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Can An Airshed Governance Framework in India Spur Clean Air for All? Lessons from Mexico City and Los Angeles

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Executive Summary

India's struggle to reduce dangerous levels of air pollution is at a tipping point. According to the World Health Organization, 15 out of the 20 most polluted cities in the world are in India, exposing over 660 million people to unhealthy air that fails to meet India's National Air Quality standards for Particulate Matter, size less than 2.5 µm. Air pollution accounts for over 12 percent of the country's deaths including 8.5 boys and 9.6 girls out of every 10,000 children before the age of five. The World Bank estimates this problem is costing the country billions – over 8 percent of its GDP in 2013.

It's clear the problem extends far beyond urban centers. People living in the Indo-Gangetic Plain (IGP) can expect to live seven years less than those in other regions of the country due to poor air quality. And dirty air from this region is traveling across the subcontinent. One study estimates that approximately 30 percent of ozone in eastern India and Bangladesh comes from IGP and central India.

The Government of India have taken many important steps to address rising air pollution but sustained progress remains a challenge. As it continues to take action, it may be helpful to look towards other countries that have transformed their most polluted cities in the past. While air pollution remains a significant challenge in both cities, the cases of Mexico City and Los Angeles offer two examples where a regional airshed approach resulted in significant reductions in priority air pollutants despite population growth and expanded car use.

In both case studies a number of key elements of their airshed approach drove success. Sustained public outcry and at least three decades long effort gave officials the time and motivation to cultivate the political and financial support needed to create the appropriate regional institutions. These institutions in turn allowed different jurisdictions to coordinate reductions in air emissions from all sources including industry, energy, vehicular and residential sources. Formal coordination mechanisms through working groups and advisory committees between local, regional, state, and federal authorities provided pathways to effective regulatory and scientific cooperation across jurisdictions and sectors. It helped build trust and dialogue to achieve compliance with regulations and respond to political demands.

Development of a regional district allowed both cities to focus on air pollution sources from transboundary activities with scientifically based approaches that took into account weather, wind patterns, and other atmospheric conditions. Robust and comprehensive metropolitan based air quality monitoring, air quality forecasting and emissions inventories also helped integrate the design, implementation and evaluation of air quality policies. Open data and information is continuously presented through different platforms.

Strong partnerships with university and scientists helped ensure uptake of scientifically robust policy, technical, and modeling practices required for an effective air quality management in practices and plans. Linking national standards to public health incorporated public concerns and drove political support for robust action. While effective stakeholder participation built into the regional approach from the beginning ensured the wide variety of actors across the region had specific mechanisms for input and helped mitigate conflict and build public trust in the process.

The incomplete, but significant, progress achieved in Mexico City and Los Angeles has not been easy and has taken a significant amount of time and resources. But India has the opportunity to adapt key lessons to inform development of regional airshed districts that prioritize integrated policy, monitoring and modeling methods and reduce air pollution.

Introduction

Airshed level governance has become a critical innovation for addressing the complex political, economic, administrative, and health impacts associated with air pollution. It recognizes the cumulative impact from multiple sources, atmospheric and meteorological conditions, and transboundary nature of air pollution across administrative boundaries. The South Coast Air Quality Management District for the Los Angeles metropolitan region and central Mexico Megalopolis Environmental Commission offer two models for integrated urban-centric clean air management where key air pollutants have been reduced across a broader airshed context.

Air pollution has become one of the critical problems in India during last few decades. India has taken many steps to address rising air pollution at different levels of government but sustained progress remains a challenge. The cases of Mexico City and Los Angeles illustrate the process of combining scientific evidence with governance innovations that allow for regulatory integration of control measures to reduce both stationary source and vehicle emissions within an airshed. They offer important insights that can help India strengthen current air quality practices, that have been city centric only targeting local/ in-boundary sources, and more effectively address the often complex reasons driving urban hot spots and non-attainment areas.

India Context

With a growing population and increased transportation and mobility demands, India's urbanization and industrialization has driven air concentrations of PM2.5 (Particulate Matter of size less than 2.5 µm), PM10 (Particulate Matter of size less than 10 µm), NO2 (nitrogen dioxide), CO (carbon monoxide), and O3 (ozone) beyond National Air Quality Standards (Sharma et al. 2018). With additional studies currently underway, the limited source apportionment studies based on India's big cities suggest pollutant sources go beyond vehicle exhaust to include power generation, brick kilns, small shops (generator sets and eateries), resuspended dust, construction activities, open waste burning, and combustion of oil, coal, and biomass in the households (Guttikunda, Goel, and Pant 2014). Inter-State transport of pollution in the atmosphere continues to play an important role in air quality management, especially in the Indo-Gangetic Plain (IGP) where the transport of PM and precursor emissions of secondary aerosols from neighboring States is a major contributor to urban PM2.5 (Purohit et al. 2019).

Beginning with the passage of the Air (Prevention and Control of Pollution) Act of 1981, India has continued to improve its formal air quality management system, most recently launching the National Clean Air Programme (NCAP). NCAP aims to meet prescribed national average ambient air quality standards particularly for PM2.5 (annual average concentration of 40 µg/m3) in all locations in the country in a stipulated time frame (long-term) with targets for reducing particulate matter (both PM2.5 and PM10) ambient concentration by 20 – 30 percent nationally by 2024 over the 2017 base year. However majority of Indian cities do not have proper air pollution monitoring data; therefore without baseline data it is hard to setup future targets for many areas.

The NCAP recommends collaborative, multi-scale and cross-sectoral coordination between the relevant central ministries, state governments and local bodies (i.e. municipalities) for improving the air quality of the country. But despite this comprehensive governance framework recommendation, significant challenges remain, including a limited skilled workforce, an inadequate number of monitoring stations, gaps in source information (i.e., emission inventory data (activities and emissions factors) and source apportionment data), and inconsistent enforcement of standards. Implementation of the NCAP has been delayed and some experts have criticized the plan's lack of targets and timelines and inattention to the transboundary nature of pollution coming from non-city sources.[1]

And, as these case studies will highlight as critical for airshed governance, no formal mechanisms for multijurisdictional level coordination has been proposed or created beyond city level planning. This includes targeted financial investment or mandated development of regional cross-sectoral bodies made up of different ministries, state and city officials or representatives, or airshed-level pollution control strategies.

Successful implementation of airshed based air quality management depends on the strength of its key components – clear goals and objectives, a

[1]https://www.iamrenew.com/policy/air-pollution-panel-formed-to-foresee-implementation-of-ncap/

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comprehensive monitoring network, data and science driven emission inventory and air quality modeling, enforcement of control strategies, inclusive public participation, and an enabling environment that fosters scientific advancement and coordination and communication across scale within airsheds.

The paper is structured as follows: After a brief introduction, Section 2 outlines the key drivers of strong air quality management that have contributed to the successful reduction of air pollution in the two case study metropolitan areas. Section 3 provides key conclusions from the case studies most relevant to the Indian context while Section 4 provides recommendations around what a comprehensive airshed management model could look like in India.

The Los Angeles and South Coast Air Quality Management District

With a long history of smog pollution, the United States' first air pollution control district was formed in Los Angeles County, California in 1968. The formation was primarily a response to multiple studies that demonstrated that the ongoing air pollution problem was the combined product of a range of sources from multiple cities and that separate local efforts were ineffective against such a regional problem. During the following decade, air pollution control districts (APCDs) were formed in three other California counties. In 1977, the four county agencies were combined to form the South Coast Air Quality Management District (SCAQMD). The new agency was charged with developing uniform air quality management plans and programs for the South Coast Air Basin, consistent with federal planning requirements.

Today, the Los Angeles metropolitan area is home to over 16.8 million people about half the population of the state of California, along with a significant number of businesses and industrial facilities, an international airport and a large port. Although it remains one of the more polluted areas in the United States, the region has made tremendous progress, including an 85 percent reduction in air pollution from cars and trucks since 1977, a significant drop in the levels of volatile organic compounds (VOC) and oxides of nitrogen (NOx) from stationary sources - 12%, and 13% respectively, and a reduction in the number of days the region has exceed federal ozone limits (SCAQMD 2017). Further these success have occurred in a region with continued growth in population and vehicle miles travelled (SCAQMD 2017).

Mexico City

As the result of at least five decades of rapid industrialization, a growing population, at 2200 m above sea level, surrounded by high mountains, high radiation, and frequent thermal inversions, air pollution in Mexico City and its surrounding Metropolitan Area (MCMA) was infamous by the 1990's. Singled out as the most polluted megacity in the world by the World Health Organization (WHO) and UN Environment Programme (UNEP) in 1992, dense smog and endless traffic jams plagued the millions of people living there, causing respiratory problems and other health impacts, school closings, and a huge public outcry (Luisa T. Molina and Mario J. Molina 2002).

Since that time, the greater metropolitan area, and particularly Mexico City has made great strides in reducing air pollution. A recent study by Dockery et. al (2018) found that reductions in particulate matter and ozone levels between 1990 to 2015, avoided 22,500 premature deaths and improved life expectancy of Mexico City residents by 2.6- 3.4 years.

A combination of innovative air quality management plans, utilization of sophisticated air quality monitoring systems, a sustained government commitment to address the issue, scientific coordination and technical partnerships across jurisdictional boundaries have allowed the city to focus on "win-win" strategies that promote social development as well as environmental benefits.

Despite these achievements, ambient concentrations of Ozone, PM10, and PM2.5 in the MCMA are still at levels that exceed their respective standards which means a population of over 8 million in Mexico City, and 21 million inhabitants in the whole metropolitan area is still exposed to bad air quality.

Section 2 Key Drivers of Strong Air Quality Management

While air quality improvements in Los Angeles and Mexico City has been quite dramatic, these improvements have required enormous efforts and resources across decades. Concerted and continuous policy development coupled with coordination and engagement innovations, and

utilization of sophisticated air monitoring and modeling technologies have sustained success over an extended period. These key drivers provide important insights and can help provide a roadmap for a robust airshed air quality management vision in India.

2.1 Institutional framework

Similar to India's federal system of governance, both the United States and Mexico have National Ambient Air Quality Standards and state level requirements for air pollution control. However in both the Mexico City and the Los Angeles areas, the air quality district's governance structure additionally includes formal decision-making representation from the entire region, dedicated sources of funding for innovative programs, and meaningful enforcement and accountability measures.

Los Angeles

In California, the SCAQMD is the agency responsible for compliance with the federal Clean Air Act and implementation of the state air quality program for its region within California under the direction of the California Air Resources Board (CARB). CARB has a similar role to State Pollution Control Boards in India. Specifically SCAQMD develops the region's air quality management plan (AQMP) which is approved and submitted to CARB, who in turn submits it to the EPA as part of California's State Implementation Plan.

With a 2018-2019 budget of $12.6 million and a full time staff of nearly 880, SCAQMD's activities center on monitoring air quality, and implementing and enforcing programs to attain and maintain state and federal ambient air quality standards; this includes direct regulatory authority over stationary source emissions. For comparison, the Pollution Control Board budget of the National Capital Territory of Delhi (population approximately 19 million) is 418.49 million, approximately $5.7 million USD (Government of India 2019). The SCAQMD enforces air quality rules and regulations through a variety of means, including inspections, educational and training programs, and fines. CARB and federal U.S. EPA are primarily responsible for motor vehicle emissions.

The SCAQMD's 13-member Governing Board is comprised of ten elected officials representing each of the area's county jurisdictions as well as large cities in each county and state elected official appointments, creating a comprehensive and diverse range of representatives. The SCAQMD also includes a Hearing Board as a quasi-judicial panel authorized to provide exceptions from SCAQMD regulations under certain circumstances, such as petitions by companies for variances, abatement orders, or appeals by third parties. Hearing board decisions cannot modify rules or exempt a business from complying with a rule or violation.

SCAQMD's current 2016 air quality management plan outlines areas that have not attained NAAQS, the degree of nonattainment, and estimate the year when attainment is feasible, utilizing specific targets, a clear strategy and milestones. A comprehensive and updated analysis of emissions, meteorology, atmospheric chemistry, regional growth projections, and the impact of existing control measures is also provided. As the agency responsible for enforcement of NAAQS in the region, a discussion of the enforcement activities and plans for achieving attainment is summarized. Also included in the plan is an air toxics strategy and a policy intersection discussion around the climate and energy sectors.

California's ambitious policy actions required an equally ambitious budget. Most (73%) of the revenue to support the activities of SCAQMD comes from penalties and permit fees, while the balance is from federal and state grants. SCAQMD's ability to leverage and share incentive funding has helped strengthen implementation of air quality policies and secured larger public engagement. This includes a range of programs that provide money to businesses and homeowners to help incorporate new technology or equipment to reduce emissions such as furnace rebate programs, electric charging station incentives, grants for new, safer school buses, and financial incentives to owners of freight movement equipment. It reflects the broader political support of agencies and legislators who decided they needed new programs to fund or co-fund emission reductions above and beyond those required by current laws in order to accelerate implementation of new policies and technology. As a result, more than $1 billion was committed to accelerate emission reductions in the region through the SCAQMD from a wide range of state programs.

Mexico City

In 1990, the federal government, together with the State of Mexico government and the Federal District,

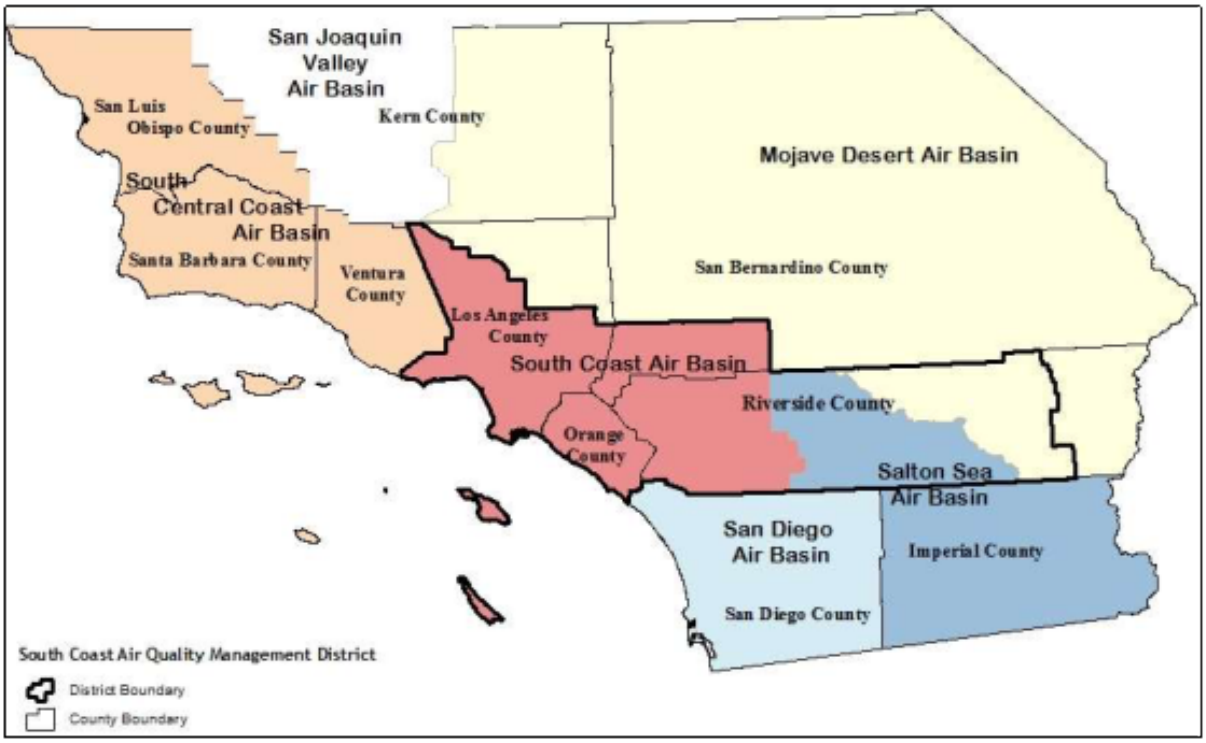

Figure 1: SCAQMD boundary within the state of California, USA

published the first air quality program called "PICCA[1]". This was an inflection point for clean air— formalizing the government´s intent to address the city's disastrous pollution levels in earnest. Most of the actions contained in PICCA (with a five year term) focused on reducing emissions from energy and transport sources which required, both in their design and implementation, close inter-agency coordination as well a set of legal tools to control emissions from different sources. In order to oversee and coordinate these efforts, the CMPCCA[2] was created to ensure PICCA implementation and address the lack of coordination among responsible institutions (Luisa T. Molina & Mario J. Molina, 2002). Since then, a series of air quality programs have been published containing actions to reduce emissions from the different levels of government and agencies: PROAIRE 1995 – 2000;[3] PROAIRE 2001-2010; PROAIRE 2011-2020 and PROAIRE 2020-2030 which is in development. PROAIREs do not have any legal binding requirements but some of the programs derived from them do, such as the driving restriction program[4] , vehicular inspection program[5] and the atmospheric contingency program.[6]

In 1996, the coordination body CMPCCA was succeeded by the Metropolitan Environmental Commission (CAM), which was mandated to track the policies, programs and projects implemented across the federal district and surrounding metropolitan area. The commission included all 16 territorial delegations of Mexico City (then a Federal District), 18 municipalities from the State of Mexico, and the federal secretary of environment SEMARNAP[7] (OECD and International Transport Forum 2017).

Recognizing air pollution's wide impact area, in 2013, by presidential agreement, the CAM became the Environmental Commission for the Megalopolis "CAMe[8]" which included municipalities of the states of Hidalgo,

[1] Comprehensive Program Against Air Pollution or Programa Integral contra la Contaminación del Aire

[2] Metropolitan Commission for Pollution Prevention and Control or Comisión Metropolitana para Prevención y Control de la Contaminación Ambiental

[3] Programa para Mejorar la Calidad del Aire en el Valle de México 1995-2000

[4] Programa Hoy no Circula

[5] Programa de Verificación Vehicular Obligatoria

[6] Programa de Contingencias Ambientales Atmosféricas

[7] Former Secretary for Environment, Natural Resources and Fishing

[8] Comisión Ambiental de la Megalópolis

Mexico, Morelos, Puebla and Tlaxcala, and since 2018, Queretaro (Figure 3). The mission of CAMe was to widen the scope to broader environmental issues including the design, coordination, and catalyzing of programs and actions that contribute to the protection and restoration of the ecological balance of the Megoloplis region of central Mexico. The goal was to serve as a platform and example of good practice in the region. Having this broader environmental governance platform was an important step towards an airshed management. However the need to strengthen the governance and economic instruments and financing CAMe remain a challenge (Climate Initiative of Mexico and Molina Center for Strategic Studies in Energy and the Environment 2018).

Figure 2: Location of Mexico City Metro Region

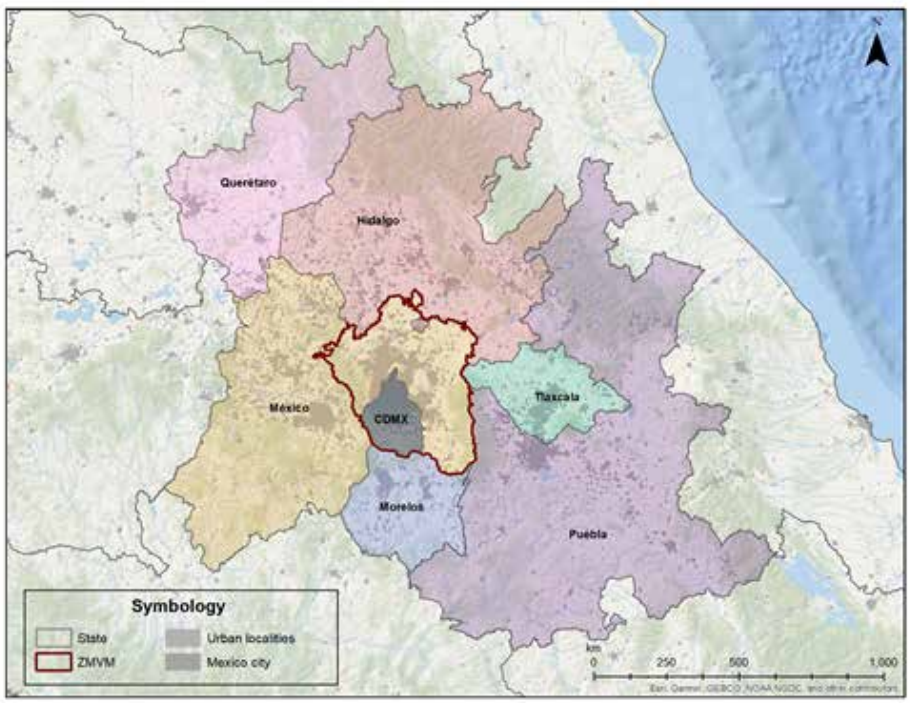

Figure 3: States under the ambit of the Megalopolis Metropolitan Commission

2.2 Monitoring and emission inventory systems

Los Angeles

"The most significant air quality challenge in the Basin, presently, is the reduction" of nitrogen oxide (NOx) emissions sufficient to meet ozone standard deadlines. NOx emission sources are primarily heavy-duty diesel trucks and off-road equipment. Consumer products and off road equipment are major sources of the region's VOC emissions, while commercial cooking, paved road dust, and residential fuel combustion are the top three highest sources for PM2.5.

The current emissions inventory is based on both reported 2012 emissions and estimated future emissions, calculated from economic projections and control factors based on adopted regulatory requirements. The inventory is divided into two major source classifications: stationary and mobile sources. Reported point source emissions are calculated jointly between CARB and the District. They are based on reported data from facilities using the District's Annual Emissions Reporting Program, a web-based reporting system for criteria, GHG, and toxic pollutants determined by facility specific operational data, combustion fuels used, and process information for each emission source type. Over the years a number of significant improvements have been made to quantify emission sources including use of continuous monitoring and source testing, technical assistance to facilities and auditing of reported emissions, and industry specific surveys and source specific studies.

The on-road emissions are calculated using CARB's EMFAC 2014 model, which estimates emissions from trucks, automobiles, and buses, and travel activity data. CARB provides emission inventories for off-road equipment as well.

Baseline emissions data presented in the 2016 AQMP are based on average annual daily emissions (i.e., total annual emissions divided by 365 days) and seasonally adjusted summer planning inventory emissions. The summer planning inventory emissions are developed to capture the emission levels during the high ozone season and are used to perform ozone modeling and analysis, estimate the cost-effectiveness of ozone control measures, and to report emission reduction progress as required by the federal and California Clean Air Act.

The SCAQMD collects data on current air quality, provides forecasts and analyzes pollutant level trends, including the modeling and providing data for specific projects. A network of air quality monitoring sites has been established and operated by CARB and SCAQMD including 39 permanent monitoring stations for criteria pollutants and 4 sites that specifically monitor for Lead (Pb) (Parrish, Xu, Croes, & Shao, 2016).

SCAQMD creates an Annual Air Quality Monitoring Network Plan which describes the network of ambient air quality monitors located within the SCAQMD's four-county jurisdiction and a review of actions taken during the previous fiscal year. The plan also outlines proposed actions including special programs, recent or proposed modifications to the network, and minimum monitoring requirements for data submission and archiving requirements (Bermudez, Vlasich, & Dietrich, 2018).

Federal regulations require that the air quality monitoring network be reviewed annually to assess the current and future air monitoring strategies. Network changes are made in consultation with the EPA and CARB. Background levels of air pollutants, high concentration areas, pollutant movement between air basins, and population exposure are all monitored. Monitoring is also conducted to represent air quality concentrations for specific pollutants in certain areas and for estimating the impact of emissions from significant sources or source categories. Trend analysis and site comparison monitoring are also used, as is real time reporting which is uploaded to the EPA's public AIRNOW system.

While each AQMD is responsible for the monitoring network in their region, CARB has a monitoring and laboratory division to operate and maintain California's air quality and greenhouse gas monitoring network, including quality assurance, chemical laboratory analysis, and emergency response programs.

Mexico City

The Mexico City atmospheric monitoring system (SIMAT) started operations in 1986 with only four monitoring stations. Today, it is a robust system integrated by the automatic monitoring network (24), particulate matter stations (16), atmospheric deposition (8), meteorological network (24 sites) a calibration and maintenance shop, an environmental analysis laboratory, and a data center. Historic and non-validated datasets can be downloaded

by year from the city's air quality monitoring system, SIMAT[9] website (www.aire.cdmx.gob.mx) while real time concentrations can be also viewed through a mobile app (airecdmx).

In addition to pollutant concentrations, the air quality index is publicly reported and updated hourly. This information is publicly forecasted for future days via media outlets including the internet, social media, web based applications, and news outlets. These new databases and information have deepened the understanding of atmospheric pollutants and their spatial distribution and are a key element to track progress.

Mexico´s environmental law[10] defines that states and municipalities are responsible for air quality monitoring while the role of the federal government (including CAMe role) is to support them technically (assuring quality assurance and quality control, representative coverage evaluation and data analysis). If funds are allocated by Congress, funds may be available for states for the acquisition of new monitoring stations. CAMe´s trust has also been used to fund the acquisition of equipment and spare parts for monitoring stations.

Mexico City Secretary of Environment integrates and updates the emission inventory of the MCMA every two years and covers criteria air pollutants, air toxics and greenhouse gases and compounds. It has been continuously improved and currently uses models such as EDMS, MEGAN, and MOVES. Emissions inventory is a key tool to estimate source attribution and to prioritize actions, including those impacting both air quality and climate emission reductions. The most recent 2016 inventory includes emissions from 16 alcaldias (districts), 59 State of Mexico municipalities, and the municipalities of Tizayuca, and Hidalgo.

Since 2017, a chemical model developed by Mexico City Air Quality Management Directorate in collaboration with the Barcelona Supercomputing Center is being used to forecast 24 and 48 hour, concentrations of criteria pollutants (NO_2, SO_2, CO, O_3, PM_{10}, $PM_{2.5}$) on a high-spatial (1 km^2) and high-temporal (1 hour) resolution. The model uses the high resolution emission inventory and its performance (around 80%) is continuously evaluated with data from the air quality monitoring system.

[9] Sistema de Monitoreo Atmosfèrico

[10] Ley General del Equilibrio Ecológico y Protección Ambiental

2.3 Intra-agency coordination and use of advisory committees

Los Angeles

SCAQMD relies on significant integration and coordination with other agencies in order to successfully meet the Basin's clean air goals. This includes traditional collaboration between the SCAQMD, CARB, and the U.S. EPA but also includes engagement with the California Energy Commission (CEC), the California Public Utilities Commission, and the California State Transportation Agency (Caltrans). Regional and local governments have also been part of the integrated planning process. The development process incorporates collaborative efforts by a wide range of non-government stakeholders with a focus on businesses, environmental and health organizations, community groups, and academia. In the months leading to the 2016 AQMP development, a series of AQMP White Papers were published in close collaboration with stakeholders. These provided the technical and policy foundation for many aspects of the Plan. A two-day Control Strategy Symposium also took place as a forum of ideas for new control technologies, efficiencies and innovative approaches to reduce emissions.

SCAQMD also utilizes a wide range of advisory committees to help coordinate and develop the range of policy, technical, and modeling practices required for effective management. For example a 2016 Advisory Group was created made up for 40 stakeholders representing a diverse cross section of stakeholders including large and small businesses, government agencies, environmental and community groups, and academia. This group provided feedback and recommendations on the development of the most recent regional plan, including development and policy and control strategies. In addition, a Scientific, Technical, and Modelling Peer Review (STMPR) Advisory Group convened to make recommendations on air quality modelling, emissions inventory, and socioeconomic modelling and analysis. The group provides an important linkage between the air quality and the socioeconomic modelling communities and helps provide consensus on air quality modeling approaches for future AQMP revisions. Both Advisory groups have a designated liaison to the Governance Board.

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Mexico City

The different coordination bodies created to deal with the air pollution problem in Mexico City and Metropolitan area has changed over time in terms of composition and duties. The CAM for instance, was formed with public officers from the Federal Government as well as State of Mexico and Federal District (now Mexico City). Both economic and human resources to manage the work came from their own governments , thus creating negative incentives and competition for both time and funds to carry out CAM activities (Luisa T. Molina and Mario J. Molina 2002). Three working groups around air quality, natural resources, and environmental education were formed, organized and coordinated by the Technical Secretariat of CAM. While scientific information and the input from atmospheric scientists was solicited, a more informal process was used where contacts of existing CAM representatives were invited to speak with the group in addition to the establishment of more formal hearing or platforms at this time (Beatriz Cárdenas 2019). Operational matters were overseen by an Advisory Council, formed by representatives from the scientific community, specialists in the environmental disciplines, and private sector representatives, and members of the Federal and State Congress.

Further since the first air quality program in the 90´s, collaboration between government and scientists and research institutions around air quality and health has facilitated the incorporation and implementation of the most up to date tools and models and technical best practice into their air quality management plans connections (Climate Initiative of Mexico and Molina Center for Strategic Studies in Energy and the Environment 2018). This included collaboration with the MIT and Molina on the 2000 – 2010 air quality management plan and to a series of measurement campaigns in 2003 and 2006 that resulted in a wide range of measurements and deepened scientific understanding of the meteorology, emissions, photochemistry, and impact on air quality of the MCMA (Molina et al. 2010). In addition, many peer review papers, reports and books have been published as the results of field campaigns.

Over the last years, SEDEMA commissioned different specific studies including mobile emissions improvements, a chemical model to forecast air quality and to evaluate scenarios of actions implementations, estimations of liquefied petroleum gas emissions, fuel quality, an air quality risk index and health impact evaluation of air pollution among others (Climate Initiative of Mexico and Molina Center for Strategic Studies in Energy and the Environment 2018). In 2014, SEDEMA established a partnership with the Harvard School of Public Health, Mexico City-Harvard Alliance for Air Quality and Health, to evaluate the health benefits of twenty five years of air quality improvements in Mexico City (Mexico City-Harvard Alliance for Air Quality and Public Health 2014). Capacity building and workshops such as the workshop around PROAIRE 2011-2020 have made clear science-policy connections (Beatriz Cárdenas 2019).

2.4 Stakeholder Participation

Los Angeles

Mechanisms to comply with public participation requirements have been incorporated throughout SCAQMD's rulemaking and daily operations. Board meetings can be viewed through webcasts and meeting agendas and public notices, proposed rules and amendments, staff reports, and other documents are available in the lobby at Public Information Center in SCAQMD's headquarters. This information is also publicly available on the agency's website along with the names of representatives, mission, meetings, and agenda of all Committee and Advisory Groups. Some, such as the Mobile Source Air Pollution Reduction Review Committee have their own websites and clearly delineated roles and responsibilities, history, accomplishments, policies, and meeting minutes.

The Board holds public hearing where the public can testify or present written comments before members vote on new rules or rule amendments. Further, strict rules govern Board off the record communication. If a Board Member receives information off the record and it influences the Member's decisions about a proposed rule, the Board Member must put that information on the record. If that information could substantially influence the Board's vote and was not available to the public before the close of public testimony, the hearing must be reopened to allow public comment on the new information.

SCAQMD has prioritized improving air quality in communities with disproportionate air pollution and

socioeconomic burdens. Beginning its Environmental Justice (EJ) Initiatives in 1997, in 2003 SCAQMD formed a working group comprised of representatives of key industry, environmental, and community groups, the Cumulative Impacts Working Group, and investigated the feasibility of addressing cumulative impacts of air pollution beyond requirements. A Cumulative Impacts White Paper and Reductive Strategy was produced to inform the district's workplan. In 2010, SCAQMD launched the "Clean Communities Plan" (CCP), which placed greater emphasis on the cumulative effects of air toxics in disadvantaged communities. The elements of the 2010 CCP are community exposure reduction, community participation, communication and outreach, agency coordination, monitoring and compliance, source-specific programs, and nuisance.

More recently in 2017, Assembly Bill 617 was passed to address the disproportionate impacts of air pollution in environmental justice communities. The law requires CARB, in consultation with air districts, to select communities for community air monitoring and/or the preparation of community emission reduction programs. SCAQMD staff conducted extensive community consultation and developed a broad and inclusive list of all the communities being considered for the program and a series of reports that outlined the public process, technical methodology used to develop priorities and recommendations for an initial implementation schedule. As part of this process SCAQMD conducted a comprehensive monitoring and modeling assessment of multiple air toxic air pollution sources in the district (the MATES study), developed new monitoring approaches using lower cost and remote sensing technologies to provide insight of pollution at specific locations. The results of this monitoring and modeling were used to address cumulative impacts in regulations to address the most significant sources of emissions identified and provide extra protection to sensitive populations.

Mexico City

Since the air quality program in 1990, some provisions have been implemented to consider participation of all different stakeholders into the design and implementation of the air quality programs. It has evolved over time and since 2014, CAMe coordinates between federal government including ministries of environment, transportation and health, state governments of 7 states and a scientific advisory board. Organized civil society participates and interacts with the commission. However, areas for further improvement include a formal and clear institutional organizational division, records and follow up of working groups meetings and agreements and an open call for a wider inclusion of technical and scientific groups.

Stakeholder participation is very active during the PROAIRE design which is jointly developed and integrated with input from the federal government and the governments of the State of Mexico and the Government of Mexico City, in collaboration with technicians and researchers from various institutions of the social, private, academic and governmental sectors through the formation of different working groups. The process of integrating these programs takes several months.

Over the years, civil society participation has been key in demanding governments for more strict and faster actions to improve air quality. From demanding infrastructure for non-motorized mobility and protection of cyclers and pedestrians to demand of more stringent air quality standards. Civil society demands include petition to the National Human Rights Commission for a clean air in 2018 and using legal actions to demand government for not issuing alerts and implementing actions to protect people's health before and during high pollution events. Recently, an air pollution observatory has been formed to follow up the implementation of actions as well as to demand others to be considered.

Private sector have been playing an important role over the years. Automotive industry´s lobbying has been a constant for all the vehicular emissions programs. In addition, the finance sector has also been a constant player, providing the first carbon bonds and green bonds for subnational governments in Mexico City.[11]

Section 3: Conclusions

The greater Los Angeles and Mexico City areas have seen significant reductions in priority pollutant emissions while at the same time experiencing increases in population and the number of vehicles on the road.

[11] See http://iki-alliance.mx/wp-content/uploads/CDMX.-Fondo-CC.pdf for more information.

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While challenges remain, this success is testament to the effectiveness of a comprehensive airshed management program built on the foundation of strong laws and enforcement, prioritization of communication and coordination across government agencies and scientific expertise, clear targeted milestones, a robust modeling and monitoring program, and funding incentives. The following conclusions applicable to the Indian context can be drawn:

- **Time and resources over the long term are a key to success:**
  - The State of California and SCAQMD invested over decades to address a wide variety of sources including industry, power generation, vehicle emissions, the port and shipping industry, and home heating, etc. These policies often went beyond federal required mandates.
  - Since 1990, Mexico City has included the allocation of funds and staff as part of implementation activities to control emissions from different sources including industrial, area and vehicular emissions.
- **A single district cannot manage air quality alone: a unified regional wide strategy over the entire airshed is required.**
  - CARB leads the formal process that mandates airshed-level control strategies, but districts used the process to achieve clean air goals that their residents and federal regulators want to achieve. This framework helps drive cooperation and collaboration across sectors, local agencies, and stakeholder groups, in terms of policy and application of financial and human resources.
  - Under the former Metropolitan Environmental Commission and lately the Megalopolis Environmental Commission, Mexico City has led stricter implementation.
- **Robust application of monitoring and modeling data is essential to good management.**
  - The comprehensive emissions inventory, modeling and monitoring done by SCAQMD provides important data for not only measuring progress in achieving standards but has been used to address larger challenges around cumulative risk, vulnerable populations, and future development impacts.
  - Mexico City´s emissions inventories, air quality monitoring and air quality forecast has been providing data not only to Mexico City citizens and policy makers, but at the Metropolitan region, it provides a robust basis for policy design and evaluation.
- **Strong public participation, enforcement and political will are critical enabling factors.**
  - Although spurred by a crisis, both California and Mexico City have been able to sustain the political will to address air quality over decades, without sacrificing economic opportunity. The backdrop of clear communication, transparent action, and frequent interaction with stakeholders has built trust that has, in turn allowed agency management staff to more effectively apply strong scientific analysis and data to drive policy making. The investment in quantifying health impacts of air pollution also helped to justify compliance costs by showing a clear offsetting benefit.
- **Strategic use of advisory committees and university and scientific partnerships helps drive science into policy making.**
  - SCAQMD utilizes a wide variety of scientific experts from government and academia to help coordinate and develop the range of policy, technical, and modeling practices required for an effective AQMP. The transparency around the membership and operations as well as the specific mission and responsibilities of each group creates an important accountability and implementation driver that ensure their scientific expertise is appropriately incorporated into the planning process.
  - Over the years, advise and participation from the scientific community have been a constant into Mexico City´s AQ policy making. Over the last years, a formal scientific committee was formed to advise the Megalopolis Environmental Commission. In addition, continuous collaboration with national and international scientist have generated applied scientific research on air quality modeling health impacts, and source apportionment among others.

- **National standards should be linked to public health.**
  - Public health is a determinate for each NAAQs in the USA and the regional AQMP includes this monitoring and attainment data. The investment in quantifying financial cost of health impacts of air pollution helps justify compliance costs to private actors by showing a clear offsetting benefit.
  - Mexico City led publication of the first Metropolitan Air Quality Index standard that was updated over time to protect public health. In 2008 a public Air Quality Health Risk Index for Mexico City was published based on a study that linked epidemiological and air quality monitoring data. Analysis of the premature deaths avoided and extension of the life span due to the reductions of concentrations of PM2.5 and ozone during the period of 1990 to 2015 have shown the financial cost of health impacts of air pollution in Mexico City.
- **Innovative funding can leverage comprehensive airshed management**
  - In the SCAQMD developing and leveraging innovative funding mechanisms focused on achieving air quality outcomes rather than specific emission control technologies helped ensure both agencies and specific stakeholders had both the incentives and the resources to meet or go beyond pollution control requirements.
  - In Mexico City, innovative funding has been mainly focused on reduction of vehicular and industrial emissions over the last decades in the form of loans and incentives that led to fastest fleet renewal in the country as well as the implementation of fixed sources emissions control devices. In 2011, Mexico City formed the Environmental and Climate Change Trust that has been used since then to fund several actions to reduce emissions of both criteria pollutants and greenhouse gases. The first carbon bonds and green funds at subnational level were released by the Mexico City Government.

Section 4: Recommendations

In India, given the current context and focus on a new air pollution agenda, the Mexico City and Los Angles case studies offer a model for city driven air quality management well suited to India's federal context and the extent of multi-state air pollution transport. Key recommendations to help India develop a robust airshed management program include the following:

Foster long term political support to ensure adequate human and financial resources, and ensure strategies for institutionalizing airshed management are built into the process. Air Pollution mitigation takes decades of continuous action. Institutions established in both case studies had significant technical capacity and technical resources including capable and sufficient staff on air quality management, no less than 200+ staff per region. In India, this would mean a significant increase in staff at both the Central and State Pollution control boards focused on air pollution assessment, monitoring, and control including technical specialists able to work on monitoring equipment, although it is important to note there is no standard definition for sub-regions in India so an exact number per region would be difficult to determine. It also includes working with scientific and public health institutions to address the gaps in technical staff capabilities for analyzing environmental and biological samples to better measure health and environmental impacts.

Use informal opportunities for coordination between national, local and regional institutions as a mechanism to build support for more formal coordinating bodies. A federal governance system requires local and regional legal protocols, institutional frameworks, and formal coordination mechanisms that encourage governments to combined scarce resources and scientific analysis for management initiatives that benefit the entire region to maximize impact. Informal working groups of national, state and city leaders can provide space for discussion around joint action but formalization of them assures commitments and follow up. Dialogue can help build relationships around compliance of regulations and address political demands, helping to reinforce development of more formal cooperation as trust is built.

A regional scale problem needs a regional institution: Air pollution is a regional problem that must be defined by scientific criteria like weather and topography and not by city or state administrative jurisdictions. There is a need to establish regional

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scale institutions empowered to lead the air pollution mitigation long term strategy. There should also be a mechanism for the establishment of regional air pollution control districts with multilevel government participation (inter districts/inter states) with duties well defined based on legal responsibilities. Regional co-ordination is also a key element to ensure financing issues are negotiated and there is good distribution. In India, this means directing more public investment to support multi-jurisdiction collaboration including development of working groups made up of different Ministries, state department and city governments who can focus on cross-sectoral strategies. It also includes development of a steering committee headed by high level political representatives to guide the process and ensure coherence to national management goals.

Strengthen continuous and adequate data collection and modeling: India's air quality management is hampered by the lack of adequate inventories on emissions, air quality models and uncertainty in the pollution mixture in ambient air. Investments in extensive ambient air quality monitoring and emissions inventory programs and data are critical to the development of airshed management districts and cross-sectoral policy making. These data sets the scientific foundation for identification of accurate source apportionment and airshed boundaries and provide policymakers with critical inputs needed to update regulations and set emission control priorities to protect public health and the environment. Robust continuous monitoring and modeling also directs forecast air quality every day to inform the population in a timely manner to reduce risk of exposure during seasonal times of high air pollution such as the case of thermal inversions, Diwali or agricultural crop burning. Air quality models should be used to build or enhance scenarios to evaluate cost-effectiveness of the different actions to improve air quality. Many of these activities could be done in parallel to aid implementation, including adapting regional and global models by substituting regional specific data to improve accuracy.

Foster university and scientific partnerships to help drive scientifically robust airshed management: Measurement and mitigation plans should include strategies to establish public-private and local-international scientific and university partnerships to accelerate the creation of an evidence base. The use of outside expertise and shared data in conjunction with special field studies and strong scientific partnerships can provide new insights on emission sources and air pollution science that have not only inform local strategy but have broader global impact. Experiences and knowledge produced in other parts of the world could be used to learn and leapfrog and help expand entrenched practices. With a large number of Indian academic and scientific institutions many outside experts, including Indian experts, are available to help examine and validate data, develop analyses of local and regional pollution control opportunities, and otherwise support Pollution Control Boards.

Link public health to national standards to support implementation and enforcement: Considering public health determinants directly addresses a primary concern of the public and helps leverage public and political will to enforce pollution control regulations including strong fines etc. National Standards to establish criteria based on health in the plans of the cities and regions are designed to meet these standards. Given the variations in exposure across the country, India-specific data on air pollution health effects and dissemination of these data to the public, medical community, and policy makers is critically needed. Goals should be established to meet ambient concentrations and/or meet standards in specific periods of time. The specific goals reduce political debate that can impede action.

Prioritize stakeholder participation as an essential component of airshed management: Refining policies and strategies requires involvement of different stakeholders. In the SCAQMD clear communication, transparent action, and frequent interaction with stakeholders has built trust that has, in turn allowed agency management staff to more effectively apply strong scientific analysis and data to drive policy making. Different approaches to collect and incorporate divergent views must be utilized into regional management from the beginning through targeted engagement, working groups, and effective public hearings opportunities. Documenting air quality management benefits toward public health and sharing air quality information with the public is an important political tool for designing, implementing and evaluating air pollution control policies. Strategic participation can often mitigate conflict and build public trust.

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