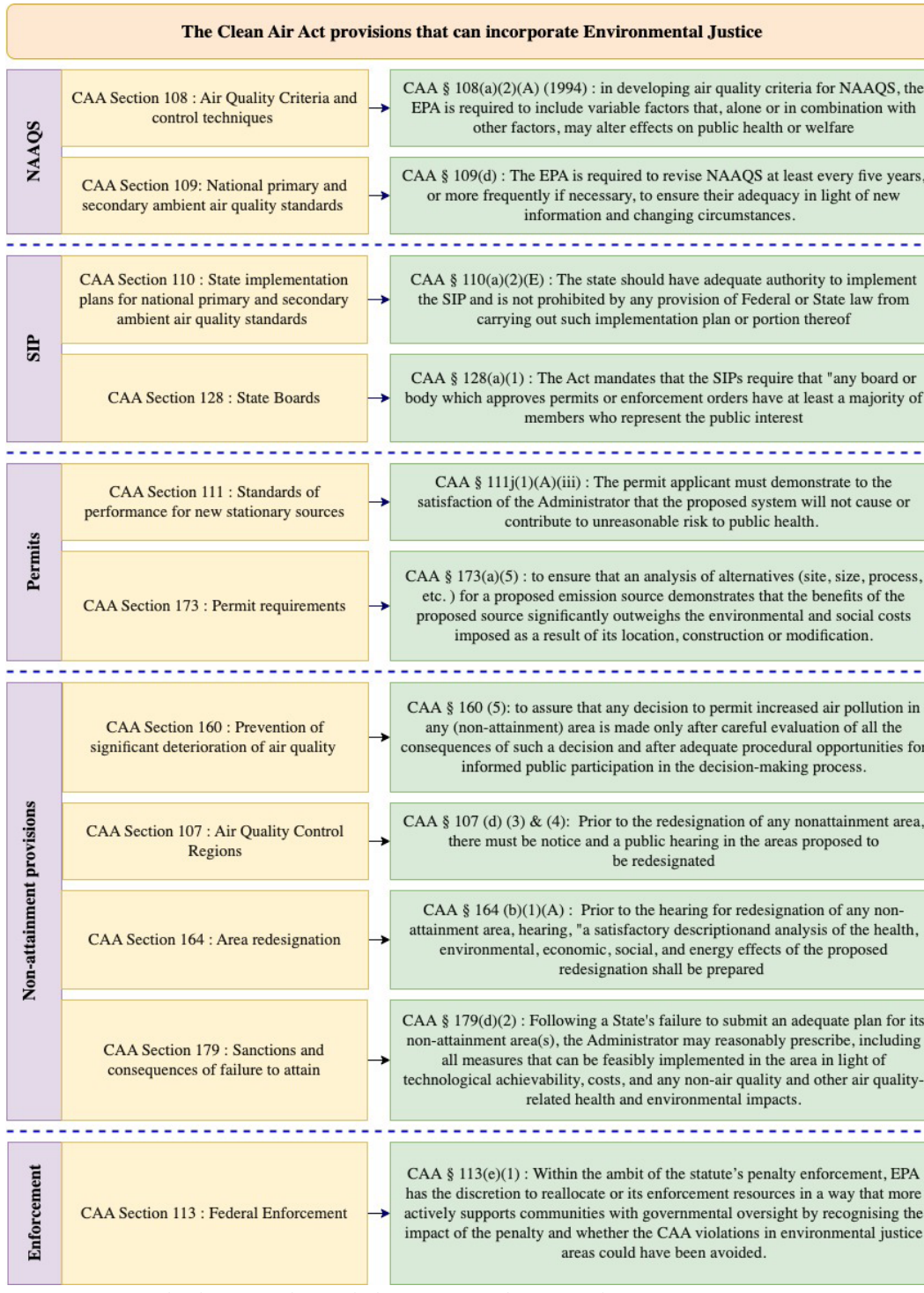
This is because the law generally prohibits states and local agencies from setting mobile source emissions standards to promote uniformity. This jurisdictional arrangement implies that regional and local agencies, who are probably in the greatest position to handle specific local air quality issues, have minimal control over emissions from mobile sources.

The operation of vehicles may be regulated by states, for instance, by restrictions on access to ports of older-model trucks, restrictions on idle time of truck engines, bans on heavy-duty vehicles in specific locations, and I&M standards for vehicles (beyond those required for nonattainment areas).

Although these national and local policies do cut mobile source emissions, they cannot specifically target mobile source hotspots (except for road and port access rules). Also, the fleet's vehicle turnover takes time. As a result, the federal and state vehicle emission rules that apply to new automobiles cut emissions gradually.

Apart from these limitations, the Act, through its various statutes, provides the EPA with differential opportunities to integrate the environmental justice measures into its standards (see *Figure 4: Various provisions within the Clean Air Act that gives the EPA the prerogative to implement environmental justice [EJ] measures*).

Figure 4: Various provisions within the Clean Air Act that gives the EPA the prerogative to implement environmental justice (EJ) masures



Note: NAAQS—National Ambient Air Quality Standards; SIP—State Implementation Plan

Source: Compiled by CSE from EPA website and; Richard Lazarus and Stephanie Tai 1999. Integrating Environmental Justice into EPA Permitting Authority. Ecology Law Quarterly. Accessed on December 6, 2022.

However, because of the broadly worded mandates, it is at the Agency's discretion to decide to what extent it wants to exercise environmental justice measures. There is no separate statute that mandates the assurance of environmental justice wherever applicable.

The Act's foundational National Ambient Air Quality Standards (NAAQS) serve as an example. The CAA requires EPA administrators to establish NAAQS to protect public health with an adequate margin of safety.[9] The Act does not specify what Congress intended when it directed the Administrator to prescribe air quality standards necessary to protect public health.[10] The Act's legislative history, on the other hand, provides some guidance.

According to the American Lung Association v. EPS litigation's Senate report, 'Congress defined public health broadly; NAAQS must protect not only average healthy individuals, but also sensitive citizens—children, for example, or people with asthma, emphysema, or other conditions rendering them particularly vulnerable to air pollution'.[11] In the Lead Industries Association v. EPA litigation, the Senate report notes that 'especially sensitive persons such as asthmatics and emphysematics are included within the group that must be protected'.[12]

Air pollution levels that pose no health risk to average healthy people may pose significant risks to some people who have heightened vulnerabilities due to preexisting physical conditions and it is well within the EPA's jurisdiction and duties to revise the air quality standards in the light of such new information, e.g. the EPA promulgated a lower NAAQS for lead due to the special sensitivities of some people, such as preschool-age children and pregnant women.[13,14]

As discussed in the earlier sections, the majority of the population with special sensitivity to air pollution belongs to the vulnerable communities owing to the intergenerational disparities they face, risk aggregation, the inequitable pollution exposure. To accommodate the pollution vulnerabilities of the different groups, the Act directs the EPA to include information on 'those variable factors . . . which, alone or in combination with other factors, may alter effects on public health or welfare' in developing the air quality criteria upon which the NAAQS are based.[15]

If the EPA were to consider the sensitivities of those members in environmental justice communities based on pre-existing physical conditions or environmental stresses from other pollution sources more systematically, the Agency may find it necessary to promulgate more protective NAAQS. Such physical conditions or environmental stresses appear to fall well within the definition of the variable

factors that the EPA is authorized to consider. However, the EPA's efforts to actively incorporate the vulnerabilities of the environmental justice (EJ) communities in the promulgations of the NAAQS have been ambiguous, if not perfunctory.

The American Lung Association and the Environmental Defense Fund, for example, challenged the EPA's refusal to issue a five-minute sulphur dioxide (SO_2) NAAQS, arguing that such a standard was especially important for addressing the health concerns of environmental justice communities vulnerable to short-term exposure to high levels of SO_2.[16] The US Court of Appeals for the D.C. Circuit remanded back to EPA in its order refusing to promulgate more stringent SO_2 NAAQS because EPA did not adequately explain its conclusion that such exposures did not cause a public health problem. As a result, the D.C. Circuit's decision implies more than just that the EPA has statutory authority to consider the special sensitivities of environmental justice communities when establishing air quality standards under the CAA.

Other than the promulgations of the NAAQS, there are other avenues where the environmental justice measures can be incorporated within the ambit of the CAA. For acquiring the EPA approval of State Implementation Plans (SIP), the CAA requires the states to have adequate personnel, funding and authority under state and local law to implement the SIP and not be prohibited by any Federal or State provision.[17] Thus, before granting its approval to a SIP, the EPA has the responsibility to ensure that the SIP will not, in any way, violate any Federal and/or state law.

Under Title VI of Civil Rights, if a state agency receives EPA funds to run a clean air programme, that state recipient is legally prohibited from discriminating based on race, colour, or national origin when conducting clean air enforcement activities.[18] This way the EPA has the authority to make sure SIPs, including their permitting requirements, do not have the kinds of disparate environmental effects that Title VI prohibits. Along with this, the act mandates that SIPs require the permitting agencies to represent at least the majority of the public interests.[19]

Another element of the CAA that enables deeper integration of environmental justice issues into risk aggregation is permit related statutes. The waiver provision for novel technology systems of continuous emission reduction applies to the new source performance standards in Section 111 of the CAA. An application for a waiver must prove that the proposed system will not cause or contribute to an 'unreasonable risk to public health'.[20]

Given the emphasis on public health in the statute and the use of the word 'contribute to', EPA should be able to take the affected community's cumulative public health effects into account. Along with this, the non-attainment permit requirements of the Act require conducting an analysis for alternatives (location, size, process, etc.) to the proposed source (of emission) and ensuring the benefits outweigh the environmental and social costs imposed by the same.[21]

The mentions of both social costs and location provide solid grounds for EPA's prerogative to consider environmental justice issues when assessing a facility's siting to obtain a nonattainment permit. The EPA also has to ensure that the permit to emit in a non-attainment area is granted only after a careful evaluation of all the consequences and granting enough opportunities for public participation in the decision-making process.[22]

When a non-attainment area is being redesignated, the Act mandates a public hearing and an analysis of the health, environment, economic, social and energy impacts of the proposed redesignation.[23,24] The element of public involvement and the analysis of the social cost of the decision gives ample room to incorporate the environmental justice agenda.

The Act also gives the EPA some direct enforcement authority. If a State fails to submit an adequate plan, the EPA has full authority to take measures incorporating the air and non-air related environmental and health impacts.[25] The Act also grants the EPA the discretion to reallocate its enforcement resources in a way that more actively supports communities with governmental oversight by recognizing the impact of the penalty and whether the CAA violations in environmental justice areas could have been avoided.[26]

Thus, under the CAA, it is well within the EPA's jurisdiction to exercise environmental justice measures in air pollution standards and measures. The accomplishment of environmental justice for all communities can be significantly impacted by the way the Agency decides to carry out and enforce its powers. However, the open-ended statutes pave the way to litigations both in favour and against environmental justice measures, inadvertently making EPA's advocacy for the environmental justice measures dependent on the bureaucratic government cycles.

The environmental pioneer—the state of California

The state of California is home to some of the most polluted areas of the USA, despite having a long history of enacting source emission requirements that are stricter than federal regulations.

The California Air Resources Board (CARB), which is a division of California EPA, is the main agency responsible for managing the State's air quality. The Board directly answers to the Governor's Office in the Executive Branch of the California State Government and collaborates with the US EPA and 35 local air pollution control districts (APCD or Air Districts) to manage air quality effectively.

California's air quality management is a collaborative effort between local, state and federal agencies. CARB establishes state-wide laws to reduce emissions from motor vehicles and fuels, off-road vehicles, and consumer goods. The Air Districts are often in charge of stationary sources and the federal government regulates the preempted mobile sources and national transportation sources like ships, trains, and aviation.

Due to the emissions from vehicles, trucks, locomotives and ships, communities close to ports, rail yards, warehouses and motorways have a higher exposure of air pollution than other locations. Like the rest of the country, the environmentally disadvantaged communities in the state are also the racially and economically disadvantaged communities—the Black and the Hispanic communities.

Localized issues with air quality in California have prompted environmental justice organizations to call for improvement. The environmental justice (EJ) movement had already gained significant traction and was in a position to have an impact on the legislative and regulatory processes by the time California started to create its comprehensive climate policy framework—Assembly Bill 32.

Global Warming Solution Act (AB 32)—The ineffective amalgamation of climate change and local air pollution policies

The California government passed the Global Warming Solution Act (AB 32) in 2006 which implemented a host of policies to reduce greenhouse gas (GHG) emissions and develop low-carbon solutions in the state.[27] Along with addressing climate change, the Act also intended to address local air quality issues and had some provisions that addressed different aspects of environmental justice issues.

Under the Act, the California Air Resources Board (CARB) was instructed to 'maximize additional environmental and economic co-benefits for California and complement the state's efforts to improve air quality' to address the disproportionate exposure to local air pollution in some communities.[28] CARB was mandated to 'consider the potential for direct, indirect, and cumulative emissions impacts from these mechanisms, including localized impacts in communities that are already impacted by air pollution'.[29]

A number of procedural reforms were also required under AB 32 to give community activists a voice. To integrate community involvement in decision-making, the Act established an environmental justice advisory committee (EJAC) and facilitated policy planning workshops in low-income and minority-populated areas. For representation, the CARB created a new executive post to work with environmental justice (EJ) communities and recruited two voting members with knowledge of environmental justice concerns.

Overall, this was a progressive step and the emphasis on environmental justice concerns in AB 32's text was unusual. Just like any other new regulation, however, the practical application of this historic legislation ran across some significant obstacles and highlighted the structural issues. During the first implementation phase of the Act, there were some intractable disagreements between the State agencies and the EJ communities.[30]

The GHG cap-and-trade programme is one of the sources of controversy. Carbon pricing is viewed by economists and many policymakers as a crucial tool for encouraging economy-wide investments in the most affordable emissions reduction alternatives while also generating revenue to support other policy goals. The GHG cap-and-trade policy, in contrast, has faced intense opposition from the EJ community.

A significant portion of this hostility stems from mistrust of market-based policy solutions and worries about the latitude that businesses have in adhering to these restrictions. Environmental justice organizations see fewer opportunities for community engagement and agency, whereas economists regard this flexibility as essential to guaranteeing cost-effective emissions reductions. Advocates for the EJ community have also expressed concerns that the trade of emissions permits would allow the continuous (or increasing) exposure of underprivileged populations to locally co-emitted pollution.

Another concern around the Act was regarding the scope of the Act and the range of the pollution issues that can come under its umbrella. The vast breadth of the Act's legalese which promised to address both local air pollution and climate change was proving to be difficult to implement in practice.

For instance, environmental justice supporters favoured GHG permit trading limitations that gave priority to ancillary health advantages and co-pollutant emissions reductions in particular areas. These recommendations did not receive widespread support since focusing GHG reductions at particular sources could

dramatically raise the expense of meeting the state's aggressive GHG targets.

The employment of climate policy to address the two fundamentally separate issues of local and global pollution, according to economists and other stakeholders, would impede progress on both fronts.[31] However, the CAA, which was the only Act that could address air pollution environmental justice then, had proved inadequate to address environmental justice issues as discussed in the earlier sections; and the EJ community was hesitant to rely on the regulatory system under the CAA to solve local pollution issues.

The manner in which CARB and the EJ communities interacted gave rise to another related area of contention. EJAC members voiced frustration during the AB 32 implementation process that CARB was not adhering to procedural requirements and that their feedback was not taken seriously. Seven of the EJAC's eleven members joined a lawsuit against CARB in 2009, claiming the implementation of AB 32 was not in line with the law's intention to safeguard the EJ communities.[32]

These grounds of contention remained unresolved in 2017 when the second, more ambitious phase of GHG emission reductions was set to begin. Environmental justice organizations vehemently opposed the GHG cap-and-trade programme's renewal. Carbon pricing, according to supporters, is essential for both income generation and cost-effective GHG mitigation. A significant compromise was eventually made. An extension was made to the GHG cap-and-trade scheme. However, the State vowed to address local air pollution concerns more directly with California's Assembly Bill 617, rather than depending on climate change policies to provide improvements to local air quality.

AB 617—baby steps and big promises

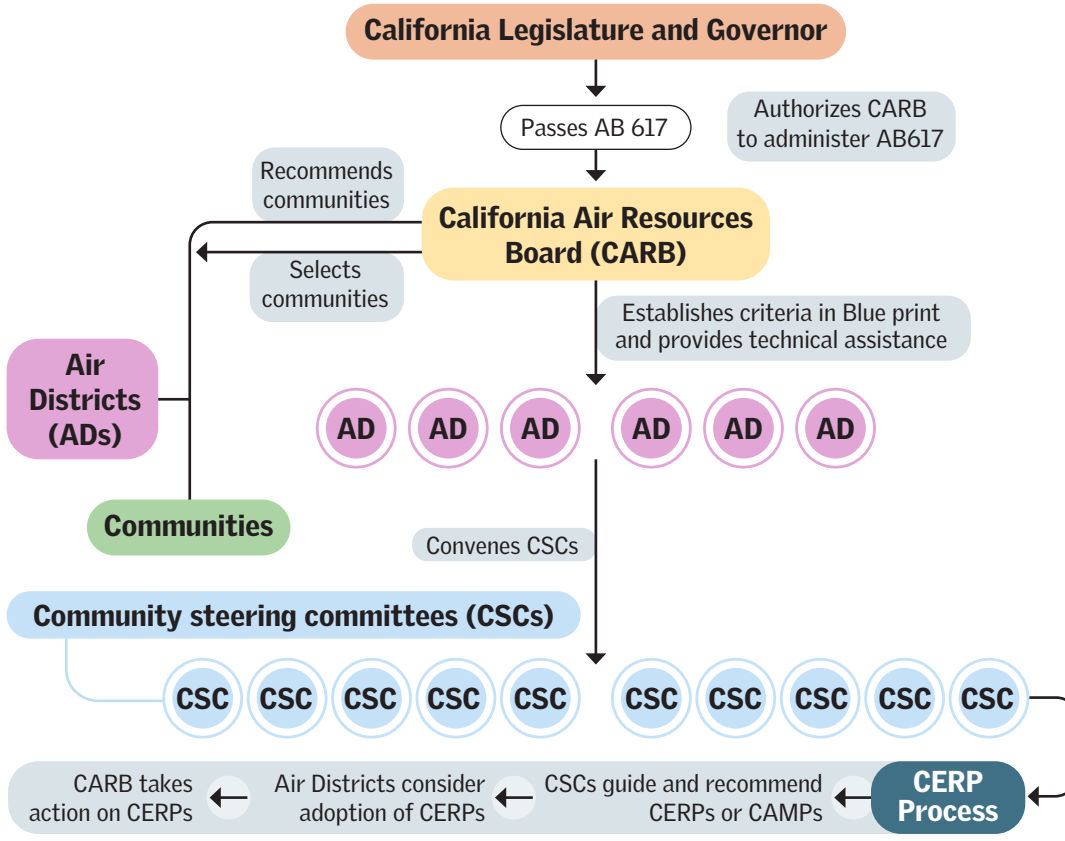
Despite being at the forefront of climate and clean air policies, California still experiences poor air quality compared to several other states, with many communities facing a disproportionate exposure to air pollution. Following the shortcoming of AB 32 in addressing environmental injustice, the State governor signed Assembly Bill 617, which was signed into law in 2017, to address air pollution with strategies that put community well-being and representation at the centre of solution drafting.[33]

The AB 617 law represents a significant shift in the state's approach to air pollution regulation, placing greater emphasis on community involvement and engagement. AB 617 is implemented through a multi-step process that involves various state and local agencies, as well as community stakeholders.

The governance of AB 617 is unusual in that it is divided among CARB, local air districts, and communities. Local air districts collaborate with communities on community air monitoring and emissions reduction plans, provide incentive funding and have the power to impose stricter pollution controls on sources. CARB oversees the process and awards grants to community organizations to take part. Communities provide guidance and partner with air districts on monitoring and emissions reduction programmes (see *Figure 5: California Assembly Bill 617 Community Emissions Reduction Program [CERP] and Community Air Monitoring Plan [CAMP] policy development process*).

The law authorizes CARB to administer the requirements of the bill and makes it the lead agency to oversee the implementation of the law. The California Air Resources Board (CARB) created the AB 617 Community Air Protection Blueprint

Figure 5: California Assembly Bill 617 Community Emissions Reduction Program (CERP) and Community Air Monitoring Plan (CAMP) policy development prcess



Note: CERP—Community Emissions Reduction Program; CAMP—Community air monitoring plan

Source: Jonathan K. London et al. 2022. The past, present and future of AB 617: Envisioning a way forward together. University of California Davis.

(Blueprint) to help local air pollution control and management districts (Air Districts) carry out the law.[34]

To implement the law, the primary requirement is the identification of disadvantaged communities. To achieve that, the CARB established the Community Air Protection Program (CAPP), which is a statewide programme that identifies communities with the highest levels of air pollution based on a range of criteria such as proximity to major sources of pollution and socio-economic indicators.

The framework of the CAPP is still in its early stages and CARB has released a concept paper with the proposed framework to obtain community feedback.[35] With the help of the local Air Districts' inputs and the California Communities Environmental Health Screening Tool (CalEnviroScreen), the programme identifies the disadvantaged communities based on a combination of data sources and factors that characterize the cumulative exposure of the communities to criteria air pollutants and toxic air contaminants. These factors include:

- Information derived from measurements, air quality modelling, or other sources that quantify the burden of exposure regarding concentrations of criterion air pollutants and hazardous air contaminants;
- Sensitive receptors (such as schools, daycare facilities, and hospitals), exposed populations and proximity to mobile, regional and stationary sources of concern for emissions, such as motorways;
- The number of sources contributing to emissions and the size of local emissions;
- Indicators of public health that are indicative of illness incidence and/or exacerbations; Estimates of the cancer risk based on air quality models; and
- Socioeconomic elements like poverty, unemployment and segregation.

From the list of eligible communities, CARB selected 10 communities for the first phase of AB 617 and three additional in the second year of the programe. Depending upon the degree of exposure, data availability and community capacity, these communities were placed in one of the three regulatory tracks: enhanced community air monitoring, community emission reduction plan, or both.

After the communities are identified, the local air districts assist these communities to form multi-stakeholder community steering committees (CSCs) which comprise residents, local organizations, governments and businesses, each with their own perspectives and goals. The committee's primary task is identifying the community issues and concerns, determining the final geographic boundary of the community being served, and facilitating community outreach and engagement. The local air district works with the steering committee to establish a charter to clearly

set out the committee process and structure. This charter sets out a roadmap for developing and implementing a community emissions reduction plan.

The communities that had been subject to disproportionate air pollution exposure but did not have a proper air pollution monitoring network that would be 'representative' of their exposure came under the enhanced community air monitoring regulatory track. Air monitoring in these communities focuses on getting new information to support activities including the development of future clean air plans, or plan elements.

The CSCs for these communities were tasked with developing their Community Air Monitoring Plan (CAMP). With CARB's assistance and inputs from the CSCs, the respective Air Districts draft a Community Air Monitoring Plan (CAMP) to monitor air quality and identify sources of pollution. The Air Districts also conduct outreach programs with disadvantaged communities to get their recommendations. Communities with established source apportionment came under the regulatory track incorporating community emission reduction plans. Most of the communities came under both the monitoring and the emission reduction programme.

Once the sources of air pollution are apportioned by CAMP, the local districts and CARB develop the Community Emission Reduction Programs (CERPs) by taking the inputs from the CSCs. The CERPs are required to prioritize actions that result in the most significant emissions reductions and are implemented over time. The CERP's progress towards emission reduction goals is monitored regularly. Community stakeholders are involved in this monitoring process to ensure that progress is being made and that the community's concerns are getting addressed.

The primary requirement in the entire process from identifying communities for the CAPP to developing and implementing the ERPs is meaningful community engagement. AB 617 also includes provisions to ensure compliance with emission reduction plans and penalties for non-compliance. Despite the inclusive administration, AB 617 is a complex law with several challenges and issues that need to be addressed to ensure its successful implementation.

While AB 617 is funded through various sources, including cap-and-trade auction proceeds and fees assessed on certain industries, the funding is limited. This can pose a challenge for implementing the law in all the identified impacted communities, especially those with complex air pollution sources that require more resources for mitigation. The fact that the programme is funded by cap-and-trade auction proceeds implies that the emission reduction plans they are funding are just compensation for the industries to continue polluting the neighbourhoods.

The implementation of AB 617 requires the use of sophisticated air monitoring and modelling techniques, which can pose technical challenges for some communities. The lack of technical expertise and resources can make it difficult for some communities to collect and analyze the necessary data to develop effective emissions reduction plans.

Along with technological challenges, the law also faces certain enforcement and implantation challenges. While AB 617 includes provisions for enforcing compliance with emissions reduction plans, enforcement can be a challenge. There is a need for consistent monitoring and enforcement of compliance to ensure that the goals of the law are met.

AB 617 requires meaningful community engagement. It can be challenging to engage all community members, especially the historically marginalized or mistrustful of government agencies. Effective community engagement requires trust, understanding cultural differences, and addressing language barriers.

Lastly, the implementation of AB 617 involves coordination among multiple state and local agencies, including CARB, local air districts, and community organizations. Coordination among these agencies can be challenging, especially given the differing priorities and approaches to implementing the law.

Overall, the implementation of AB 617 has faced several challenges and issues. But the administration framework and the lessons drawn from it provide us with a blueprint to emulate it in India's current air pollution legislature and legalese.

4.2 European Union and United Kingdom: Towards citizen's science

While air quality has generally improved over the previous few decades in the EU, it still has a disproportionately large and uneven impact on millions of Europeans.[36] Numerous international strategies, including the Sendai Framework for Disaster Risk Reduction, the Paris Agreement, the Sustainable Development Goals for the United Nations, and WHO health strategies, acknowledge the need for policy and action to concentrate on safeguarding the most vulnerable members of society from environmental health risks.

The necessity to protect vulnerable people from pollution and severe temperatures is mentioned in the main European policies, including the 7th EAP, the EU Strategy on Adaptation to Climate Change, and the air quality and noise directives and the Aarhus Convention. Yet, initiatives aimed at disadvantaged groups are not specifically mentioned in the policy framework.[37]

The European Network of the Heads of Environmental Protection Agencies and the European Environment Agency (EEA) have undertaken a joint initiative on CleanAir@School during 2018–20. Citizens were mobilized to monitor air quality around schools across Europe using a common approach developed by EEA.[38]

This citizen science campaigns helped to understand children's exposure to a key air pollutant, NO_2, in the school environment. Children learnt about air pollution and health impacts and road transport effect on air quality. This also became the point of connection between the environmental protection agencies and local communities on ways to improve air quality.

Environmental protection agencies from Flanders in Belgium, Estonia, Ireland, Italy, Malta, the Netherlands, Slovakia, Spain and Scotland in the United Kingdom were involved in running measurement campaigns as part of the project, and several other agencies are participating as observers. The Scottish Environment Protection Agency used NO_2 low-cost sensors instead of passive samplers to identify peak NO_2 levels during the day when parents dropped off and picked up their children in cars or when school buses running on diesel fuel delivered the pupils.[39]

In the United Kingdom especially London and a few other cities of Europe, the nascent beginning of environmental justice has taken shape around citizen's science. The application of low-cost sensors have created the opportunity to arm the community with data to drive change at the grassroots level.

One of the biggest low-cost sensor networks was piloted in 2018 in London as a 'Breathe London' campaign by the Greater London Authority.[40] This allows assessment of pollution hotspots and evaluate impact of policies through a network of 100 stationary sensors, combined with mobile monitoring on nearly 600 km of varied roads of Greater London. This has helped to create insight into local air pollution levels and exposure where people live and work. This has enabled implementation of the first Ultra Low Emission Zone (ULEZ) in Central London. The monitoring has helped to capture the impacts of the ULEZ restrictions.[41]

Such hyper-local measurements have improved air quality modelling to identify pollution hotspots and create annual pollution maps. This has supported enhanced source apportionment at the city's schools, hospitals and care homes, and helped to calculate pollution impacts of different policy scenarios.

4.3 Africa

The countries of Africa are most challenged in terms of air quality data. It is noted that Africa with 1.3 billion people, have about 50 publicly accessible air quality monitoring

stations measuring $PM_{2.5}$. There are very few regulatory monitors. While the absence of data constraints cohesive air quality management strategy, it also makes it very challenging to understand the iniquitous impact of the toxic air on vulnerable communities. In Arica, the nascent steps are towards sensor-based monitoring to enable data generation as well as sensitize communities about their exposures.

The United Nations Environment Programme (UNEP), together with UN-Habitat and IQAir, have started sensor-based monitoring in Africa. They have a global air quality data platform, bringing together real-time air pollution data from citizens, communities, governments and the private sector.[42]

Under the UN Platform Addis Ababa, Nairobi and Kampala are engaged in deploying local monitoring networks. The data is expected to inform the citizens and the governments for decision making.

More efforts have been made, including the Open Seneca Nairobi project to promote citizens science pollution mapping.[43] In Nairobi, mini buses, called *matatus*, and boda bodas (motorcycle taxis) have been equipped with sensors to generate data. People are being sensitized about how to interpret the air quality data thus collected.[44] These programmes are designed to raise awareness, especially along transport corridors to influence commuter behaviour, urban planning and legislation.

As in India, there are also efforts to generate data on the exposure on indoor air quality impacted by cooking on solid fuels.

4.4 Latin America

Although air pollution in Latin America poses a serious threat to the environment, few studies have examined how environmental justice may be affected by this problem.[45] There is a dearth of research on environmental justice and environmental health disparities related to air pollution in Latin America, with the majority of studies taking place in Brazil, Mexico and Chile.

There is a definite pattern of increased exposure in socially impoverished areas, according to studies that examined disparities in exposure to air pollution. Research that looked at how different people are affected by air pollution has yielded conflicting results, although many have discovered a distinct modification of effect, with people in lower socioeconomic categories showing larger effects. Notwithstanding the colonial and slave histories of Latin America, ethnic or minority communities have never been taken into account in research.

5

ENVIRONMENTAL JUSTICE POLICY AND DATA ANALYSIS FRAMEWORK

HIGHPOINTS

Local air pollution issues require clearer definitions of vulnerable groups, which are often overlooked by policies.

Effective air quality policies must engage marginalized communities and ensure equitable risk reduction.

Policymaking requires thorough scoping, multi-layered analysis, and stakeholder input to address disparities within the air quality management framework.

Air-quality monitoring to profile vulnerability risk

As the environmental justice movement built its momentum, efforts had to be made to generate air quality data to inform policy and communities. A regionally representative ambient air quality measurement can mask enormous disparities in air quality exposure across different neighbourhoods of a region.

In the absence of spatially distributed data, there has been considerable ambiguity and uncertainty about risks and exposure patterns that has made decision-making process difficult to fend off political challenges. The authorities are more likely to refrain from responding to these concerns if evidence is uncertain. The experts have pointed out that risk aversion may develop among civil servants as organizations aim to create new regulations that cause the least amount of harm rather than significant gains.[1]

Measuring the socio-economic benefits of regulatory action is difficult if the data is imprecise and subjective. It is exceedingly difficult to quantify socio-economic aspects. Data is either unavailable, incomplete or inaccurate, and laden with biases, e.g. the value one places on human life or accessibility to affordable healthcare varies.

However, technological innovation that has enabled sensor-based monitoring technologies could be applied to areas that are outside the orbit of regulatory monitoring to generate indicative data on the spatial variations in air pollution exposure. The monitoring protocol and its usability for regulatory compliance are still not final. But these sensors generate useful indicating data.

In fact, the regulators have begun to support deployment of sensor-based monitoring in targeted communities to generate data. For instance, in California, the California Air Resources Board (CARB) and the local air district have sponsored two groups of non-profits that have installed more than 100 small monitors outside residents' homes and near childcare centres and schools in Richmond and neighbouring San Pablo. These sensors measure the levels of particulate matter, nitrogen dioxide and ozone. Another agency that has fitted cars with air monitors are driving around Richmond to collect more detailed, block-level data. Analysis of the data so far has led the community to identify two pollution hotspots near industrial facilities and major highways.[2] There has also been a pilot in the Los Angeles basin by Aeroqual, which started in 2017, following the California state government's rule AB 617 which mandated community-level air quality monitoring installed in the area by mid-2019.[3]

Leveraging data and research to define vulnerable groups

One of the challenges have been the ambiguity in defining vulnerable groups for policymaking. The policy drafting organizations have their own valuation inaccuracies and unclear definitions that further compound the issue. These ideas are largely derived from research methods. Often researchers need to have controlled comparison groups to evaluate the impact of an environmental justice policy or action on different community groups. However the inconsistent definitions of 'minority' or 'low income' or the ambiguous definition of 'disparate impact' make data collection and sorting difficult.

If a given environmental rule has broadly worded mandates, the degree of implementation is left at the discretion of the ruling government. For example, the Bush administration actively worked to modify the definition of environmental justice and the EPA shifted the focus of the environmental justice programme by de-promoting minority and low-income people and emphasizing the concept of environmental justice for everyone.[4]

5.1 Why can environmental justice strategies be overlooked?

Instance where the environmental justice agenda can be overlooked are when social and/or environmental justice are clubbed as a part of a regional air pollution policy or a climate change policy. Environmental injustice is a characteristic of local air pollution; climate change and local air pollution are two fundamentally different problems.

Through the lens of climate change, the disproportionate impacts the underserved communities face can get overlooked for the 'greater good'. For example, in California under the Global Warming Solutions Act, or AB 32, government agencies attempted to address climate change and local air pollution under the same regulatory framework. There were disagreements on the function of market-based greenhouse gas (GHG) regulations.

Environmental justice supporters vehemently opposed California's GHG cap-and-trade programme because it does not ensure local air quality improvements, whereas economists and many policymakers supported the market-based mechanisms for GHG reductions (such as cap-and-trade or a carbon tax). Moreover, the 2006 legislation included many pro-ideas that were meant to provide environmental justice (EJ) communities with a seat at the table, but these first efforts fell short.[5]

Another important area to look into when it comes to the implementation of environmental justice laws or agendas is where the funding for the implantation of the statues is coming from and who decides how the funds would be dispersed. If the funds are coming from activities that violate environmental justice principles like the cap-and-trade or the polluter pays programmes, the laws are just allowing the industries to continue to pollute while giving the disadvantaged communities compensation which might not be enough.

Secondly, if the decision-making committee for the dispersion of funds comprises advocates of polluting industries, all the efforts towards emission-exposure reduction for the underserved may fall short. The sponsoring agencies can very well manipulate the results of a source apportioned studies in their favour.

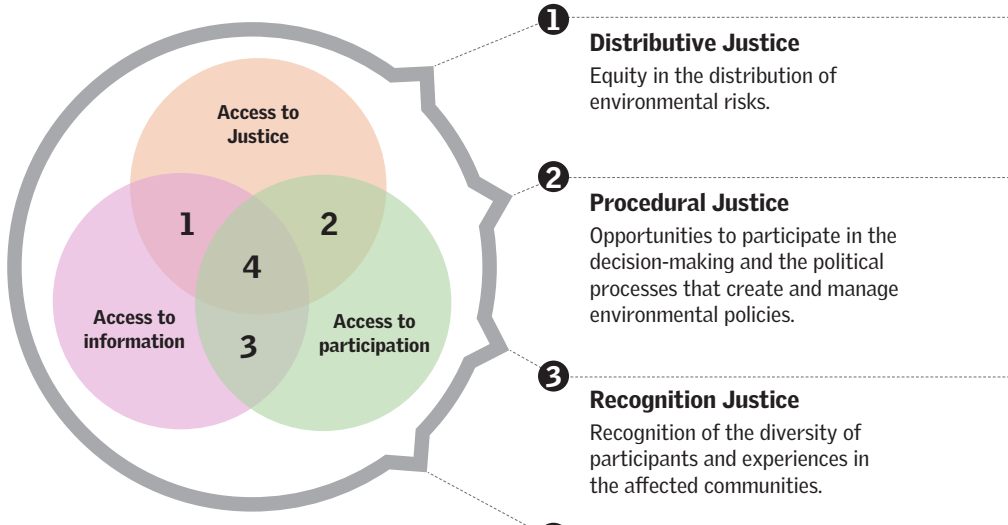
Understanding the different methodologies that can inform the consecutive steps of environmental justice policy is important for effective policymaking. Environmental justice policy, like every other justice-driven policy, needs science-backed, multi-variate and participatory analyses to inform appropriate identification of disparities faced by vulnerable communities and effective solutions.

Any Environmental justice policy intervention has three pillars, i.e. access to information, access to participation and access to justice. Within the ambit of these pillars, different aspects of environmental justice can be defined (see *Figure 6: Types of environmental justice*)

To reduce disparity in air pollution exposure and remediate negative environmental and social impacts faced by historically marginalized communities, policy drafting and its implementation have to ensure that the communities and the disparate exposure they face are recognized, that the affected communities are given opportunities to participate in decision-making and political processes of environmental regulation and that there is an equitable distribution of environmental risks. This requires a thorough scoping and study of indicators of environmental injustice to define the disparity and the scientific methods and models to recognize and quantify this disparity.

Environmental justice studies can be different from conventional air pollution studies because of community interest and incentives, diversity of stakeholders and, the trans-disciplinary and inter-disciplinary expertise required for defining the problem. Apart from the usual air pollution analysis, environmental justice policymaking involves an added layer of the socio-demographic aspect of the control group along with stakeholder consultation and participation at every step.

Figure 6: Elements of environmental justice



Source: Compiled by CSE

Simultaneous identification of both regulatory and air pollution modelling options, cross-sectoral cumulative impact, risk, benefits and cost assessment for every regulatory option, and stakeholder inputs and participation are also equally indispensable. All these factors necessities the researchers and the regulatory bodies to select the comparative indicators and the analysis methods after a thorough scoping of applicability, accessibility and availability of the necessary information, tools and institutions.

The selection of indicators to qualify the prevalence of environmental injustice and further quantify the same to enable continuous monitoring and assessment of any policy measure implemented is an important preliminary step in any environmental justice policy drafting. The role of indicators here is to move environmental justice issues from a theoretical concept to something tangible and quantifiable.

The genesis of environmental injustice in any society is a result of multiple factors acting simultaneously hence, any environmental justice indicator must incorporate multiple measures from two or more fields that can entail these factors. Measure here is a single dataset from a field that adds to or impacts environmental injustice like health, enforcement, environmental pathogenesis etc.

Usually, one or more socio-economic status (SES) measures are analysed as an independent variable against a measure of health or environmental condition as the dependent variable. Only by combining different measures can an indicator detect and quantify existing and potential environmental injustices in any given community. As a result, even though the term 'environmental justice' is frequently used, it is always defined and quantified using context-specific indicators, which are composed of context-specific measurements (which can be objective or subjective) that are specifically developed consultatively to address an environmental justice (EJ) question that is important to a particular community.

The creation of an indicator can be achieved by either a top-down or bottom-up approach. A top-down approach can be implemented by a government monitoring or a surveillance agency when environmental injustice is well-defined and quantifiable and the local government wants to ensure and demonstrate that all the possible environmental injustices within its jurisdiction are detected and monitored.

However, it is more common and practical to apply a bottom-up approach to create environmental justice indicators. This can be approached as a response to known or suspected environmental justice issues. Through a consultative process with all the stakeholders, the exact nature of the disparity can be defined and accordingly, suitable sets of measures can be identified and combined to create an indicator. This way, the indicator will be created taking into consideration the problem definition, data sources and analytical and monitoring capacities.

The measures that can be combined to create an environmental justice indicator can be grouped into four broad fields—health measures, demographics, environment and, regulatory and enforcement procedures. An indicator can be created by combining two or more measures from these fields. For example, measures from environment, health and demography can be combined to create the indicator of prevalence of asthma by SES in areas with polluting facilities.[6] The bottom-up framework to create an environmental justice indicator is based on the idea that at the root of environmental injustice, an understanding of equity based on the SES of the community is imperative (see *Figure 7: Environmental justice indicator framework*).

Any indicator that is designed can only be as effective as the consultation process and the knowledge bank behind it. For the indicators to fulfil their intended purposes it is important to implement the best methodology available and accessible to create the database required to deploy and later monitor the indicators. Sorting of

the applicable air pollution analysis and modelling methods should be one of the prerequisites for environmental justice analysis.

From simple proxy methodologies that use the location or amount of pollution to approximate the hazard of air pollution at a location to complex process-based methods like Chemical Transport Models (CTMs) that simulate atmospheric conditions for the chemical species of interest using emission and meteorological data, air pollution analysis and modelling methods have evolved a lot over the decades. Depending upon the policy objective and its status quo and, the availability of data, data analysis and modelling methods can be selected.

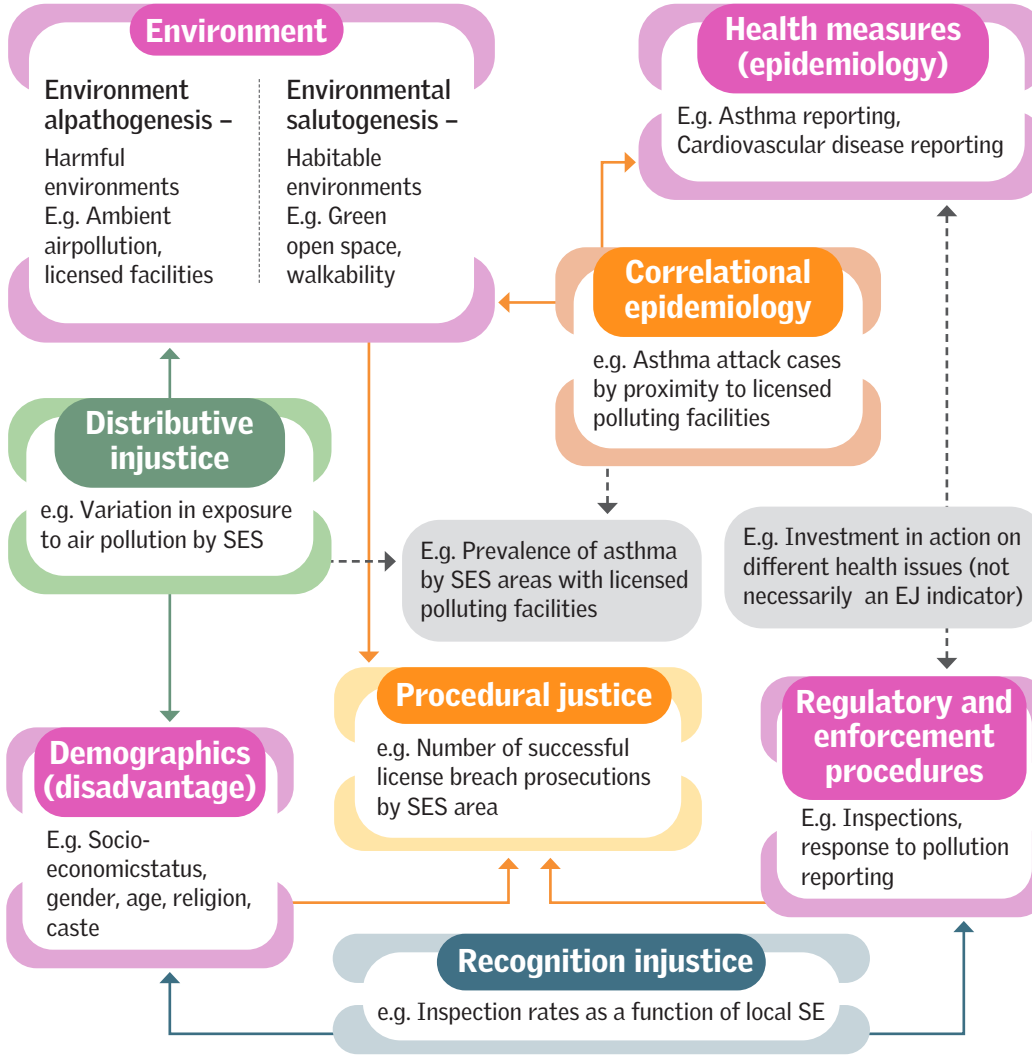
Based on the goal of the study, the pollutant and the domain of interest, researchers will have to select appropriate air pollution data analysis and modelling methods. This selection process should also take into consideration the availability of data and accessibility of the method (methods like ArcGIS require higher computational capacity and are also not open access). A critical review of environmental justice studies by Rivkah Gardener-Frolick et al. identified the tenets for selecting the environmental justice data analysis methods, i.e. accuracy, interpretability, spatiotemporal resolution and usability (see *Figure 8: Factors impacting air-pollution-related health effects and corresponding elements of method selection framework*).[7]

Accuracy of concentration estimates in environmental justice studies becomes a linchpin when the objective is to understand the scale of disparity in distributional patterns against regulatory standards or health-based guidelines or the potential impacts of environmental justice intervention. In other instances where the goal of a study is to find relative concentrations like the identification of air pollution hotspots, the method can be precise and need not be accurate because a piece of precise information would still give valuable inputs on which neighbourhoods are relatively more exposed.

Environmental justice studies require certain spatial or temporal resolutions and some methodologies with high accuracy might not be able to provide these requirements. Many environmental justice goals are to ascertain exposure disparity at neighbourhood levels. Moreover, the accuracy of monitor-based data depends on the instrumentations and the measurement techniques and acquiring this accuracy becomes difficult in areas with sparse monitoring networks; basing the inference on only areas with sufficient monitors leads to biased results and interpretations. This brings us to another important tenet, i.e. interpretability.

Interpretability in environmental justice studies is the ability to identify the causal relationships and the factors governing the observed concentrations.

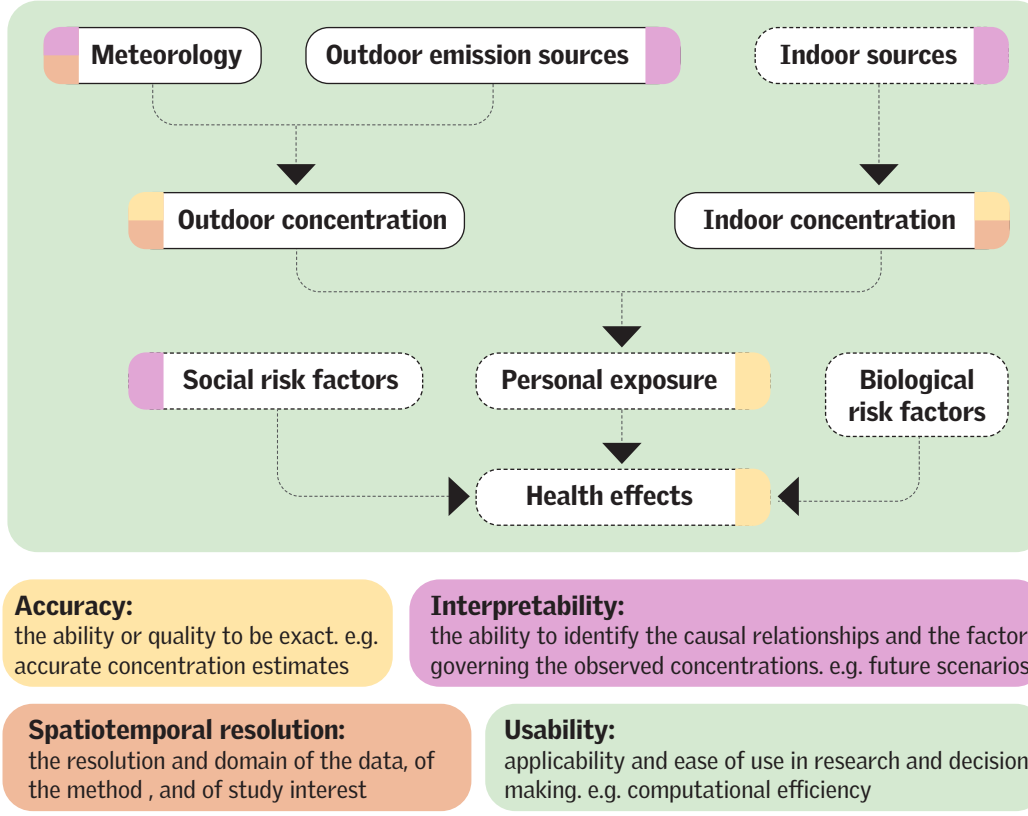
Figure 7: Environmental justice indicator framework



Source: Geoffrey R. Browne, Lucy Dubrelle Gunn and Melanie Davern, 2022. A Framework for Developing Environmental Justice Indicators, MDPI

After the identification of an environmental justice (EJ) community, the next step is narrowing targeted actions backed by evidence-based policies. Regression modelling methods like land use regression (LUR) and process-based methods like Chemical Transport Models (CTMs) and Reduced Complexity Models (RCMs) are very interpretable due to their ability to determine the impact of various factors, individually or in combination, on the overall concentration. Interpretability is important in environmental justice studies if the goal is to identify the upstream socio-economic drivers that cause the disparate exposure. This will aid the policy-makers in incorporating these drivers in the initial stages of drafting and deploying targeted actions to reduce the disparity in exposure.

Figure 8: Factors impacting air-pollution-related health effects and corresponding elements of the method selection framework



Note: The colour boxes within the flowchart represent the corresponding elements of the method selection framework for consideration

Source: Rivkah Gardner-Frolick, David Boyd, and Amanda Giang, 2022. Selecting Data Analytic and Modeling Methods to Support Air Pollution and Environmental Justice Investigations: A Critical Review and Guidance Framework, *Environmental Science and Technology*.

Last but not least is the usability of the methodology. Environmental justice studies, unlike other air pollution studies, are interdisciplinary and policy action-oriented and the researchers working on environmental justice studies might or might not be adept with the complex air pollution estimation methods. It is equally difficult to find methods that are easy and cheap but, offer accuracy at fine temporal and spatial scales.

Table 2 shows a list of the methods and their corresponding accuracy, usability, interpretability, spatial-temporal scale and their common applications and data requirements. Depending upon the status of the policy, and availability of data administrational capacity a framework for environmental justice policy assessment can be formed.

Table 2: Methods commonly used in environmental justice analysis

	Method	How has it been used?					Why is it used?		
		Common application	Data requirement	Spatial scale	Temporal scale	Common pollutants	Accuracy	Interpretability	Usability
Proxy – methods	**Unit-hazard coincidence**	Pattern description	Location of hazard, sometimes emissions	Regional–national	Yearly or longer—data does not change quickly	Hazardous Air Pollutants (HAPs)	Low—Low concentration accuracy but can capture other detrimental effects from environmental hazards	Medium—Can pinpoint where the hazards are but their area of impact may be mischaracterized	High—Highly useable with easily accessible data
	Proximity analysis	Pattern description	Location of hazard, sometimes emissions	Local–national	Yearly or longer—data does not change quickly	Hazardous Air Pollutants (HAPs) or Traffic-related air pollutants (TRAPs)	Low – Low concentration accuracy but can capture other detrimental effects from environmental hazards	Medium—Can pinpoint where the hazards are but their area of impact may be mischaracterized (though to a potentially lesser extent than UHC)	High—Highly useable with easily accessible data
Monitor-based methods	**Personal exposure**	Pattern description, Health	Monitoring from wearable monitors or stationary micro-environment monitors	Hyperlocal	Short term	HAPs or TRAPs	High—Highly accurate concentration estimation of what a person breathes	Medium—Can be highly accurate depending on study design but may not be generalizable to larger populations	Low—Personal or micro-environmental monitoring can be costly and difficult to organize
	Interpolation	Pattern description	Stationary or mobile monitor	Local–regional	Short-term to yearly or longer	Criteria pollutants	Medium—Dependent on the availability of data but can capture relevant statistics (mean, standard deviation) of concentration	Low—It may not be clear what is influencing concentrations without further data analysis	High—Highly useable with easily accessible data
	Satellite data	Pattern description	Satellite	Regional – National	Short-term to yearly or longer	Particulate matter (PM), Ozone (O3)	Medium—Dependent on meteorological data	Low—It may not be clear what is influencing concentrations without further data analysis	Low—Data may be more difficult to access and the format may be challenging

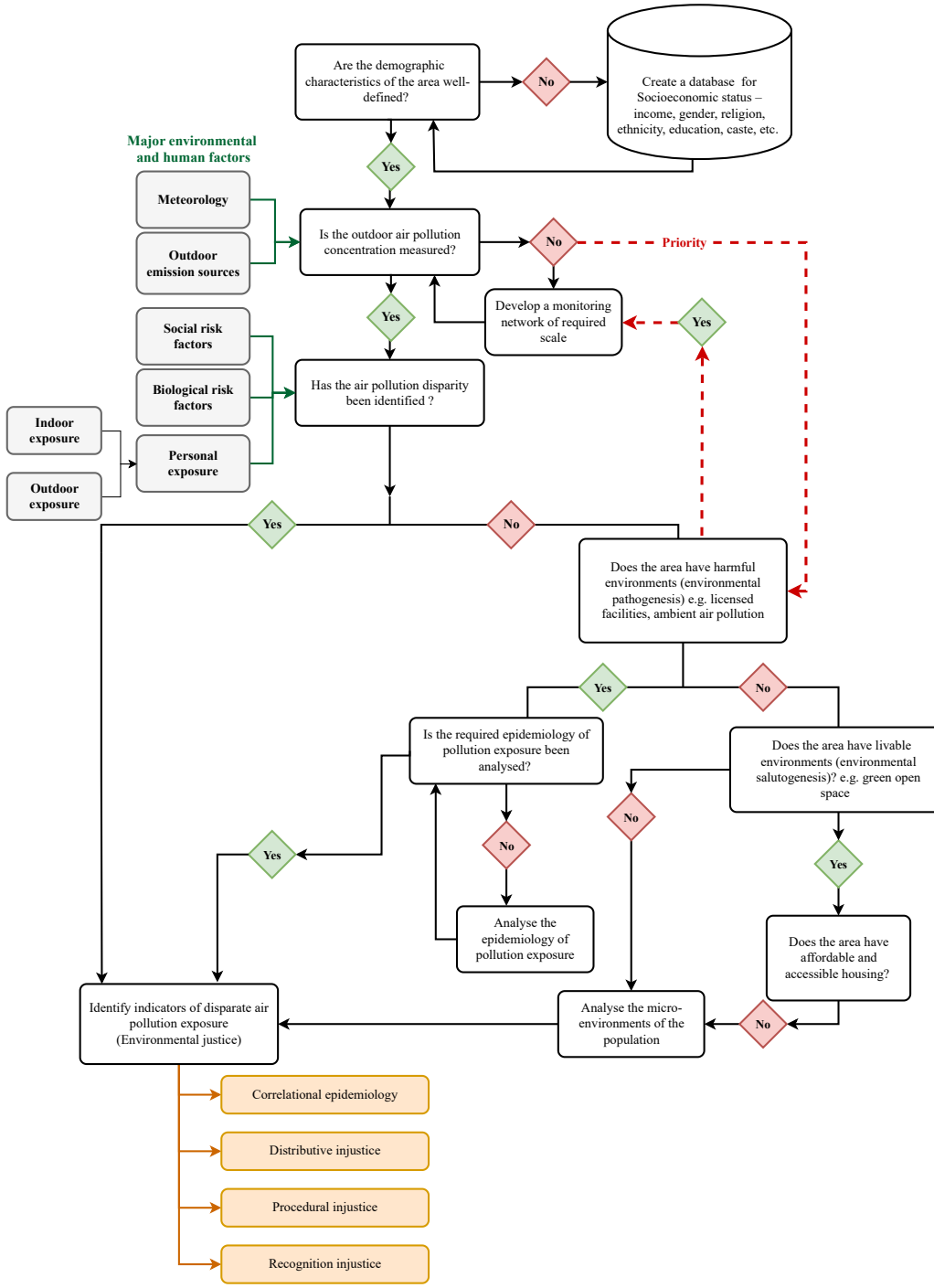
	Method	How has it been used?					Why is it used?		
		Common application	Data requirement	Spatial scale	Temporal scale	Common pollutants	Accuracy	Interpretability	Usability
Statistical methods	**Kriging interpolation**	Pattern description	Stationary or mobile monitor	Local–regional	Short-term to yearly or longer	Criteria pollutants	Medium—Dependent on data availability but generally estimates concentrations well due to consideration of spatial autocorrelation	Low—It may not be clear what is influencing concentrations without further data analysis	High—Highly useable with easily accessible data
	Land Use Regressions	Pattern description	Stationary or mobile monitor, geographic variables	Local–regional	Yearly or longer– data does not change quickly	Criteria pollutants, TRAPs	Medium—Dependent on the availability of concentration and geographic data	High—Ability to see which variables are most significant in the model	High—Highly useable with easily accessible data as geographic variables are often easy to obtain
	Emerging models	Pattern description	Stationary or mobile monitor, geographic variables, meteorologi-cal, or others	Local–regional	Moderate length–yearly	Criteria pollutants	Medium—Dependent on the availability of data and user experience	Low—It may not be clear what is influencing concentrations and the ability to extrapolate is low	Low—The method is complex, and success is highly dependent on data inputs and user experience
Process-based methods	**Dispersion models**	Pattern description, health, explanation, future scenario	Emissions from point, line, or area source(s), meteorological	Local–regional	Short-term to yearly or longer	Range of non-reactive aerosols and gases	High—Concentration can be highly accurate (especially more complex models) due to consideration of meteorology	Medium—Can be interpretable through what-if analysis	Medium - Easy to use for modelling with some simple options available but can get more complicated
	Chemical Transport Models (CTMs), Reduced Complexity Models (RCMs)	Pattern description, health, explanation, future scenario	Emissions from point, line, or area source(s), meteorological	Local–national	Short-term to yearly or longer	Any health-relevant aerosol or gas	High—Concentration can be highly accurate (especially more complex models) due to consideration of meteorology	Medium—Can be interpretable through what-if analysis	Low - The method is complex and requires modelling expertise

Note: Pattern description: Captures air pollution patterns related to sociodemographic variables. Health: Connects concentrations with health risks or outcomes. Explanation: Focus on ore interpretation—what affects concentrations and why. Future scenario—What-if analysis

Source: Rivkah Gardner-Frolick, David Boyd, and Amanda Giang, 2022. Selecting Data Analytic and Modeling Methods to Support Air Pollution and Environmental Justice Investigations: A Critical Review and Guidance Framework, Environmental Science and Technology.

Figure 9: Environmental justice policy decision-making framework

Example of a decision-making framework to assess the applicability of environmental justice policy in an area or a community. The indicators for environmental justice (EJ) policy can be further refined or designed depending upon the kind of air pollution exposure disparity.



Note: *The "**priority**" in the framework is put to ensure that the areas with polluting facilities are captured by the monitoring network*

Source: CSE

6
NEXT STEPS

HIGHPOINTS

Adopt framework for operationalising equity based air quality assessment and community based exposure management.

Implement regulatory tools to map exposure levels of communities and refine action accordingly.

Sectoral strategies and interventions need to account for the impact on vulnerable communities.

India needs to adopt a dedicated environmental justice policy framework. There are policy levers within the current legal framework that can enable equity measures. Often tackling inequities in air pollution exposure gets obscured by the emphasis on making sure that everyone has access to a good environment and in doing so, the innate disparities in air pollution exposure get overlooked.

Both science and regulatory framework have evolved to recognise the markers of disproportionate exposure, identification of the disparately exposed communities, and what influence their exposures.

This requires well-defined provisions for access to information, and access to participation for the vulnerable and marginalized population. Access to information and participation will aid in recognition of the diversity of the population and experiences in the affected communities.

Need framework for operationalising environmental justice approaches

The environmental legislations and regulations as well as judicial interventions in air pollution related public interest litigation, have already laid down the foundation for just action to address the special risks to the disadvantaged communities. However, specific policies, programmes and schemes despite taking on board the inclusive and equity principles do not get translated into specific operational framework for explicit implementation strategies.

At the same time, the framework that has been adopted by the Ministry of Environment Forests and Climate Change for framing of the climate action plans in states have provided for assessment of vulnerability of communities, livelihood impacts, adaptation measures for the vulnerable communities, skill development to minimise livelihood disruptions among others. This framework needs to be adequately expanded for clean air action.

Under the NCAP programme, cities are required to plan and report progress based on pre-defined indicators in different sectors of pollution. These indicators need to be reoriented to account for differentiated impacts on different communities. Even without this intended design several strategies are included in clean air action plans that are delivering on environmental justice programme. Nearly, all strategies identified for clean fuel transition in industry, transport, households, need to be calibrated based on equity action. The national programme Ujjwala to expand community access to LPG to replace solid fuels for cooking and complementary state government policies is an examples.

Develop regulatory tools to address vulnerability and refine action plans accordingly

The current policy approaches have not adopted any clear definition of vulnerability and vulnerable to address disproportionately higher impacts on these groups for enabling remedial action. The current provisions are discretionary in nature. A well-defined criteria and tool for equity impacts need to be mainstreamed into programme design, impact assessments, clearances and approval, permit schemes among others. NCAP as well as sectoral policies need to include the full range of vulnerability including, children, women, elderly across all socio-economic groups as well as the disadvantaged communities. It is necessary to integrate these indicators early on to ensure equitably distributed welfare gains from the clean air action and reduce overall disease burden.

The air legislations need to include exposure management in addition to improvement in ambient air quality to strengthen community based approaches

The current limitation of the air quality management approach is the singular focus on ambient air quality in the Air Act, 1981. There is no explicit focus on 'exposure' that determines the health risk due to communities. The only policy recognition has come from the 2015 report of the Steering Committee on Air Pollution and Health Related Issues of the Union Ministry of Health and Family Welfare, which has stated that it is more important to know how close people are to the pollution source, what are they inhaling, how much time they are spending close to the pollution source than what occurs generally in the air that is influenced by climate and weather. Ambient concentrations do not always well represent human exposures and cannot indicate exposure and health outcome.

Innovate and strengthen air quality monitoring to map out exposure patterns of communities for remedial action

Even though the air quality monitoring network is expanding steadily across the country there are still large data shadow areas in the regions as well as in cities. It is often not possible to generate data on the exposure levels of the communities in the vicinity of pollution sources or in urban peripheries etc. In fact this is one of the lessons from the US where the regulatory monitoring covers only 20 per cent of their counties. As a result, there is not enough information on exposure patterns of a large number of communities.

Therefore, in India as well, multi-dimensional monitoring is needed to get indicative data for dispersed polluted industrial zones, areas of power generation, congestion hotspots, highway traffic, waste dumpsites and waste to energy plants,

slums and squatter settlements, unauthorized colonies outside the municipal limits, and sensitive areas including schools, hospitals, old age homes among others.

As it is very expensive to expand regulatory monitors so widely, it is necessary to leverage satellite data and sensor network to generate the targeted data on exposure patterns to refine the action strategies. The Central Pollution Control Board has supported initiatives on satellite based air quality monitoring. It has also stated in a 2022 directive that sensor based monitoring can be applied to assess local exposures in pollution hotspots but not for regulatory compliance. The civil society groups and academia have begun to assess air quality based on satellite data and sensor based network. This needs to be planned better from the perspective of community exposure mapping.

Strengthen hyperlocal hotspot action along with city/region-wide systemic changes under NCAP to address vulnerable groups

Under the NCAP programme the cities designated as non-attainment have been mandated to identify and implement hotspot action plan to address local pollution. But there is no policy to combine the pattern of exposures of the local communities as a criteria to define hotspot action. These hotspots include industrial areas, high traffic areas, highways, densely populated residential neighbourhoods, and low income neighbourhoods. While mapping the pollution sources that include road dust, construction sites, traffic congestion, and open burning of waste etc. indicate the nature of exposure of the local communities, nature of their vulnerability, coping capacity and the expected local benefits are not included. Communities living near highly toxic landfills are often not included in these hot spot action plans. This will require supportive surveys to refine action. Moreover, several sources like traffic congestion cannot be solved only with local traffic engineering solutions. These require more systemic action for real impacts.

Sectoral strategies and interventions need to account for the impact on vulnerable communities

It is not only exposure and disproportionate health risk to the vulnerable communities that need to be assessed. It is equally important to assess the impact of sectoral policy measures for pollution control on the vulnerable communities with very weak coping capacity. The sectoral action designed for reducing overall air pollution are also linked with jobs and livelihoods of the vulnerable communities. Increased costs associated with complying with regulations or relocation of polluting industries can have a direct negative effect on earnings and employment,

leading to displacement. It is important to take these effects into consideration and incorporate safeguards into the policy measures.

In the industrial sector, air pollution control measures require effective emissions control systems, clean fuels, siting policy to keep them away from the habitat, and strong compliance framework. There are pollution control strategies for the critically polluted areas. Even siting policies have been adopted for industrial locations. These need to be planned through the prism of impacts on communities that determines the health and welfare risks.

Moreover, during pollution episodes in winter the non-compliant industries are shut down. Most of these are small and medium industries (MSMEs) that employ the vulnerable groups including informal workers. Stronger compliance requirements, transition to clean fuels and technologies and any relocation can impact the jobs and livelihoods in these units. The air pollution control policies need to integrate the safeguards and several enablers to support innovative approaches to minimise dislocation.

Already small step are being taken towards cluster development approaches to allow development of common infrastructure for MSMEs. Sharing of assets such as common boilers equipped with emission- control systems and access to clean and affordable fuels are being developed in several states to reduce the burden of compliance on each unit and also enhance productivity and competitiveness of the industry. Similarly through aggregation model, innovation, skill building, market access strategies are being facilitated.

On the other hand, economic instruments like interest subvention, subsidies and tax incentives can be designed to reduce the cost of finance and transition. Environmental safeguards can be further scaled up and supported to improve the occupational health and safety of the workers. The overall efforts to reduce pollution in MSME clusters can also reduce environmental risks for the communities living in close proximity.

Integrate equity benchmarks in infrastructure projects for pollution control

Multi-sector clean air action requires infrastructure development to enable sustainable choices for the larger population. But the planning and design of the new infrastructure or urban renewal may not have adequate safeguards to protect the vulnerable communities. This is evident in the infrastructure plans in the transport sector. Currently, all clean air action plans have included affordable

zero emission travel modes including walking and cycling. These are the modes of the urban poor which is also part of the solution to air pollution. But this needs to be mainstreamed as a mode of choice for the higher income groups. But the infrastructure projects to enable mass scale walking and cycling are often neglected in the planning and execution of clean air action plans.

Similarly, several steps are being taken to scale up formal and modern public transport systems like metro and modern bus systems to clean air and climate action. But public transport services are not being planned and deployed equitably and affordably. A CSE study of 2018 showed that compared to the global standard, where transport is considered affordable if no more than 10–15 per cent of household income is spent on it, or where the bottom 20 per cent of households spend less than 10 per cent of their income on transport, nearly one-third (34 per cent) of Delhi's population remains unable to afford even basic non-air-conditioned bus services.[1] Reduced spending on housing, healthcare, and education results from higher transportation spending, which impedes inclusive growth. Nonetheless, a number of state governments do implement laws to maintain free bus fares for specific demographics, such as women. However, there is no state-level funding plan for viability gas funding, tax reforms, revenue generation from other sources, etc. to create a sustainable financing model. The long-term affordability and sustainability of the public transportation system require creative solutions.

On other hand, development and modernization of public transport infrastructure—metro, bus rapid transit systems etc.—can also push the poor out of the city and disrupt their livelihoods, increase travel distances and costs of living. A preliminary study by the Transportation Research & Injury Prevention Programme (TRIPP) discovered that the Delhi Metro had displaced slums. For the majority of the relocated households, cycling and bus distances had increased by several kilometers, as had journey time.[2] In a similar vein, the number of trips and average distances to services had both gone up. This contributed to the community's declining percentage of people who cycle and walk.[3] Another study conducted by CEPT reveals that while spending on health and education has stagnated, the bottom 50% of the population now spends a larger portion of their household budget on transportation. In Ahmedabad, the BRT has forced out almost 2,000 vendors.[4]

This further aggravates the structural inequity that weaken the coping capacity of the communities. Pro-poor mobility and housing need to be aligned with air pollution control measures to allow diverse livelihood choices and make labour market efficient.

Numerous transportation policies have emerged that, with appropriate implementation, can tackle inclusive planning. For example, the Transit Oriented Development Policy mandates mixed-use and mixed-income development with enhanced accessibility in compact urban forms close to transit nodes. Institutional measures are required for effective delivery and the policies at the national, state, and local levels must be made more pro-vulnerable planning.

Waste management to de-risk communities

Waste management must address disparities in exposure levels among different communities. Due to the higher income groups' tendency to push such operations into the back alleys of cities, the not-in-my-backyard mentality is currently impeding spatial planning for decentralized waste management in neighborhoods. Concurrently, in an attempt to get rid of their garbage, cities are indiscriminately installing waste-to-energy facilities in neighborhoods with high population densities and in neighborhoods with vulnerable communities While safe siting regulations are being flouted, the technically advanced emissions control systems and compliance required in these plants are also being insufficiently addressed.

However, robust and well-funded waste management policies and programmes like the national Swachh Bharat Sarvekshan are in place to mandate the cities to achieve certain waste management requirements like – 100 per cent waste collection, segregation, material recovery etc. While this has created conditions for reduce waste-related risks, the overall the programme is still not nuanced enough to ensure that specially exposed groups specially those communities that live on the marginal lands close to the dump sites are addressed. Therefore, the evolving clean air action plans need to address the disproportionate distribution of inequities in population and further fine tune the interventions.

Generate data on local sources of pollution and exposure risks to increase community awareness and participation

Along with the identification of the vulnerable communities that disproportionately bear air pollution exposure, an understanding of what causes this disparity is required to devise an effective legal and implementation framework. Leverage the all the regulations related to environment impact assessment and public participation requirements for meaningful action.

References

The spotlight

1 Health Effect Institute 2024. State of Global Air 2024: Special Report, Boston, USA. Accessed at https://www.stateofglobalair.org/resources/report/state-global-air-report-2024

2 The World health Organisation 2015. Health and the environment: addressing the health impact of air pollution. Accessed at https://apps.who.int/gb/ebwha/pdf_files/WHA68/A68_18-en.pdf

3 Jun Rentschler and Nadia Leonova 2022. Air pollution kills—Evidence from a global analysis of exposure and poverty, *The World Bank Blogs*. Accessed at https://blogs.worldbank.org/en/developmenttalk/air-pollution-kills-evidence-global-analysis-exposure-and-poverty

4 Anamika pandey et al. 2021. Health and economic impact of air pollution in the states of India: The Global Burden of Disease Study 2019, *The Lancet Planetary Health*. Accessed at http://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30298-9/fulltext

5 Anon. 1950. The Constitution of India, Government of India. Accessed at https://cdnbbsr.s3waas.gov.in/s380537a945c7aaa788ccfcdf1b99b5d8f/uploads/2023/05/2023050195.pdf

6 United States Environmental Protection Agency n.d. . Environmental Justice Timeline. Accessed at https://www.epa.gov/environmentaljustice/environmental-justice-timeline

7 United States Environmental Protection Agency 1992. Environmental Equity: Reduced Risk For All Communities, *US EPA*. Accessed at https://www.epa.gov/sites/default/files/2015-02/documents/reducing_risk_com_vol1.pdf

8 United States Environmental Protection Agency n.d. . Environmental Justice Timeline. Accessed at https://www.epa.gov/environmentaljustice/environmental-justice-timeline

9 Ibid.

10 Ibid.

11 United States Environmental Protection Agency n.d.. Inflation Reduction Act Environmental and Climate Justice Program. Accessed at https://www.epa.gov/inflation-reduction-act/inflation-reduction-act-environmental-and-climate-justice-program

12 Ministry of Health and Family Welfare 2015. Report of the Steering Committee on Air Pollution and Health Related Issues, *Government of India*. Accessed at https://theasthmafiles.ss.uci.edu/sites/default/files/artifacts/media/pdf/report_of_the_

steering_committee_on_air_pollution_and_health_related_issues_ministry_of_health_family_welfare.pdf

13 Anumita Roychowdhury and Gaurav Dubey 2018. The Urban Commute: And how it contributes to pollution and energy consumption, *Centre for Science and Environment*, New Delhi. Accessed at https://www.cseindia.org/the-urban-commute-8950

14 Anvita Arora and Geetam Tiwari 2007. A Handbook for Socio-economic Impact Assessment (SEIA) of Future Urban Transport (FUT) Projects, Transportation Research and Injury Prevention Program (TRIPP), *Indian Institute of Technology*, New Delhi. Accessed at https://www.researchgate.net/profile/Anvita-Arora/publication/316881853_A_Handbook_for_Socio-Economic_Impact_Assessment_SEIA_Methodology_for_Future_Urban_Transport_FUT_Projects/links/5915d6064585152e199f60bf/A-Handbook-for-Socio-Economic-Impact-Assessment-SEIA-Methodology-for-Future-Urban-Transport-FUT-Projects.pdf

15 Anvita Arora and Geetam Tiwari 2007. A Handbook for Socio-economic Impact Assessment (SEIA) of Future Urban Transport (FUT) Projects, Transportation Research and Injury Prevention Program (TRIPP), *Indian Institute of Technology*, New Delhi. Accessed at https://www.researchgate.net/profile/Anvita-Arora/publication/316881853_A_Handbook_for_Socio-Economic_Impact_Assessment_SEIA_Methodology_for_Future_Urban_Transport_FUT_Projects/links/5915d6064585152e199f60bf/A-Handbook-for-Socio-Economic-Impact-Assessment-SEIA-Methodology-for-Future-Urban-Transport-FUT-Projects.pdf

16 Darshini Mahade, Rutul Joshi, Abhijit Datey 2013. Ahmedabad's BRT system: A sustainable urban transport panacea? *Economic and Political Weekly*. Accessed at https://www.researchgate.net/publication/259289231_Ahmedabad's_BRT_system_A_sustainable_urban_transport_panacea

1. Equity impacts of air pollution in India

1 Health Effect Institute 2020. State of Global Air 2020: Special Report, Boston, USA. Accessed at https://www.stateofglobalair.org/resources/archived/state-global-air-report-2020

2 H. Spencer Banzhaf et al. 2019. Environmental Justice: Establishing Causal Relationships. *Annual Review of Resource economics*. Accessed at https://www.annualreviews.org/content/journals/10.1146/annurev-resource-100518-094131

3 Yi Chenju et al. 2022. In-utero exposure to air pollution and early-life neural development and cognition, *Ecotoxicology and Environmental Safety*, Elsevier. Accessed at https://pubmed.ncbi.nlm.nih.gov/35525116/

4 Sahana Mathiarasan and Anke Hüls 2021. Impact of Environmental Injustice on Children's Health—Interaction between Air Pollution and Socioeconomic Status, *Int. J. Environ. Res. Public Health*. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7832299/

5 Mariana Veras, Dunia Waked, and Paulo Saldiva 2022. Safe in the womb? Effects of air pollution to the unborn child and neonates, *Sociedade Brasileira de Pediatria*, Elsevier. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9510928/

6 Yi Chenju et al. 2022. In-utero exposure to air pollution and early-life neural development and cognition, *Ecotoxicology and Environmental Safety*, Elsevier. Accessed at https://pubmed.ncbi.nlm.nih.gov/35525116/

7 Douglas Almond and Janet Currie 2011. Killing me softly: The Fetal Origins Hypothesis. *J Econ Perspect*. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4140221/

8 Yi Chenju et al. 2022. In-utero exposure to air pollution and early-life neural development and cognition, *Ecotoxicology and Environmental Safety*, Elsevier. Accessed at https://pubmed.ncbi.nlm.nih.gov/35525116/

9 Sahana Mathiarasan and Anke Hüls 2021. Impact of Environmental Injustice on Children's Health—Interaction between Air Pollution and Socioeconomic Status, *Int. J. Environ. Res. Public Health*. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7832299/

10 Mariana Veras, Dunia Waked, and Paulo Saldiva 2022. Safe in the womb? Effects of air pollution to the unborn child and neonates, *Sociedade Brasileira de Pediatria*, Elsevier. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9510928/

11 Yi Chenju et al. 2022. In-utero exposure to air pollution and early-life neural development and cognition, *Ecotoxicology and Environmental Safety*, Elsevier. Accessed at https://pubmed.ncbi.nlm.nih.gov/35525116/

12 Douglas Almond and Janet Currie 2011. Killing me softly: The Fetal Origins Hypothesis, *J Econ Perspect*. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4140221/

13 CAPHER-India 2023. Effects of Air Pollution on Children's Health: Policy Brief 2023/1, New Delhi

14 UNICEF 2022. Childhood Air Pollution Exposure. Accessed at https://www.unicef.org/media/123156/file/Childhood_Air_Pollution_Key_Messages_2022.pdf

15 Kalpana Balakrishnan et al. 2015. Establishing integrated rural-urban cohorts to assess air pollution-related health effects in pregnant women, children and adults in Southern India: An overview of objectives, design and methods in the Tamil Nadu Air Pollution and Health Effects (TAPHE) study, *BMJ Open*. Accessed at https://bmjopen.bmj.com/content/5/6/e008090

16 Kalpana Balakrishnan et al. 2018. Exposures to fine particulate matter (PM2.5) and birthweight in a rural-urban, mother-child cohort in Tamil Nadu, India, *Environmental Research*. Accessed at https://www.sciencedirect.com/science/article/abs/pii/S0013935117312276

17 Health Effect Institute 2019. State of Global Air 2019: Special Report, Boston, USA. Accessed at https://www.stateofglobalair.org/sites/default/files/soga_2019_report.pdf

18 Narsimha Rao et al, 2021, Household contributions to and impacts from air pollution in India, Yale University, *Journal Nature Sustainability*. Accessed at https://www.nature.com/articles/s41893-021-007440.epdf?sharing_token=VQrXZYNUeZ99qw-JS8OqKO9RgN0jAjWel9jnR3ZoTv0Pg3Od43MRsZEe_7oYkd1g93Afsp2B-GhYSQO52nzYghYcvmcQEoMif0Rgk3N4buMvlpFNYZM53Pozg7MCorj4BSvwu-we8qIZ6PggGZufJpnSRgZ_B29BGkBJLfSrRDEBI%3D

19 Jun Rentschler and Nadia Leonova 2023. Global air pollution exposure and poverty, *Journal Nat Commun*. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10363163/

20 Jun Rentschler and Nadia Leonova 2022. Air pollution kills – Evidence from a global analysis of exposure and poverty, *The World Bank Blogs*. Accessed at https://blogs.worldbank.org/en/developmenttalk/air-pollution-kills-evidence-global-analysis-exposure-and-poverty

21 *As citied in* Anumita Roychowdhury et.el 2006. The Leapfrog factor: clearing the air in Asian cities, Centre for Science and Environment

22 Centre for Science and Environment 2019. State of India's Environment 2019 in Figures, *CSE*

23 The World health Organisation 2015. Health and the environment: addressing the health impact of air pollution. Accessed at https://apps.who.int/gb/ebwha/pdf_files/WHA68/A68_18-en.pdf

24 Anamika Pandey et al. 2021. Health and economic impact of air pollution in the states of India: the Global Burden of Disease Study 2019, *The Lancet Planetary Health*. Accessed at http://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30298-9/fulltext

25 A M Patankar 2010. Monetary burden of health impacts of air pollution in Mumbai, India: implications for public health policy, *Public Health*. Accessed at https://pubmed.ncbi.nlm.nih.gov/21334032/

26 Sashmita Behera et al 2021. Uneven economic burden of non-communicable diseases among Indian households: A comparative analysis, *PLoS ONE*. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8664228/

27 Anushree S. Panikkassery 2020. Impact of Out of Pocket Health Expenditure on Consumption Pattern of Below Poverty Line Households in India, *SAGE Journal*. Accessed at https://journals.sagepub.com/doi/10.1177/0976399619900608

28 Bharati Chaturvedi, Shruti Sinha, Komal Daal 2023. UNFAIR Quality: The impact of air pollution on three occupations, Chintan Environmental Research

and Action Group, *Clean Air Fund*. Accessed at https://idronline.org/wpcontent/uploads/2023/08/Chintan_UnfairReport_compressed.pdf

29 Ibid.

30 Vaishnavi Barthwal et al 2022. Health impact assessment of Delhi's outdoor workers exposed to air pollution and extreme weather events: an integrated epidemiology approach, *Environmental Science and Pollution Research*. Accessed at https://link.springer.com/article/10.1007/s11356-022-18886-9

31 Manas Ranjan Ray , Twisha Lahiri 2017. Air pollution and its effects on health – Case studies, India, *MDPI*. Accessed at https://www.mdpi.com/2225-1154/5/4/77

32 Anumita Roychowdhury, Rajneesh Sareen and Mitashi Singh, Construction and Demolition Waste: Closing the waste loop for sustainability, 2023, *Centre for Science and Environment*, New Delhi. Accessed at https://www.cseindia.org/construction-and-demolition-waste-11992

33 Ibid.

34 Xiaodong Yan et al. 2023. Occupational health risk assessment of construction workers caused by particulate matter exposure on construction sites, *Heliyon*. Accessed at https://www.sciencedirect.com/science/article/pii/S2405844023076417

35 Edited by Ann Rademacher and K Sivaramakrishnan n.d. Ecologies of Urbanism in India: Metropolitan Civility and Sustainability, *Hong kong University Press*. Accessed at https://www.csds.in/uploads/custom_files/1526550677_One%20Air%20Two%20Interventions%20Delhi%20In%20the%20Age%20Of%20Environment.pdf

36 Anon 2020. Supreme Court of India: Judgment in Sushila Aggarwal & Ors. Vs. State (NCT of Delhi), LiveLaw. Accessed at https://www.livelaw.in/pdf_upload/pdf_upload-380054.pdf on September 24, 2024

37 Ibid.

38 Amita Baviskar 2012. Chapter 7, Public interest and private compromises: The politics of environmental negotiation in Delhi, *India Cambridge University Press*, Edited by Julia Eckert et al

39 Gaurav Tomar, Ajay Singh Nagpure, Yash Jain, and Vivek Kumar 2023. High-Resolution PM2.5 Emissions and Associated Health Impact Inequalities in an Indian District. *Environmental Science and Technology*. Accessed at https://pubs.acs.org/doi/abs/10.1021/acs.est.2c05636

40 Jacob Kopas et. al. 2020. Environmental Justice in India: Incidence of Air Pollution from Coal-Fired Power Plants. *Ecological Economics*.

41 Gaurav Tomar, Ajay Singh Nagpure, Yash Jain, and Vivek Kumar 2023. High-Resolution PM2.5 Emissions and Associated Health Impact Inequalities in an Indian District. *Environmental Science and Technology*. Accessed at https://pubs.acs.org/doi/abs/10.1021/acs.est.2c05636

2. Regulatory framework for inclusive clean air action in India

1 Anon. 1950. The Constitution of India. Government of India. Accessed at https://cdnbbsr.s3waas.gov.in/s380537a945c7aaa788ccfcdf1b99b5d8f/uploads/2023/05/2023050195.pdf

2 Anon. 1981. Air (Prevention and Control of Pollution) Act, 1981, Government of India. Accessed at https://www.indiacode.nic.in/bitstream/123456789/12658/1/the_air_%28prevention_and_control_of_pollution%29_act_1981_no._14_of_1981_date_29.03.1981.pdf

3 Anon. 2006. Environmental Impact Assessment (EIA) Notification, 2006, Notification No. S.O. 1533(E), Ministry of Environment, Forest and Climate Change, Government of India. Accessed at https://environmentclearance.nic.in/writereaddata/EIA%20Notifications.pdf

4 Anon. 2023. EIA Notification S.O. 3372(E), Ministry of Environment Forest and Climate Change. Accessed at https://environmentclearance.nic.in/writereaddata/EIA_Notifications/70_SO3372E.pdf

5 Anon. 2022. EIA Office Memorandum IA3-22/23/2021-IA.III [E167077], Ministry of Environment Forest and Climate Change. Accessed at https://environmentclearance.nic.in/writereaddata/OM%2022-23-2021.pdf

6 Anon. 2022. EIA Office Memorandum IA3-22/10/2022-IA.III [E 177258].], Ministry of Environment Forest and Climate Change, Accessed at https://environmentclearance.nic.in/writereaddata/OMs-2004-2021/292_OM_07_05_2022.pdf

3. The missing links

1 Anumita Roychowdhury and Gaurav Dubey 2018. The Urban Commute: And how it contributes to pollution and energy consumption, *Centre for Science and Environment*, New Delhi. Accessed at https://www.cseindia.org/the-urban-commute-8950

2 Anvita Arora and Geetam Tiwari 2007. A Handbook for Socio-economic Impact Assessment (SEIA) of Future Urban Transport (FUT) Projects, Transportation Research and Injury Prevention Program (TRIPP), *Indian Institute of Technology*, New Delhi. Accessed at https://www.researchgate.net/profile/Anvita-Arora/publication/316881853_A_Handbook_for_Socio-Economic_Impact_Assessment_SEIA_Methodology_for_Future_Urban_Transport_FUT_Projects/links/5915d6064585152e199f60bf/A-Handbook-for-Socio-Economic-Impact-Assessment-SEIA-Methodology-for-Future-Urban-Transport-FUT-Projects.pdf

3 Ibid.

4 Darshini Mahade, Rutul Joshi, Abhijit Datey 2013. Ahmedabad's BRT system: A sustainable urban transport panacea? *Economic and Political Weekly*. Accessed at https://www.researchgate.net/publication/259289231_Ahmedabad's_BRT_system_A_sustainable_urban_transport_panacea

4. Global learning curve

1 Anon. 2003. 28 C.F.R. § 42.104. Accessed at https://www.ecfr.gov/current/title-28/chapter-I/part-42/subpart-C/section-42.104 on December 2, 2022

2 Alejandro Colsa Perez et al. 2015. Evolution of the environmental justice movement: activism, formalization and differentiation, *Environmental Research letters*, IOP Publishing Ltd.

3 Anon. 2003. 28 C.F.R. § 42.104. Accessed at https://www.ecfr.gov/current/title-28/chapter-I/part-42/subpart-C/section-42.104 on December 2, 2022

4 Anon. 1994. 59 FR 7629—Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations. Accessed at https://www.govinfo.gov/content/pkg/FR-1994-02-16/html/94-3685.htm on December 2, 2022

5 Anon. 1994. 42 U.S.C. §§ 7401-7671q – Air Pollution Prevention and Control, Accessed at https://www.govinfo.gov/content/pkg/USCODE-2010-title42/html/USCODE-2010-title42-chap85.htm on December 2, 2022

6 Anon. 1994. 42 U.S.C. §7409 (b) (1)—National Primary and Secondary Air Quality Standards, Accessed at https://www.govinfo.gov/content/pkg/USCODE-2010-title42/html/USCODE-2010-title42-chap85.htm on 2 December 2022

7 Meredith Fowlie, Reed Walker, David Wooley 2020. Climate policy, environmental justice, and local air pollution. *Economic studies at Brookings*

8 Ibid.

9 Anon. 1994. 42 U.S.C. §7409 (b) (1)—National Primary and Secondary Air Quality Standards, Accessed at https://www.govinfo.gov/content/pkg/USCODE-2010-title42/html/USCODE-2010-title42-chap85.htm on December 2, 2022

10 Anon. 1994. 42 U.S.C. §7409 (b)—National Primary and Secondary Air Quality Standards, Accessed at https://www.govinfo.gov/content/pkg/USCODE-2010-title42/html/USCODE-2010-title42-chap85.htm on December 2, 2022

11 Anon. 1998. American Lung Association v. EPA, 134 F.3d 388, 389 (D.C. Cir. 1998). Accessed at https://cite.case.law/f3d/134/388/11586395/ on February 7, 2023

12 Anon. 1980. Lead Industries Association v. Environmental Protection Agency, 647 F.2d 1130, 1152 (D.C. Cir. 1980). Accessed at https://cite.case.law/f2d/647/1130/1224568/ on February 7, 2023

13 Anon. 1994. 42 U.S.C. §7409 (d) (1)—National Primary and Secondary Air Quality Standards, Accessed at https://www.govinfo.gov/content/pkg/USCODE-2010-title42/html/USCODE-2010-title42-chap85.htm on December 2, 2022

14 Anon. 1980. Lead Industries Association v. Environmental Protection Agency, 647 F.2d 1130, 1152 (D.C. Cir. 1980). Accessed at https://cite.case.law/f2d/647/1130/1224568/ on February 7, 2023

15 Anon. 1994. 42 U.S.C. § 7408(a)(2)(A)—Air quality criteria and control techniques. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partA-sec7408.htm on February 7, 2023

16 Anon. 1998. American Lung Association v. EPA, 134 F.3d 388 (D. C. Circuit 1998). Accessed at https://law.resource.org/pub/us/case/reporter/F3/134/134.F3d.388.96-1255.96-1251.html on February 8, 2023.

17 Anon. 1994, 42 U.S.C. §7410 (a) (2) (E)—State implementation plans for national primary and secondary ambient air quality standards. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partA-sec7410.htm on February 8, 2023

18 Anon. 1964. 42 U.S.C. §2000d—Prohibition against exclusion from participation in, denial of benefits of, and discrimination under federally assisted programs on ground of race, color, or national origin. Accessed at https://www.govinfo.gov/app/details/USCODE-2011-title42/USCODE-2011-title42-chap21-subchapV-sec2000d/context on February 7, 2023

19 Anon. 1994. 42 U.S.C. § 7428(a)(1)—State Boards. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partA-sec7428.htm on February 8, 2023

20 Anon. 1994. 42 U.S.C. § 7411 j (1) (A) (iii)—Standards of performance for new stationary sources. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partA-sec7411.htm on February 8, 2023.

21 Anon. 1994. 42 U.S.C. §7503 (a)(5)—Permit requirements. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partD-subpart1-sec7503.htm on February 8, 2023

22 Anon. 1994. 42 U.S.C. §7470 (5)—Congressional declaration of purpose. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partC-subparti-sec7470.htm on February 8, 2023

23 Anon. 1994. 42 U.S.C. §7407 (d) (3)&(4)—Air quality control regions. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partA-sec7407.htm on February 8, 2023

24 Anon. 1994. 42 U.S.C. §7474 (b) (1) (A)—Area redesignation. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partC-subparti-sec7474.htm on February 8, 2023

25 Anon. 1994. 42 U.S.C. §7509 (d) (2)—Sanctions and consequences of failures to attain. Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partD-subpart1-sec7509.htm on February 8, 2023

26 Anon. 1994. 42 U.S.C. §7413 (e) (1)—Federal enforcement . Accessed at https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partA-sec7413.htm on February 8, 2023

27 Nunez 2006. Assembly Bill 32—California Global Warming Solutions Act. Accessed at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32 on March 2, 2023

28 Nunez 2006. AB 32 Part 1 Chapter 2 §38501 (h). Accessed at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32 on March 2, 2023
29 Nunez 2006. AB 32 Part 5 §38570 (b) (1)—Market based compliance mechanism. Accessed at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32 on March 2, 2023
30 Meredith Fowlie, Reed Walker, David Wooley 2020. Climate policy, environmental justice, and local air pollution. *Economic studies at Brookings*
31 Ibid.
32 Anon. 2009, Association of Irritated Residents vs. California Air Resources Board (Docket n/o -CPF–09–509562). California Supreme Court. Accessed at http://climatecasechart.com/case/assoc-of-irritated-residents-v-cal-air-resources-board/ on March 2, 2023
33 Cristina Garcia 2017. Assembly Bill 617—Nonvehicular air pollution: criteria air pollutants and toxic air contaminants. Accessed at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB617 on March 2, 2023
34 Anon. 2018. Community Air Protection: BLUEPRINT. California Air Resources Board. Accessed at https://ww2.arb.ca.gov/sites/default/files/2020-03/final_community_air_protection_blueprint_october_2018_acc.pdf
35 Anon. 2018. Community Air Protection Program Framework : CONCEPT PAPER. California Air resources Board. Accessed at https://ww2.arb.ca.gov/sites/default/files/2018-02/capp_concept_paper_february_2018.pdf
36 Éloi Laurent 2022. Air (ine) quality in the European Union, *Current Environmental Health Reports*. Accessed at https://link.springer.com/article/10.1007/s40572-022-00348-6
37 Anon. 2019. Environmental justice, environmental hazards and the vulnerable in European society, *European Environment Agency*. Accessed at https://www.eea.europa.eu/publications/unequal-exposure-and-unequal-impacts/environmental-justice-environmental-hazards-and
38 Anon. n.d. Citizen science on air quality: CleanAir@School. Accessed at https://epa-citizen-science.discomap.eea.europa.eu/public-awareness-campaigns/cleanairschool/
39 European Environment Agency 2019. Assessing air quality through citizen science, *EEA*, Copenhagen. Accessed at https://www.eea.europa.eu/publications/assessing-air-quality-through-citizen-science
40 Environmental Defense Fund 2021. The Breathe London Blueprint: How cities can use hyperlocal air pollution monitoring to support their clean air goals, *EDF*. Accessed at https://globalcleanair.org/wp-content/blogs.dir/95/files//2021/02/EDF-Europe-BreatheLondon_Blueprint-guide.pdf
41 Ibid.
42 UN Environment Programme 2020. World's largest platform for air quality data launched at Tenth World Urban Forum. Accessed at https://www.unep.org/news-

and-stories/press-release/worlds-largest-platform-air-quality-data-launched-tenth-world-urban

43 UN-Habitat 2019. Citizen scientists measure air pollution in Nairobi. Accessed at https://unhabitat.org/news/05-jul-2019/citizen-scientists-measure-air-pollution-in-nairobi#:~:text=The%20project%20is%20called%20%E2%80%9COpen,to%20build%20air%20pollution%20sensors.

44 Ibid.

45 Nelson Gouveia et al. 2022. Air Pollution and Environmental Justice in Latin America: Where Are We and How Can We Move Forward? *Current Environmental Health Reports*.

5. Environmental justice policy and data analysis framework

1 Colin Provost, Brian J. Gerber 2019. Political control and policy-making uncertainty in executive orders: The implementation of environmental justice policy. *Journal of Public Policy*. Cambridge University Press

2 Naveena Sadasivam, 2021. A California law gave the people power to cut pollution. Why isn't it working?, *GRIST*, Accessed at https://grist.org/equity/ab617-richmond-california-chevron-refinery-air-monitoring/

3 Aeroqual n.d. SCAQMD Leads Successful Study of U.S. EPA-Funded Community Air Monitoring. Accessed at https://www.aeroqual.com/case-studies/los-angeles-community-air-monitoring-network

4 Colin Provost, Brian J. Gerber 2019. Political control and policy-making uncertainty in executive orders: the implementation of environmental justice policy. *Journal of Public Policy*. Cambridge University Press

5 Meredith Fowlie, Reed Walker, David Wooley 2020. Climate policy, environmental justice, and local air pollution, *Economic studies at Brookings*. Accessed at https://www.brookings.edu/wp-content/uploads/2020/10/ES-10.14.20-Fowlie-Walker-Wooley.pdf

6 Geoffrey R. Browne, Lucy Dubrelle Gunn and Melanie Davern, 2022. A Framework for Developing Environmental Justice Indicators, *MDPI*. Accessed at https://www.mdpi.com/2305-6703/2/1/8

7 Rivkah Gardner-Frolick, David Boyd, and Amanda Giang, 2022. Selecting Data Analytic and Modeling Methods to Support Air Pollution and Environmental Justice Investigations: A Critical Review and Guidance Framework, *Environmental Science and Technology*. Accessed at https://pubs.acs.org/doi/epdf/10.1021/acs.est.1c01739

6. Next steps

1 Anumita Roychowdhury and Gaurav Dubey 2018. The Urban Commute: And how it contributes to pollution and energy consumption, *Centre for Science and Environment*, New Delhi. Accessed at https://www.cseindia.org/the-urban-commute-8950

2 Anvita Arora and Geetam Tiwari 2007. A Handbook for Socio-economic Impact Assessment (SEIA) of Future Urban Transport (FUT) Projects, Transportation Research and Injury Prevention Program (TRIPP), *Indian Institute of Technology*, New Delhi. Accessed at https://www.researchgate.net/profile/Anvita-Arora/publication/316881853_A_Handbook_for_Socio-Economic_Impact_Assessment_SEIA_Methodology_for_Future_Urban_Transport_FUT_Projects/links/5915d6064585152e199f60bf/A-Handbook-for-Socio-Economic-Impact-Assessment-SEIA-Methodology-for-Future-Urban-Transport-FUT-Projects.pdf

3 Ibid.

4 Darshini Mahade, Rutul Joshi, Abhijit Datey 2013. Ahmedabad's BRT system: A sustainable urban transport panacea? *Economic and Political Weekly*. Accessed at https://www.researchgate.net/publication/259289231_Ahmedabad's_BRT_system_A_sustainable_urban_transport_panacea.

Air pollution does not discriminate, but social inequities do. While everyone—the poor and rich alike—breathe the same air, it is the marginalized—the poor and socially excluded—who face higher exposure to the toxic risk. The 'not in my backyard syndrome' and growing urban gentrification are pushing low-income neighbourhoods to polluted areas with poor pollution-control efforts. This is increasing the disease burden and associated health costs of vulnerable groups.

At the same time, the growing stringency of air-pollution-control measures—including a ban on polluting technologies and vehicles, shifting of industrial units and waste dumps among others—often does not include safeguards and rehabilitation measures to protect the interest of the poor and the vulnerable. This adversely affects their livelihoods and social welfare. Public-health risk reduction has to ensure a just transition.

The National Air Quality Programme therefore needs to integrate environmental justice principles and adopt targeted monitoring and mitigation strategies to protect low-income and marginalized communities in high-risk areas. Globally, air pollution mitigation measures are integrating environmental justice programmes to reduce disproportionate exposure among disadvantaged communities to provide equitable protection. Only such an approach to secure good health for everyone can bring down the overall disease burden in the country.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phone: 91-11-40616000 Fax: 91-11-29955879
E-mail: cse@cseindia.org Website: www.cseindia.org