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Air pollution management and control in Latin America and the Caribbean: implications for climate change

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ABSTRACT

Objective. *To assess the status of the legal framework for air quality control in all countries of Latin America and Caribbean (LAC); to determine the current distribution of air monitoring stations and mean levels of air pollutants in all capital and large cities (more than 100 000 inhabitants); and to discuss the implications for climate change and public policymaking.*
Methods. *From January 2015–February 2016, searches were conducted of online databases for legislation, regulations, policies, and air pollution programs, as well as for the distribution of monitoring stations and the mean annual levels of air pollution in all LAC countries.*
Results. *Only 117 cities distributed among 17 of 33 LAC countries had official information on ground level air pollutants, covering approximately 146 million inhabitants. The annual mean of inhalable particles concentration in most of the cities were over the World Health Organization Air Quality Guidelines; notably, only Bolivia, Peru, and Guatemala have actually adopted the guidelines. Most of the cities did not have information on particulate matter of 2.5 microns or less, and only a few measured black carbon.*
Conclusions. *The air quality regulatory framework should be updated to reflect current knowledge on health effects. Monitoring and control of ground level pollutants should be extended and strengthened to increase awareness and protect public health. Using the co-benefits of air pollution control for health and climate as a framework for policy and decision-making in LAC is recommended.*

Keywords Air pollution; climate change; environment and public health environmental policy; Latin America; South America; Caribbean Region.

Air pollution is a key concern for the World Health Organization (WHO). At its 68th World Health Assembly, in May 2015, WHO adopted the resolution, "Addressing the Health Impacts of Air Pollution." It recognized air pollution as a priority public health issue, one that is among the most important global environmental threats to health (1). WHO estimates that each year 3.7 million people die from exposure to contaminated air in urban areas. Approximately 80% of these deaths are due to ischemic heart diseases and strokes; 14% to chronic obstructive pulmonary disease or acute lower respiratory infections; and 6% to lung cancer (2). The most health-relevant air pollutants are particulate matter (PM), especially PM with a diameter of 10 microns or less (PM_{10}; $PM_{2.5}$), which can penetrate and lodge deep inside the lungs. WHO estimates that approximately 58 000 deaths per year are attributable to ambient air pollution, and 80 000 to household air pollution in Latin America and the Caribbean (LAC) (2).

SHORT-LIVED CLIMATE POLLUTANTS AND THEIR PRECURSORS

Short-lived climate pollutants (SLCPs) are agents that reside in the atmosphere for a relatively short period and have a

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warming influence on climate. The main SLCPs are particles that contain black carbon (BC), tropospheric ozone (O_3), and methane (CH_4). These are the most important contributors to the global greenhouse effect after carbon dioxide (CO_2), and are substantial "climate forcers" (substances that significantly contribute to increased global temperature). CO_2 is responsible for much of the change experienced to date, and is expected to exert significant control of the warming rate during the next few decades (3). Hence, the implementation of measures to limit SCLPs is essential to slow the negative trends of climate change (4 – 6). The pollutants Nitrogen oxides (NOx), Sulfur dioxide (SO_2), BC, Organic Carbon (OC), as well as ammonia (NH_3), are important precursors to $PM_{2.5}$ and PM_{10} (7).

A major fraction of $PM_{2.5}$ is constituted by BC, from 31% – 57% in urban areas (8–11). BC acts as a climate forcer by absorbing sunlight and darkening ice and snow, contributing to local and regional warming (12). BC can cause adverse health effects, such as asthma and other respiratory problems, low birth weights, heart attacks and other cardiovascular diseases, and lung cancer (13, 14). Anenberg and colleagues (15) estimated that 3.7 million annual premature deaths are due to $PM_{2.5,}$ and about 700 000, to O_3.

URBANIZATION TRENDS

Latin America and the Caribbean constitute a heterogeneous territory in terms of physical and human geography. The area covers about 200 million km^2. In 2013, its population reached 600 million inhabitants, with 79% living in urban centers (16). LAC is the most urbanized geographic area in the developing world (2/3 of the population lives in cities of more than 20 000 inhabitants) (17). High urbanization trends, trade liberalization of goods and services, and the economic development experienced by LAC countries in recent decades has increased the demand for energy and transport. These are the main drivers of emissions in LAC (18).

AIR QUALITY MANAGEMENT IN LAC

There are previous reports on air quality in LAC (19, 20), and a number of initiatives at the global level to leverage information on all aspects for air quality management (21, 22). However, a comprehensive analysis of the situation, with spatial visualization of the information including status of regulation, coverage and distribution of ground-level air monitoring stations, and ambient concentration of the main pollutants, by country, was missing.

The objective of this study was to fill this gap by presenting an overview of the status of air quality regulations in LAC. This overview comprises an assessment of the existing network of air quality monitoring stations, comparing to the area's needs; and the current levels of the most important pollutants for air quality indicators, comparing to the WHO Air Quality Guidelines (WHO-AQG) (23). Furthermore, findings are compared to the global agenda of the United Nations Convention on Climate Change (UNCCC), highlighting how reducing concentrations of short-lived climate pollutants can benefit both the climate and human health.

MATERIALS AND METHODS

Data collection

A search was conducted for the most recent year of data available on air quality policies and regulations for PM_{10} and $PM_{2.5}$ in all 33 LAC countries. Data was gathered online from official national and international legal sources the WHO Global Health Observatory (WHO GHO), the United Nations Environmental Program (UNEP), the Economic Commission for Latin America and the Caribbean (ECLAC), the World Bank, and the Clean Air Institute (CAI), as well as local repositories of legal documents in LAC. PAHO Country Offices were informally consulted for verification. The most recent official population figures and urbanization trends available from international organizations, such as ECLAC and the United Nations, were used (17, 24, 25).

Air pollution legislation and regulations

Norms regulating air quality define the maximum allowed concentration of atmospheric contaminants during a specific period. Any reports available from international organizations were considered (19, 20). National-level information was included for analysis. Data has been categorized and classified according to the permissible value limits for PM_{10} and $PM_{2.5}$ in each country.

Air pollution measurements and average annual levels of pollutants

The data presented is based on a real-time air quality-monitoring network. Average annual levels of PM_{10} and $PM_{2.5}$ provided directly by the country or by WHO Air Pollution database were used (21). All the information was organized and systematized with Microsoft Excel™ (Microsoft Corporation, Redmond, Washington, United States).

Data visualization

Data was graphed and organized on thematic maps that summarize the information from countries and cities, including their national air quality standards, the distribution of air monitoring stations and networks, and average annual levels of PM_{10} and $PM_{2.5}$. Cartographic information was managed in a Geographic Information System (GIS) through ArcGIS software, version 10.1 (Environmental Systems Research Institute, Redlands, California, United States). The geographic layers were obtained from Natural Earth (26).

All LAC cities with more than 100 000 inhabitants were mapped; however, if a country did not have a city of this size, its capital city was included. Each city's average annual levels of PM_{10} and $PM_{2.5}$ were compared to the WHO-AQG.

RESULTS

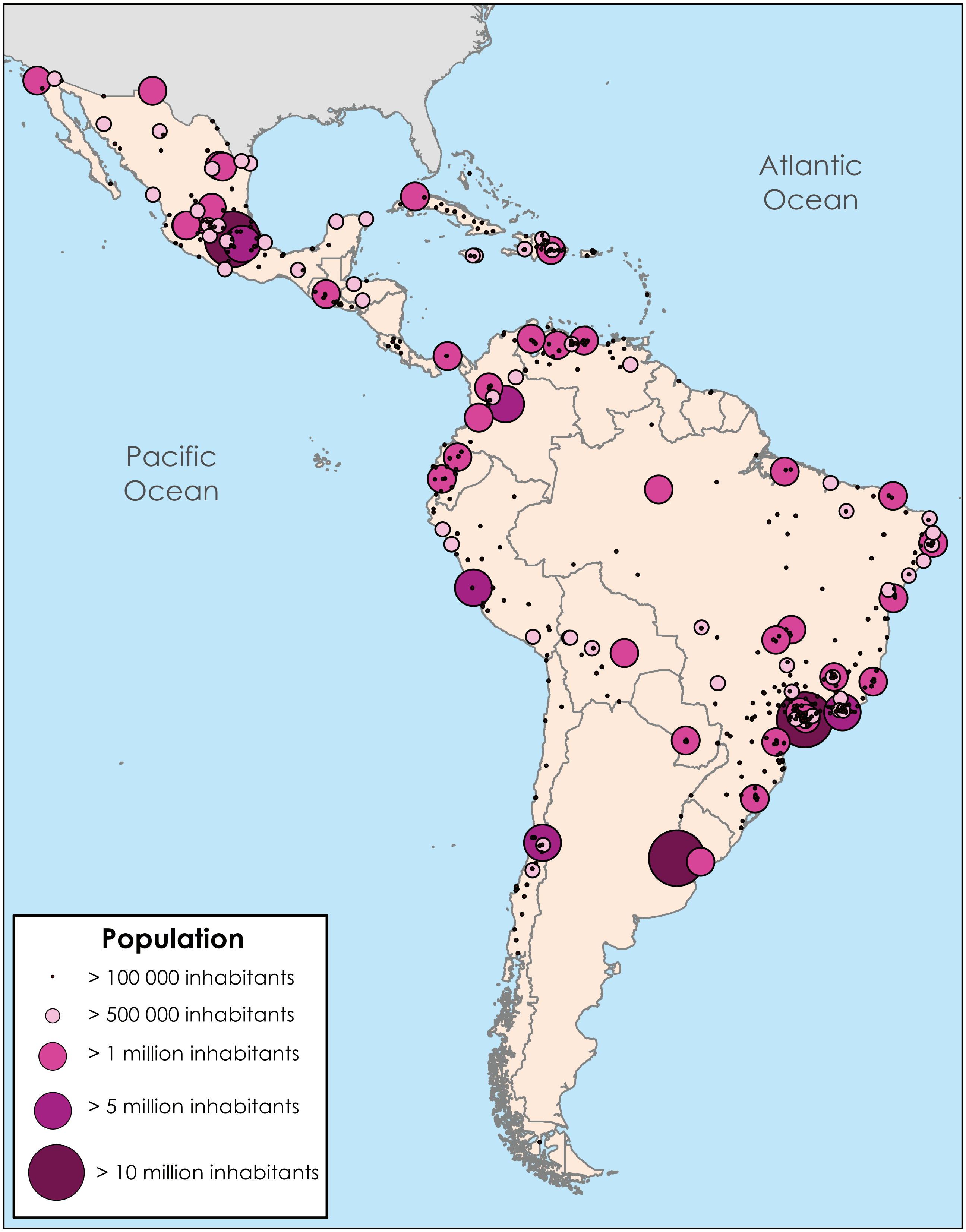
Urban population size

According to the United Nations (27) in 2014 there were approximately 564 cities with more than 100 000 inhabitants in LAC, with close to 286 million inhabitants in all. Among these, 58 cities had more than 500 000 inhabitants; 35 had more than 1 million; five cities had more than 5 million: Puebla (Mexico), Rio de Janeiro (Brazil), Santiago (Chile), Bogota (Colombia), and Lima (Peru); and three were classified as megacities with more than 10 million inhabitants: Buenos Aires (Argentina), Mexico City Metropolitan Area (Mexico), and São Paulo (Brazil). Figure 1 shows the distribution of cities with more than 100 000 inhabitants in LAC in 2014 (27).

Air quality monitoring networks

Only 17 of the 33 LAC countries had any information on ground level air quality measurements (Figure 2). However,

FIGURE 1. Urban population size of cities in Latin America and the Caribbean, 2014



Source: Prepared by the authors with data from the United Nations Statistical Office, Demographic Yearbook 2014 (27).

FIGURE 2. Distribution of air quality monitoring stations among countries of Latin America and the Caribbean

Prepared by the authors from the study data.

most of these monitoring stations were only in each country's capital city and a few major cities.The population living in cities with air monitoring networks was approximately 146 million people (20% of the total LAC population). Only 16 out of 58 cities with more than 500 000 inhabitants had undergone any measurement of air pollution in recent years.

In total, 17 LAC countries had official air quality monitoring stations: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, El Salvador, Ecuador, Guatemala, Jamaica, Mexico, Panama, Paraguay, Peru, Uruguay, Honduras, and Venezuela. PM_{10} measurements were performed in 104 cities, and $PM_{2.5}$ in 57 cities.

The best monitoring systems for cities and population coverage were found in Brazil, Chile, Colombia, and Mexico. Brazil had networks of automatic monitoring stations in large cities, such as Belo Horizonte, Brasilia, Curitiba, Rio de Janeiro, and São Paulo. São Paulo State monitors the metropolitan area and 23 other cities in addition to its capital city, with a network of 49 automatic and 39 manual stations (28). In addition, Rio de Janeiro State monitors its metropolitan area and all the high priority areas in 16 other cities identified by the State Environmental Agency using a network of 58 automatic and 60 semi-automatic monitoring stations (29). High priority areas have more sources of emissions, as well as dense urban settlements.

Chile had a network of monitoring stations distributed throughout the country. Most were in the Metropolitan area of Santiago, and in larger cities on the Pacific coast, e.g., Arica, Tocopilla, Valparaiso, and Talcahuano.

Colombia had monitoring stations in Bogotá, Medellín, Cali, and Bucaramanga. Stations perform continuous measurements of PM, gaseous pollutants, and meteorological variables. The air quality-monitoring network in Bogotá consisted of 13 fixed monitoring stations and a mobile station, located across the city. In Medellín, there were 21 air quality monitoring stations; in Bucaramanga, 9; and in Santiago de Cali, 3.

Mexico had more than 80 sites with monitoring stations or networks where air quality was being measured regularly. However, in 2010, only 51 of them produced valid annual measurements of PM_{10} or $PM_{2.5}$. Approximately 32 million people or 28% of the Mexican population (30) was living in the areas covered by these stations..

Bolivia had a network of air quality monitoring stations in La Paz, Santa Cruz, and Cochabamba. Ecuador had stations in Quito and Cuenca. All the other countries had some type of air quality data for their capital city only: Buenos Aires, Argentina; San José, Costa Rica; Santo Domingo, Dominican Republic; San Salvador, El Salvador; Guatemala City, Guatemala; Tegucigalpa, Honduras; Kingston, Jamaica; Panama City, Panama; Lima, Peru; Montevideo, Uruguay; and Caracas, Venezuela.

Air quality norms and regulations

The study found that the main pollutants regulated in LAC were PM_{10}, NO_2, and SO_2. PM_{10} was being regulated in 19 countries; O_3, in 17 countries; NO_2, in 18 countries; and $PM_{2.5}$, in 13 countries.

WHO has set the AQG and three Interim Targets (IT) for PM_{10} and $PM_{2.5}$ to help countries with high PM concentrations gradually improve air quality (23). The acceptable limits for these pollutants in each LAC country's regulations is compared to the WHO-AQG in Table 1. National standards for air contaminants varied among countries, but in most of them, the standards were well above the WHO-AQG. Only Bolivia, Guatemala, and Peru had adopted the WHO-AQG for PM_{10}, and only Guatemala, for $PM_{2.5}$.

The study did not find any air pollution regulations in 10 countries: Antigua and Barbuda, Bahamas, Barbados, Dominica, Grenada, Haiti, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, and Suriname.

Current concentrations of air pollutants

Average annual data from the 104 cities that monitor PM_{10} showed that only Salvador de Bahia (Brazil) was within the WHO 20 μg/m^3 guideline. Of the others, 9 cities had concentrations that exceeded the IT-1 (70 μg/m3), but 20 were within it; 46 were within IT-2 (50 μg/m^3); and 24 were within IT-3 (30 μg/m^3). For the 57 cities that monitor $PM_{2.5}$, the annual average data showed that 4 cities met the WHO 10 μg/m^3 guidelines. $PM_{2.5}$ average levels for 12 cities were within the IT-1 of 35 μg/m^3; 25 cities were within IT-2 (25 μg/m^3), 9 cities were within IT-3 (15 μg/m^3). Seven cities had concentrations that exceeded WHO IT-1. Figure 3 shows PM_{10} and $PM_{2.5}$ in some LAC cities.

The study did not find any information on air quality for the following countries: Antigua and Barbuda, Bahamas, Barbados, Belize, Cuba, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Haiti, Nicaragua, Panama, Paraguay, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago.

Short-lived climate pollutants

Almost 12% of the world's BC emissions are from LAC (31). However, most LAC countries do not monitor BC directly. Lima was the first city to monitor BC emissions (31). Studies on BC concentration are scarce, but some have been performed in Mexico. The Mexico City Metropolitan Area is the largest source of SCLPs in Latin America.

The composition of PM is complex and varies according to sources, time, and place. Retama and colleagues (32) derived the extended measurements of equivalent black carbon (eBC) from light absorption measurements and found that the cross-correlation between the eBC and $PM_{2.5}$ presents a complex relationship between BC (produced by primary emissions and particle mass that is a mixture of primary and secondary processes). Although the eBC was approximately 20% of the mass of $PM_{2.5}$ in their study, the maximum concentration changes differ from the rainy to the dry seasons, being eBC 8.8 – 13.1 μg m^{-3} (44 %) and for $PM_{2.5}$, 49 – 73 μg m^{-3} (61 %). Takahama and colleagues (33) characterized BC during 2010 by three complementary techniques: incandescence, light absorption, and volatility. They found three different-sized modes of BC mass in particles; the mode from 200–300 nm was associated with urban burning activities.

In 2006, as part of the Megacities Initiative in Mexico City, BC was measured at two-minute intervals using an aethalometer at 880 nm. The researchers found that Mexico City's PAH-to-BC mass ratio of 0.01 was similar to that found on a freeway loop in Los Angeles (United States), approximately 8 – 30 times higher than in other cities (34). In addition, the emission factor of BC from diesel vehicles in Mexico City was found to be over 6 times higher than that of Zurich (Switzerland), and about 1.5 times higher than that of Oakland, California (United States) (35).

TABLE 1. Maximum concentration levels of the main components of air pollution—particle matter (PM), tropospheric ozone (O_3), nitrogen oxides (NOx), sulfur dioxide (SO_2), and carbon dioxide (CO_2)—allowed in countries of Latin America and the Caribbean compared to World Health Organization Air Quality Guidelines (WHO-AQG) and the United States Environmental Protection Agency (EPA) standards

Standards by country	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		O^3 (µg/m^3)		NO_2 (µg/m^3)		SO_2 (µg/m^3)		CO_2 (ppm)
	24hr[a]	Annual	24hr	Annual	8hr	1hr	1hr	Annual	24hr	Annual	8hr
WHO	50	20	25	10	100		200	40	20	—	—
EPA	150		35	12	160	240		100	372	80	9
Antigua and Barbuda	WL[c]	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Argentina	150	50	65	15	157	235	—	100	365	80	10
Bahamas	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Barbados	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Belice	—	—	—	—	—	—	—	—	—	—	—
Bolivia	150	50	25	10	100	236	400	100	365	80	10
Brazil	150	50	—	—	—	160	320	100	365	80	9
Chile	150	50	50	20	120	—	400	100	250	80	8.6
Colombia	100	50	50	25	80	120	200	100	250	80	8.8
Costa Rica	150	150	—	—	—	160	400	100	365	80	10
Cuba	—	—	—	—	—	—	—	—	—	—	—
Dominica	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Dominican Republic	150	50	65	15	160	250	400	100	150	100	10
Ecuador	100	50	50	15	100	160	—	40	125	60	10
El Salvador	150	50	65	15	120	—	—	100	365	80	10
Grenada	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Guatemala	50	20	25	10	—	—	—	40	20	—	—
Guyana	—	—	—	—	—	—	—	—	—	—	—
Haiti	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Honduras	—	—	—	—	—	—	—	—	—	—	—
Jamaica	150	50	65	15	—	235	100	—	365	80	10
Mexico	75	40	45	12	70	95	395	100	288	66	11
Nicaragua	150	50	—	—	160	235	400	100	365	80	10
Panama	150	50	—	—	157	235	—	100	365	80	10
Paraguay	—	—	30	15	—	—	—	—	—	—	—
Peru	150	50	25	15	120	—	200	100	20	80	8.7
Saint Lucia	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
St. Kitts and Nevis	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
St. Vincent and Grenadines	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Suriname	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Trinidad and Tobago	75	50	65	15	120	—	200	40	125	50	10
Uruguay	150	50	—	—	120	—	320	75	125	60	10
Venezuela	150	50	—	—	160	200	367	100	365	80	10

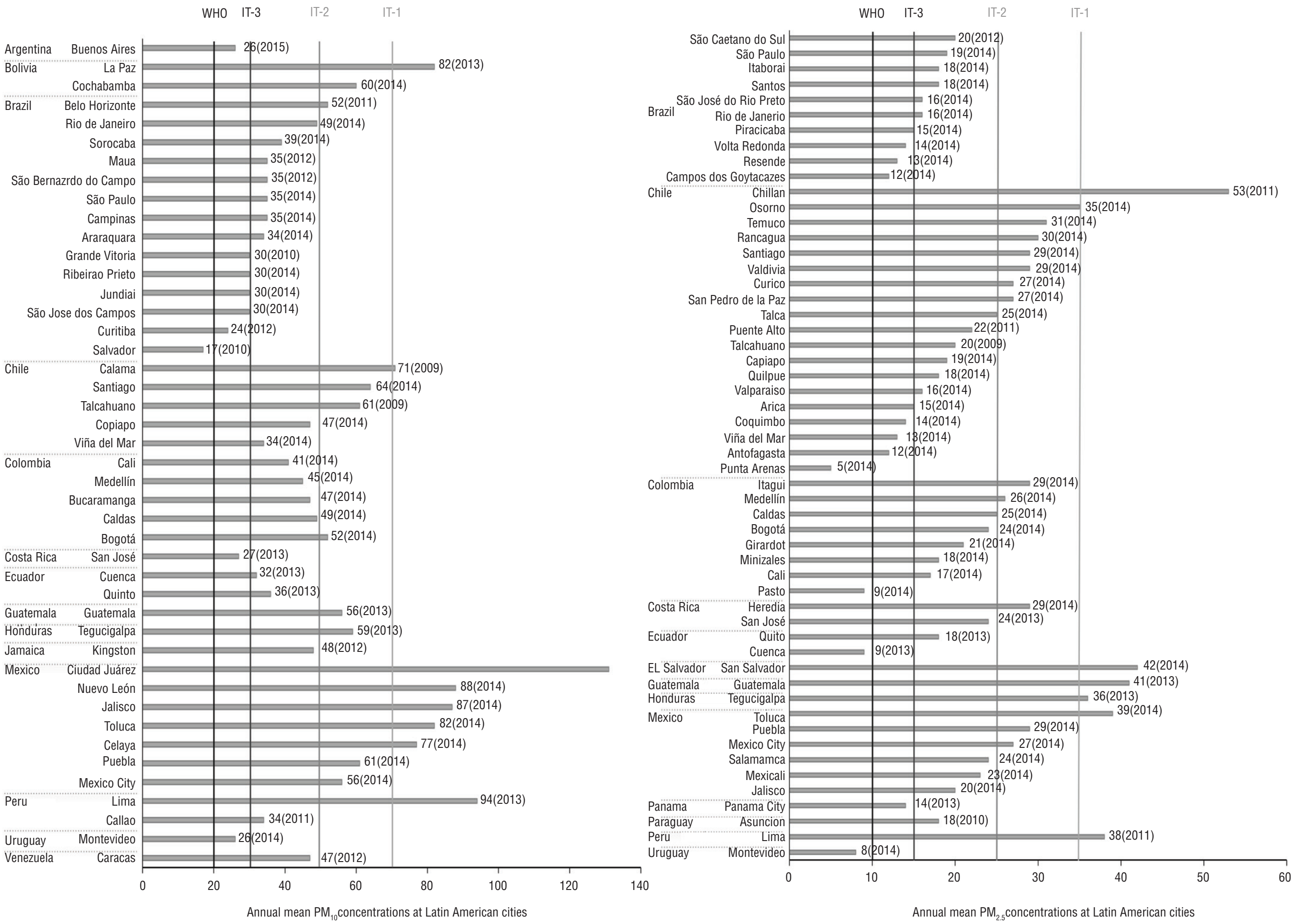
[a] Hour.
[b] No data.
[c] Without legislation.
Sources: Argentina: Calidad Atmosférica Jefatura de Gabinete de Ministros,Secretaria de Medio Ambiente y Desarrollo Sustentable Gobierno de la Ciudad de Buenos Aires. Brazil: Compañía Ambiental del Estado de São Paulo, Companhia Ambiental do Estado de São Paulo. Bolivia: Informe Nacional de Calidad del Aire 2008–2009, Ministerio de Medio Ambiente y Agua. Chile: Instituto Nacional de Estadística Biblioteca del Congreso Nacional de Chile (www.leychile.cl/Navegar?idNorma=1025202). Colombia: Republic of Colombia, Ministry of Environment, Housing, and Territorial Development, 2006 (www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=19983). Ecuador: Informe anual, 2011. Calidad del Aire. Quito, Distrito Metropolitano, 2011. EPA: National Ambient Air Quality Standards. Air quality guidelines. (www.epa.gov/air/criteria.html). Mexico: Mexican official standards, Secretaría de Salud. Peru: Estándares Nacionales de Calidad Ambiental del Aire vigentes al 2014. WHO: Air Quality Guidelines (23), 2005.

The United Nations Environmental Program (UNEP) has indicated that implementing specific measures targeting significant sources of BC and CH_4 would avoid about 2.4 million premature deaths globally, and halve the rate of warming over the next decades (3). According to the global-scale UNEP/World Meteorological Organization (7) assessment, this could reduce BC by close to 300 000 tons. Ozone (O_3) is also a SLCP, and the Global Burden of Disease Study estimates that in 2010, almost 22 079 disability-adjusted life years in LAC were attributable to O_3 exposure (24).

DISCUSSION

The normative framework and air quality monitoring are important components of air quality management. Thus, we presented here an overview of the status of air quality management in LAC, including regulations and monitoring, and the situation in public health terms. PAHO had reported decreasing annual means of PM_{10} in some countries in 2006 – 2010 (18). The Clean Air Institute had published a useful review of this topic in 2012 (20), presenting annual average PM_{10} for 16

FIGURE 3. Particle matter (PM)$_{10}$ and PM$_{2.5}$ in cities of Latin America and the Caribbean and their situation compared with the World Health Organization–Air Quality Guidelines (WHO-AQG), 2010–2014



cities in LAC and PM$_{2.5}$ for 11 cities. Only one of these cities complied with the WHO-AQG (20). Likewise, the present overview of 104 cities for PM$_{10}$ and 57 cities for PM$_{2.5}$ found that five cities complied with the WHO-AQG for the annual mean of PM$_{10}$, and four complied for PM$_{2.5}$.

The interim targets proposed by WHO are steps toward progressive reduction of air pollution (36).Therefore, when formulating policy targets, governments should consider the local context carefully before adopting the guidelines directly as legally based standards. In addition, governments should indicate how and when the standards are to be achieved. Since the epidemiological evidence indicates that the possibility of adverse health effects remains even if the guideline value is achieved, some countries might chose to adopt guidelines for lower concentrations than the WHO-AQG values (31). It is important for all the countries to have an updated regulatory framework for all the pollutants, especially for PM$_{2.5}$.

The urbanization process continues to increase in LAC (24, 37). Similarly, there are trends of increased motorization of the urban population, which may predict future rising levels of pollutants in cities (24, 35). Household combustion of solid fuels for cooking or heating could also contribute to the overall urban air pollution in countries where considerable fraction of the population uses solid fuels as their main source of energy. All these trends, associated with the predicted effects of climate change (38), are driving forces of air pollution in LAC. To prevent raising the burden of diseases attributed to air pollution, it is necessary to promote concerted action by all sectors, particularly those related to urban planning. This includes sustainable solutions for public transportation and mobility, and sustainable clean energy solutions for all. Air pollution control to protect public health and the environment are urgent and imperative.

The methodology of Health Impact Assessment (HIA) used and validated in several countries is a handy tool that could be used to assess the cost-benefits of different types of policy interventions that tackle air pollution (26, 37, 38). A HIA study in Mexico estimated that the application of new PM$_{2.5}$ standards could prevent approximately 6 669 deaths each year in 12 Mexican cities (30). Also, HIA can estimate the burden of air pollution on sub-population groups, quantifying the contribution of air pollution to health inequities. Furthermore, HIA results can be useful for supporting stakeholder's negotiations when updating the regulatory framework at the national level.

Updating standards does not improve air quality, but is important for influencing programs such as emissions control. Multisectoral action is required to change processes and accelerate the adoption of cleaner energy. Each update in the regulations should be coupled with agreements with polluters on rigorous implementation plans and realistic deadlines.

It is important to measure the average annual concentration of fine particles because of their associated chronic health effects and to better estimate the burden of diseases attributable to air pollution. Satellite models help build average estimations of exposure, but are more reliable in larger areas with ground level measurements. However, differential population risks and vulnerabilities in small areas imply that areas with high air pollution should be identified.

Coverage of monitoring networks is clearly insufficient, reaching only 146 million people, less than one-third of the urban population of LAC. There is a need to invest in monitoring networks, as measuring air pollution raises awareness and gives guidance to evidence-based effective interventions. It is also necessary to evaluate progress toward meeting the WHO-AQG and for accountability reports of the control policies implemented.

BC is a component of $PM_{2.5}$ and could be measured separately without great technical challenges. Understanding its distribution according to different sources and estimating its effect on climate and health in LAC are necessary. There is now an opportunity to boost $PM_{2.5}$ control as part of the mitigation of climate change, so that the corresponding co-benefits of emission control strategies can be generated and estimated.

The WHO and the UNEP resolutions on air pollution (39, 40), as well as the Plan of Action on Air Pollution adopted by the XIX Meeting of the Forum of Ministers of Environment of Latin America and the Caribbean (41) can guide the development of national air quality action plans, taking into consideration the unique circumstances of each country.

LIMITATIONS

This study has some limitations. Some of the data may be incomplete, as there might be information that was not available in any of the sources. Furthermore, legal frameworks, particularly those regarding regulatory matters, may have changed after the information was collected. Additionally, many of the impacts of short-lived pollutants on the climate of Latin America and the Caribbean are not well understood or quantified. Local studies on their concentration and health effects are needed.

CONCLUSIONS

Scientific evidence indicates that fast and widespread action to reduce the SCLPs has the potential to significantly slow the rate of global warming, offering one of the few pathways to achieving near-term climate impacts (9). The annual mean values of PM_{10} and $PM_{2.5}$ in most measured sites in LAC are significantly higher than the WHO-AQG. In addition, countries have been slow to incorporate the WHO-AQG guidelines into national-level regulations and in establishing networks for air quality monitoring. However, there is increased awareness of the problem and resolutions by the United Nations Environment Assembly (40) and by the World Health Assembly (39) calling for action on air pollution.

Air pollution, especially SLCPs, impose a heavy cost in terms of ill health and premature deaths in LAC. More knowledge of their sources, atmospheric transfer, impacts, and effectiveness of remedial measures is need. Another key priority is raising awareness of the direct and indirect health effects of SCLPs among both decisionmakers and the general population.

Air quality monitoring sites are limited in LAC. Investments should be made to strengthen and improve the existing monitoring networks, and at a minimum, extend coverage to all cities with more than 500 000 inhabitants. In particular, whenever possible, $PM_{2.5}$ and BC should be measured.

It is imperative to strengthen air quality management in LAC and to implement the WHO-AQG in the medium- to long-term. An intersectoral air quality management program that is sensitive to the participation of organized communities and different interest groups could help policy and decisionmakers focus on obtaining the best, most sustainable benefit for health, equity, and the climate when considering policy options.

Furthermore, it is necessary to generate information on air quality and estimates of the burden of disease attributable to air pollution at the country level. This information will facilitate risk communication and provide reliable data for future estimations of the economic and social costs and benefits associated with the different policy options. Implementation of the Climate Change Paris Agreement (33) is a challenge, but represents a great opportunity to build and strengthen air quality management in LAC, optimizing the immediate benefits for both climate and public health, especially at the local level. Therefore, bolstering the capacity of the health sector to better respond to and take advantage of these challenges and opportunities is essential.

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RESUMEN

Gestión y control de la contaminación atmosférica en América Latina y el Caribe: implicaciones para el cambio climático

Objetivo. Evaluar la situación del marco jurídico sobre el control de la calidad del aire en todos los países de América Latina y el Caribe; determinar la distribución actual de las estaciones de control del aire y la concentración media de los contaminantes atmosféricos de todas las capitales y ciudades grandes (de más de 100.000 habitantes); y analizar las implicaciones para el cambio climático y la formulación de políticas públicas.
Métodos. Se efectuaron búsquedas en bases de datos en línea entre enero del 2015 y febrero del 2016 con el fin de localizar leyes, reglamentos, políticas y programas de lucha contra la contaminación atmosférica, así como de determinar la distribución de las estaciones de control y la concentración media anual de contaminantes atmosféricos de todos los países de América Latina y el Caribe.
Resultados. Solo 77 ciudades ubicadas en 17 de 33 países de América Latina y el Caribe, lo que abarca a aproximadamente 146 millones de habitantes, disponían de información oficial sobre los contaminantes de la capa más baja de la atmósfera. En la mayoría de las ciudades, la concentración media anual de partículas inhalables supera los valores considerados aceptables en las directrices de la OMS sobre la calidad del aire; cabe destacar que, en realidad, solo Bolivia, Perú y Guatemala han adoptado estas directrices. La mayoría de las ciudades no tienen información sobre las $PM_{2,5}$ y solo algunas miden el hollín.
Conclusiones. Es preciso actualizar el marco jurídico sobre la calidad del aire incorporando los conocimientos actuales acerca de los efectos de la contaminación sobre la salud. Es necesario ampliar y fortalecer la vigilancia y el control de los contaminantes de la capa más baja de la atmósfera a fin de aumentar la concientización sobre este problema y proteger la salud pública. Se recomienda utilizar los beneficios colaterales para la salud y el clima que reporte el control de la contaminación atmosférica como marco para la formulación de políticas y la toma de decisiones en América Latina y el Caribe.

Palabras clave Contaminación del aire; cambio climático; política de salud; medio ambiente y salud pública; América Latina; América del Sur; Región del Caribe.