Vital Strategies

Inspiring an Urban Mobility That Saves Lives by Improving the Quality of the Air We Breathe

Foreword

Air pollution is both manageable and preventable, yet it remains largely neglected, negatively affecting people's health and well-being. It is estimated that, each year, about 6.7 million people die from the impacts of air pollution, the fourth leading cause of premature deaths globally.

Poor air quality severely harms people's health at all stages of life, causing a range of illnesses and health complications. Studies show that, in 2019, more than 90% of the world's population breathed air with concentrations of particulate matter ($PM_{2.5}$) that exceed the guidelines of the World Health Organization.

In Brazilian cities, home to more than 85% of the population, there is great potential to reduce emissions from transportation, one of the main sources of air pollutants. To explore these opportunities, municipal governments must implement public policies that incentivize public transit, discourage individual motorized modes of transportation, promote fuels and vehicles with low-carbon technologies, and encourage active transportation (walking or cycling). These actions improve air quality, increase traffic safety, and encourage physical activity, revealing the convergence between health and sustainable mobility agendas.

In addition to their negative effects on health, the main sources of pollutants are also responsible for the greenhouse gases that trigger climate change. Thus, accelerating the improvement of air quality is also an opportunity to mitigate global warming. Health should therefore be the core of public policies, promoting actions aimed at people's well-being and the future of the population and the planet.

Structured in three sections, this resource was developed to present evidence and experiences to policymakers, thus inspiring urban mobility policies that save lives by improving the air we breathe. The first part contains evidence on the effects of air quality on health and the impacts of transportation on air quality. The second section lists Brazilian experiences adopting urban mobility measures that improve air quality, and successful strategies for monitoring and communication on the subject. The third section contains policy recommendations aimed at the municipal level. The overall goal of this resource is to provide decision-makers with the evidence they need to communicate about much-needed but not always popular transportation policies that can improve public health.

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About this document

This document was prepared by Vital Strategies with support from Instituto Clima e Sociedade (iCS). Hannah Machado and Sumi Mehta, from Vital Strategies, coordinated the development of this report. Bianca Macêdo developed the research and content, while Amanda Corradi was responsible for writing. It was edited by Richard Sanches, Genine Babakian, Karen Schmidt and Luiza Borges and designed by Coletivo Bicho and Allan Cerqueira de Brito.

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Credit: Divulgação/Prefeitura de Fortaleza

Introduction

Air pollution is a controllable and preventable problem, but it is largely neglected, negatively affecting people's health and well-being. It is estimated that about 6.7 million people die every year as a result of air pollution, making it the fourth leading cause of early death on the planet.[1]

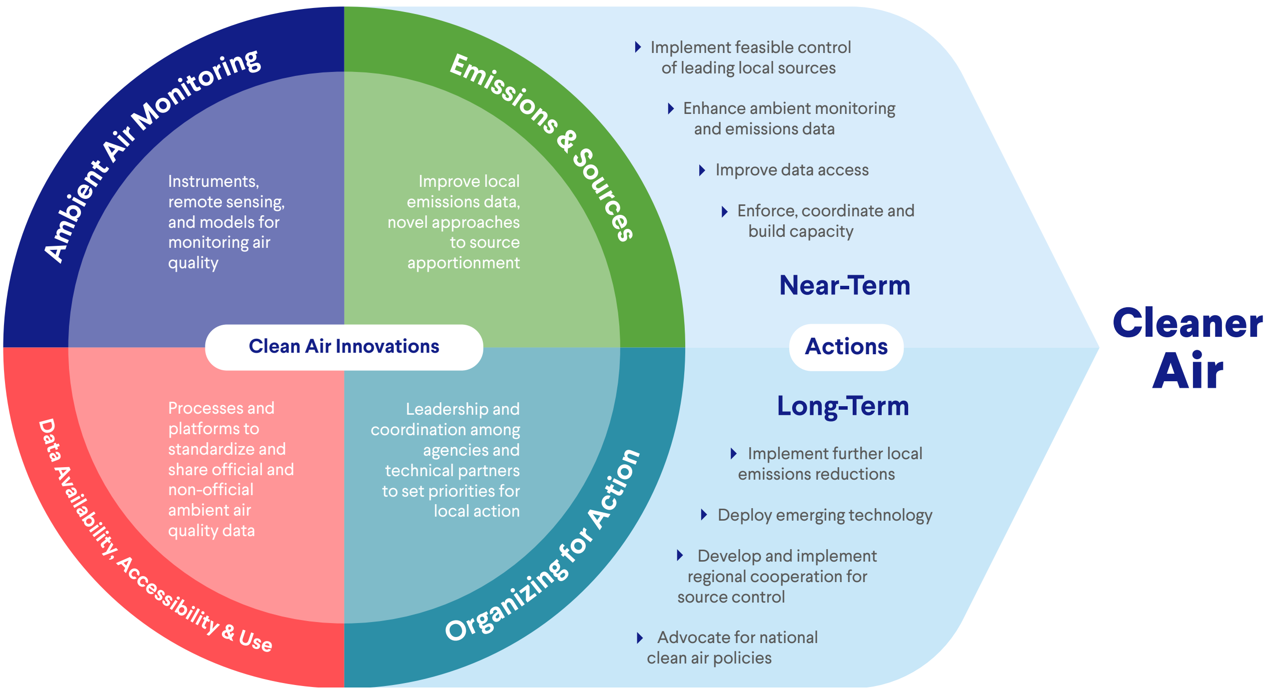
Poor air quality severely affects people's health at all stages of their lives, causing a range of illnesses and complications. It accounts for 40% of global deaths from chronic obstructive pulmonary disease, 26% of deaths from stroke, 20% of deaths from diabetes, 20% of deaths from ischemic heart disease, and 19% of deaths from lung cancer.[1]

It is estimated that more than 90% of the world population in 2019 breathed air with concentrations of particulate matter ($PM_{2.5}$) that exceed the guidelines of the World Health Organization (WHO). Air pollution is intensifying in developing countries. The highest mortality rates caused by pollution occur in Asia and Africa.[1]

For many municipal governments in low- and middle-income countries, the complexity and cost of understanding and controlling air pollution has been a barrier to taking effective action for clean air. The guide Accelerating City Progress on Clean Air[2] offers an approach to building and launching actions aimed at improving air quality, outlining sound methods and taking into account local capacity, classified into four phases:

1. Limited or non-existent
2. Basic – sufficient to support initial actions
3. Comprehensive – capable of sustaining continued actions
4. Advanced – with capacity greater than many cities in high-income countries

For each of these phases, the Accelerating City Progress on Clean Air guide presents innovations across four axes, shown in the figure below:



Source: Vital Strategies: Accelerating City Progress on Clean Air, 2020.

Evidence – impacts of urban mobility on air quality and health

Air quality overview

Air pollution is the introduction into the atmosphere of substances that are harmful to human health and the environment. In urban areas, the main sources of pollution come from: the burning of fossil fuels for energy production, transport, cooking, heating, and waste incineration. The level of atmospheric pollution is measured by the concentration of pollutant substances present in the air.[3,4]

Air pollutants can be emitted directly into the atmosphere from pollution sources – in which case, they are called primary pollutants – or they can be secondary pollutants, formed by chemical reactions in the atmosphere resulting from the interaction of the primary pollutant with the environment.

Carbon dioxide (CO_2), black carbon, methane and others are considered "climate pollutants," as they are the main cause of global warming. Many of these emission sources are also harmful to people's health, which points to the synergy between air quality and climate mitigation actions.[3]

The connection between air quality and climate has so far been underutilized, in part because communicating climate benefits often focuses on preventing massive planetary damage in the future. However, the health argument can contribute a lot to reducing emissions; by taking the same measures intended to prevent climate catastrophe, it is possible to save the lives of millions of people in the short term by improving air quality. It will save many more in the long term through the mitigation of climate change.

Main atmospheric pollutants

• **PM – Particulate Matter:** The single most important indicator used for health-damaging pollutants. Very small particles of solids or liquids suspended in the air, highly harmful to health as they penetrate deeply into the respiratory system. They are classified according to their size: PM_{10} and $PM_{2.5}$ for particles with an equivalent diameter smaller than 10 μm and 2.5 μm, respectively. Its main emission sources are automotive vehicles, industry, biomass burning, and soil dust resuspension, among others. Secondary particles are formed as a result of chemical reactions in the air from gases such as sulfur dioxide (SO_2), nitrogen oxides (NOx) and volatile organic compounds (VOCs), which are emitted mainly through combustion.

• **SO_2 – Sulfur Dioxide:** A colorless, toxic gas that oxidizes to form acid rain and can react with other compounds to form secondary particulate matter. Its main emission sources are the burning of sulfur-containing fuels, such as diesel oil, industrial fuel oil and gasoline. Volcanoes are another source.

• **NO_2 – Nitrogen Dioxide:** A key indicator for traffic-related pollution. A highly oxidizing gas and one responsible for the formation of tropospheric ozone. Its main emission sources are vehicles or stationary combustion processes, in addition to natural sources such as volcanism, bacterial actions and electrical discharges.

• **CO – Carbon Monoxide:** This colorless, odorless gas can be oxidized and become CO_2. Its main emission sources are the burning of fossil fuels by vehicles, industrial processes, residential burning of wood for heating, and forest fires.

•**VOCs – Volatile Organic Compounds:** Organic chemicals that evaporate easily at room temperature, such as methane, benzene, xylene, propane and butane. In sunlight, they undergo photochemical reactions that can produce ozone, a highly reactive gas. Its main emission sources are vehicles, industries, and fuel storage and transfer processes.

• **O_3 – Ozone:** Formed from nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight, it is one of the main compounds in photochemical smog. In addition to harming health, ozone can damage vegetation. The ozone found near the ground, where we breathe, called "bad ozone," is toxic. However, in the stratosphere (altitude of about 25 km), ozone has the important function of protecting the Earth, as a filter from the ultraviolet rays emitted by the sun.

Conama standards × WHO standards

Air quality standards are part of regulations that establish concentration values for certain pollutants in the atmosphere, which, if exceeded, could affect the health of the population.

The World Health Organization (WHO) defines the maximum limits for the concentration of pollutants in the air. However, the laws governing these standards vary from country to country. In Brazil, for example, these limits are regulated by Conama, the Conselho Nacional do Meio Ambiente [National Council for the Environment].[5]

The current national regulation is quite permissive, as it accepts considerably higher limits than those established by WHO. The high Brazilian limits can generate a false impression of good air quality because air pollutant levels do not exceed national standards, when, in fact, Brazil's pollutant limits are more harmful than those recommended by WHO.

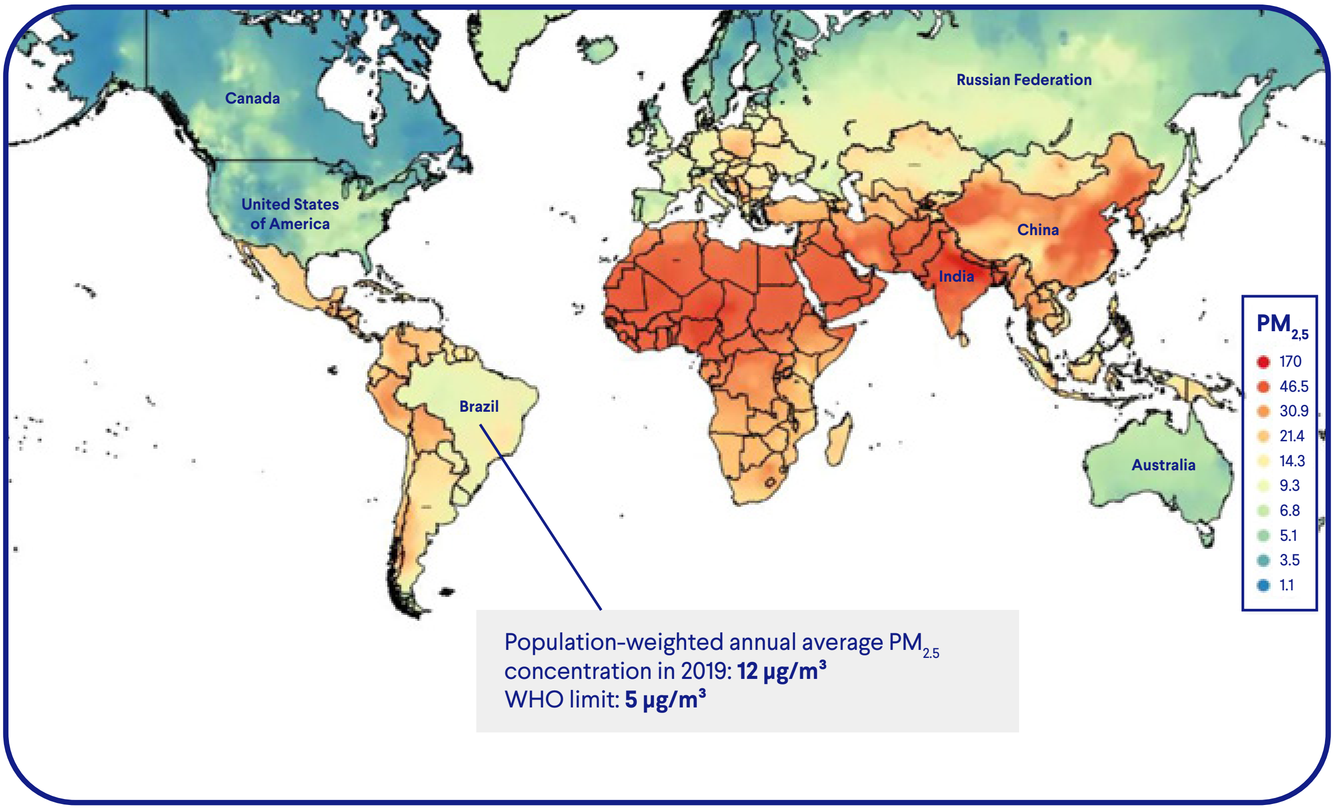
Regarding exposure to $PM_{2.5}$, it is estimated that more than 81% of Brazilians are exposed to the pollutant at concentrations above the limit stipulated by WHO.[1] Between 2010 and 2019, there was a 2% reduction in the number of deaths in the country attributed to this component. This coincided with a reduction in the concentration of $PM_{2.5}$ between 2010 and 2015; it then stagnated until 2019.

In 2021 the World Health Organization Air Quality Guidelines set new and more stringent limits for air pollutants. The new guidelines encourage governments to make continuous clean air progress; even incremental improvements will have measurable health benefits, both in areas with high air pollution levels and in regions where substantial progress has already been made.

Concentration limits in µg/m³

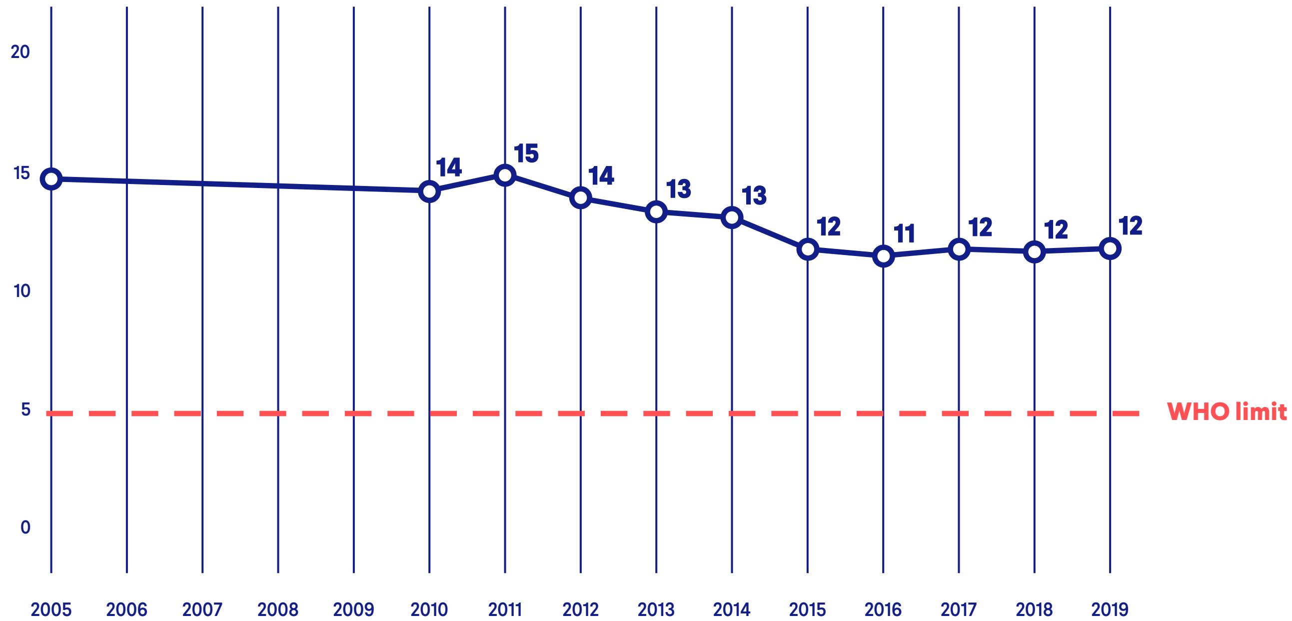
		CONAMA	WHO	
PM_{10}	24 hours	120	45	2,7x
	Annual	40	15	2,7x
$PM_{2,5}$	24 hours	60	15	4,0x
	Annual	20	5	4,0x
O_3	8 hours Maximum average mobile obtained in the day	140	100	1,4x
NO_2	Annual	60	10	6,0x
SO_2	24 hours	125	40	3,13x

Conama's air quality standards in the table correspond to the current phase (PI 1) of the four planned phases (PI 1, PI 2, PI 3 and PF) until reaching the WHO limits. Phase PI 1 started in 2018, and the others still do not have a defined date to start. Source: Conama Resolution 491 and WHO, 2021.



Source: Health Effects Institute. 2020. State of Global Air 2020. Data: Global Burden of Disease Study 2019. IHME, 2020. And WHO, 2021.

Annual evolution of population-weighted average $PM_{2.5}$ concentration (µg/m3) in Brazil



Source: Health Effects Institute. 2020. State of Global Air 2020. Data: Global Burden of Disease Study 2019. IHME, 2020.

Status of monitoring in Brazil

Regarding the development of a comprehensive monitoring program, pollutant inventories, air quality modeling and forecasting, Brazil still needs to make great progress.

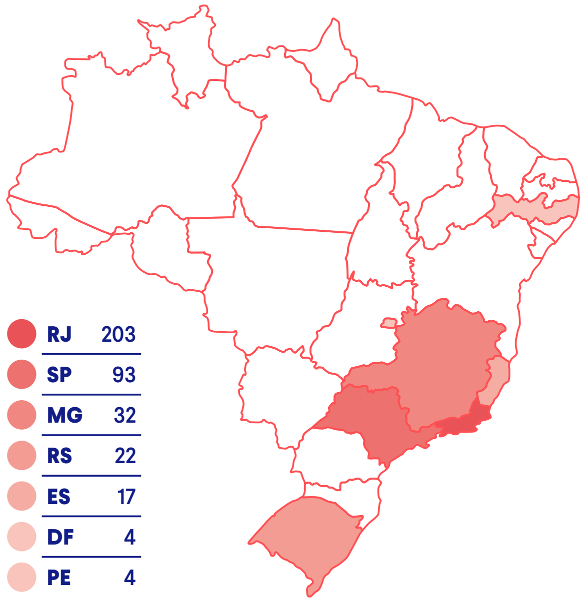
In 1989, Conama established the National Air Quality Control Program (Pronar), which is tasked with the creation of the National Air Quality Monitoring Network. The creation of a National Inventory of Sources and Emissions was also envisaged, with the objective of developing methodologies to register and estimate emissions and process data related to air pollution sources. Brazilian Institute of the Environment and Renewable Natural Resources was given responsibility for managing the program and coordinating with public administration agencies and private entities at the federal, state and municipal levels to maintain a permanent channel of communication.

In 1990 the first regulation was enacted establishing national air quality standards and the responsibility of states to monitor their respective territories. In 2018 this regulation was revised, resulting in the one currently in effect.

In 2019, 30 years after the creation of Pronar, a study carried out by the Instituto Saúde e Sustentabilidade verified that only seven federative units out of the total 27 carried out air quality monitoring, namely: the Federal District (DF, as abbreviated in Portuguese) and the states of Espírito Santo (ES), Minas Gerais (MG), Pernambuco (PE), Rio de Janeiro (RJ), Rio Grande do Sul (RS) and São Paulo (SP). In all, there are 375 air monitoring stations, with the following characteristics:[6]

- 85% of them are active
- 93% are in the Southeast region
- 56% are in metropolitan areas
- 48% are private
- 60% are automatic
- 98% are stationary

PM_{10} (which, using conversion factors, can serve as a proxy to estimate the concentration of $PM_{2.5}$) is monitored by about 50% of the stations. The reduction of $PM_{2.5}$ pollutants is considered to be more important, as it is one of the main pollutants harmful to health and the concentration limit set by the WHO is low; these levels are increasingly monitored, reaching 20% of stations in 2019 (all in the Southeast region).



Source: Instituto Saúde e Sustentabilidade: Análise do monitoramento de qualidade do ar no Brasil, 2019.

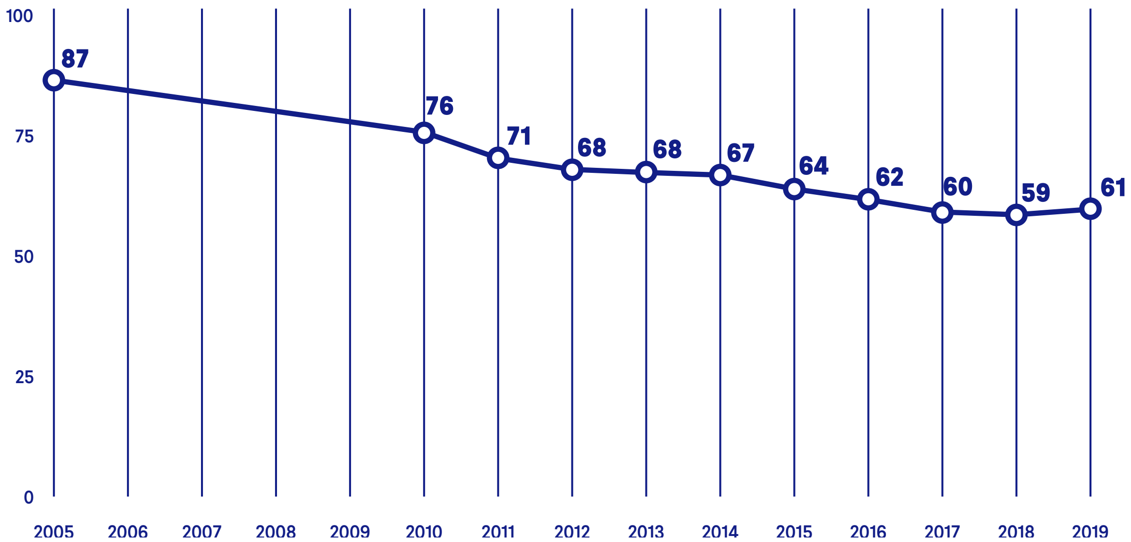
Health impacts of air pollution

Air pollution represents a great risk to human health and can affect people differently, depending on the pollutant's toxicity and the individual's degree of exposure, susceptibility and vulnerability.

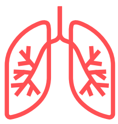
Early death is the most serious consequence of exposure to pollutants. However, an even greater number of people suffer consequences that interfere with their health, their quality of life and their well-being.

In Brazil, in 2019, 61,000 people lost their lives as a result of air pollution.[1] When analyzing the historic data, it becomes clear that, between 2005 and 2017, the number of deaths caused by air pollutions fell year after year. Starting in 2019, this number leveled off.

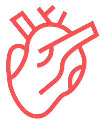
Annual evolution of the number of deaths in Brazil from air pollution in one thousand deaths



Source: Health Effects Institute. 2020. State of Global Air 2020. Data: Global Burden of Disease Study 2019. IHME, 2020.

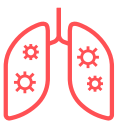


40% of deaths from chronic obstructive pulmonary disease

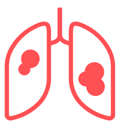


20% of deaths from ischemic heart disease

20% of deaths from diabetes



30% of deaths from acute respiratory infection



19% of deaths from lung cancer

26% of deaths from stroke

Source: Health Effects Institute. 2020. State of Global Air 2020.

Air pollution can inflict acute damage on people's health – usually manifested by respiratory or cardiac symptoms – or chronic illness, potentially affecting all organs of the body. It can also cause, complicate or aggravate many adverse health conditions. Damage can be related directly to the toxicity of particles that penetrate the organs, or indirectly, through systemic inflammatory processes.

The damage caused by air pollution affects human health at all stages of life.

During pregnancy, exposure to polluted air impairs the development of babies and is associated with low birth weight, increased risk of preterm birth, neonatal deaths (accounting for 20% of global neonatal deaths), post-neonatal deaths and fetal deaths.[1,3]

Early exposures during pregnancy – prenatal and postnatal – can harm the baby's development and also predispose it to other negative outcomes in adulthood, such as cardiovascular diseases (hypertension and coronary disease), chronic respiratory diseases, obesity, diabetes and cancer.

(Schwartz, 2004; WHO, 2018)

Several studies show significant associations between exposure to polluted air and adverse effects during pregnancy, especially to pollutants PM, SO_2, NO_2, O_3 and CO. $PM_{2.5}$ is particularly associated with low birth weight, and external polluted air is itself associated with premature birth.

(WHO, 2018)

Prematurity

Zhao *et al.*, 2011; Lima *et al.*, 2013

Low weight at birth

Gouveia *et a.l*, 2004; Medeiros e Gouveia, 2005; Junger e Leon, 2007; Nascimento e Moreira, 2009; Romão *et al.*, 2013; Santos *et al.*, 2014

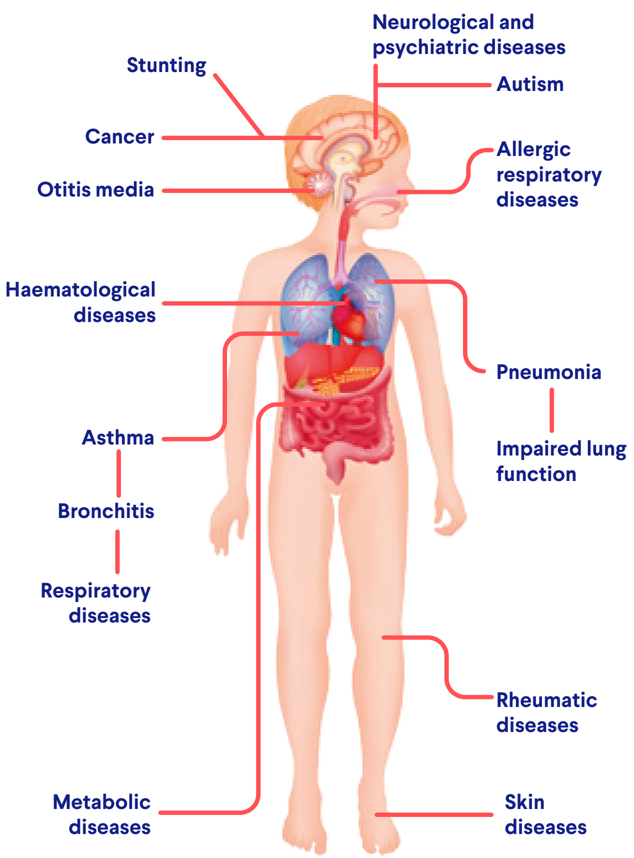
Neonatal and postnatal death

Lin *et al.*, 2004; Nishioka *et al.*, 2014

Fetal death

Pereira *et al.*, 1998; Nishioka *et al.*, 2000

Source: O estado da qualidade do ar no Brasil, 2020 and Health Effects Institute. 2020. State of Global Air 2020.



Source: O estado da qualidade do ar no Brasil, 2020.

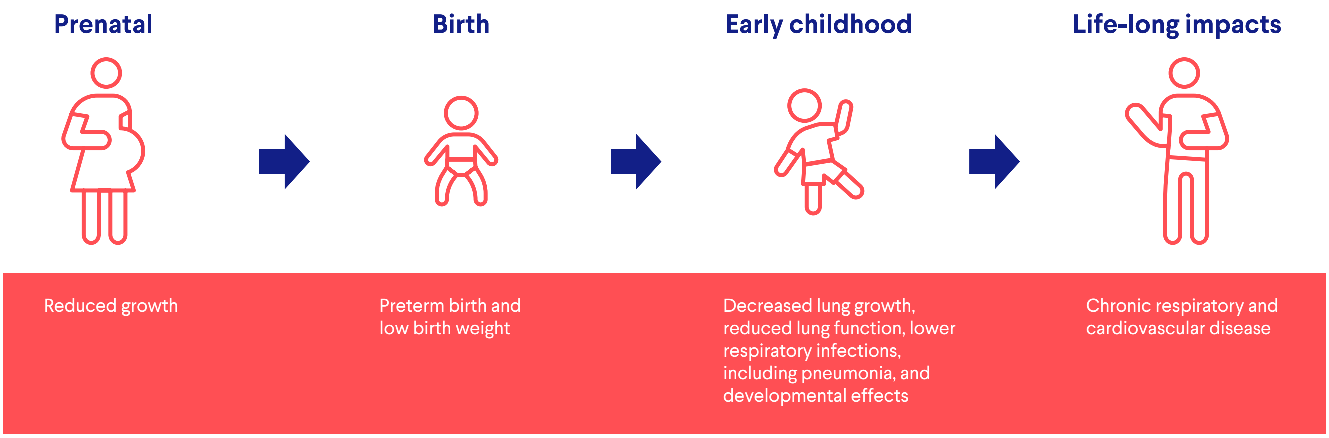
Pre- and post-natal exposure to air pollution can also negatively affect neurological development, worsen cognitive test results and influence the development of behavioral diseases. In addition, there is evidence that exposure to pollutants can negatively affect children's mental and motor development, and increase the risk of lung diseases, such as asthma, and the development of childhood cancer.[4]

Children are among those most vulnerable to the impacts of air pollution. Their lungs are still developing, and they breathe more air per kilogram than adults. In addition, they are closer to the ground, where more pollutants accumulate.[3]

It is estimated that around 2 billion children in the world live in areas with pollution levels above those established by the WHO, and that approximately 570,000 children under the age of 5 die every year as a result of infections and diseases attributed to exposure to air pollutants.[12]

Air pollution also increases the likelihood that children will suffer adverse effects as they mature into adulthood. Exposure to air pollution early in life can impair lung development, reduce lung function, and increase the risk of chronic lung disease in adulthood.[4]

Impact of air pollution at different life stages

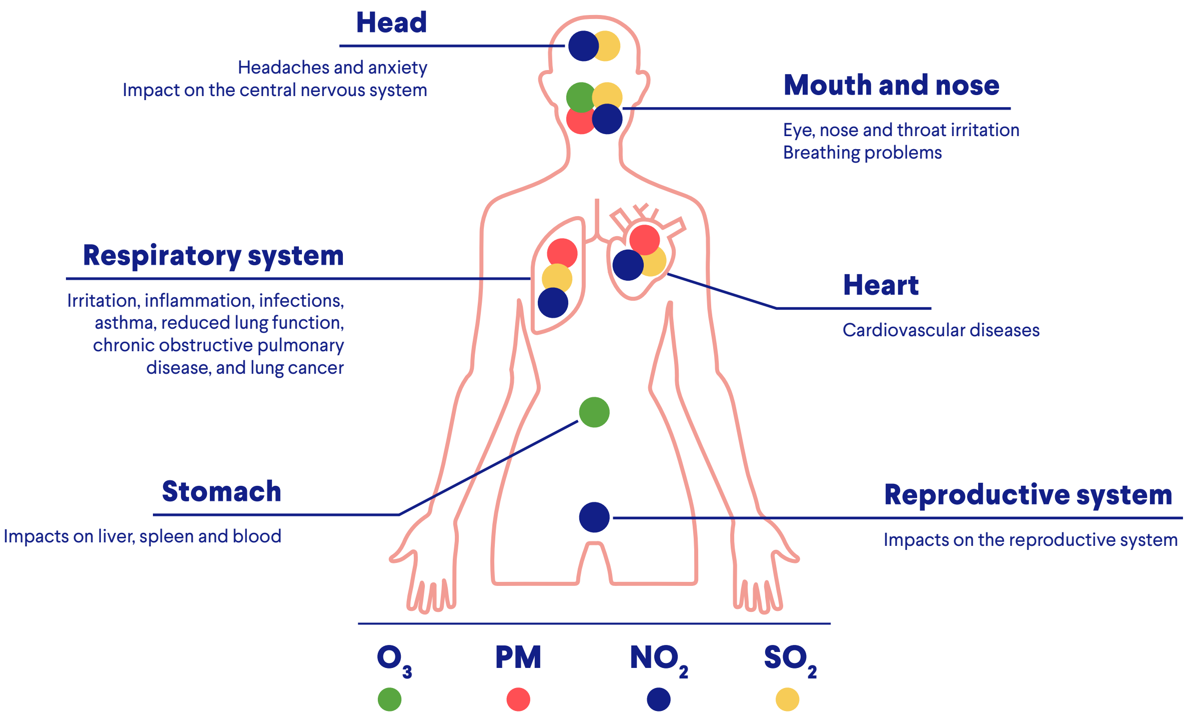


Source: Pan American Health Organization: Air pollution and child health: prescribing clean air. 2019.

Inhaling particulate matter can cause respiratory and cardiac discomfort, even requiring, in certain cases, emergency care. In addition, it can cause or aggravate conditions such as asthma, lung cancer, diabetes, dementia and even fertility problems. The smaller the particle, the deeper into the lungs it can penetrate, taking with it the chemical compounds of which it is composed.[10,11]

The impacts of early mortality and diseases resulting from air pollution claim a heavy economic burden. It is estimated that the cost of mortality attributed to particulate matter in six metropolitan areas in Brazil (where 23% of the population lives) is R$ 6.4 billion per year in lost productivity, in addition to about 8,600 hospitalizations at a cost of R$ 15.9 million per year to Brazil's publicly funded health care system (SUS)[7]

In addition to the costs directly related to public health care and premature death, there is also the negative impact of air pollution on the labor market, the loss of agricultural production, and the limitations associated with hindered cognitive development. [3]



Source: WRI Brasil: Qual o impacto da poluição do ar na saúde?, 2018.

Studies in Brazilian cities show that a reduction of 5 µg/m³ in $PM_{2.5}$ concentration generates considerable savings in resources, thanks to the reduction in the annual number of cases and the consequent increase in people's life expectancy. For the city of Fortaleza, resource savings are estimated at US$ 781 million, and for São Paulo, this value is close to US $5 billion.[8,9] The impacts of air pollution also vary according to economic status. In São Paulo, low-income people, slum dwellers and people with low education suffer greater effects from PM_{10} mortality. Low education is also related to greater mortality effects from NO_2, SO_2 and CO.

A proper assessment of the interaction between air pollution and socioeconomic status contributes to the discussion of environmental justice, which seeks to end the unequal distribution of environmental risks affecting quality of life.[13,14]

Impacts of air pollution in Sao Paulo and Fortaleza

City	Time course	Pollutant	Scenario	Annual number of cases avoided	Annual number of cases avoided per 100,000 inhabitants.	Gain in life expectancy (months)	Years of life gained	Resource savings (US$)
Fortaleza	From 2015 to 2017	$PM_{2,5}$	Long-term reduction by 5µg/m³	216,9	18,7	3,8	13,372,1	780,595,109
São Paulo	From 2009 to 2011			1,724,8	28,7	5,2	87,548,9	4,958,805,241

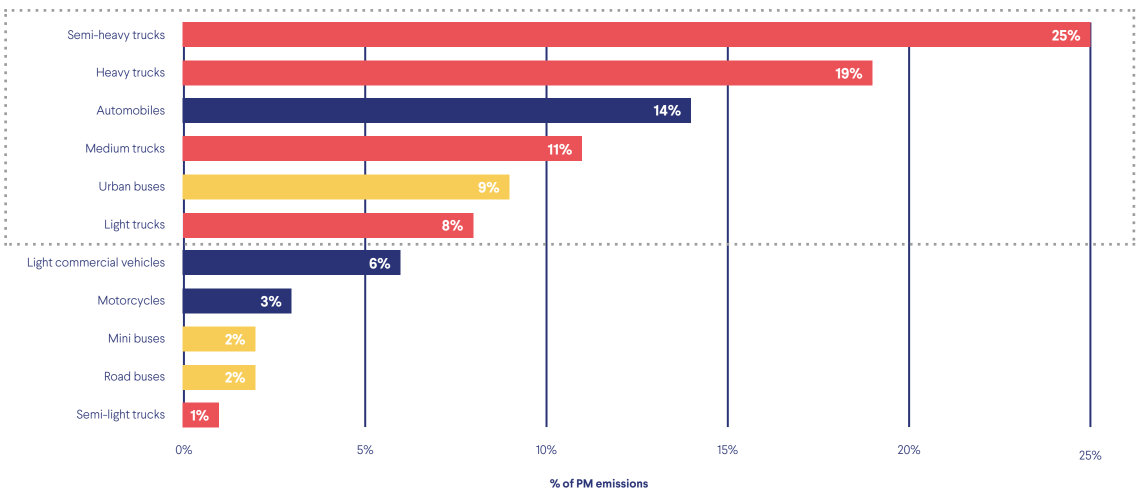
Source: 1) Rocha *et al.*: Health impact assessment of air pollution in the metropolitan region of Fortaleza,Ceará, Brazil, 2020. 2) Abe e El Khouri Miraglia: Health Impact Assessment of Air Pollution in São Paulo, Brazil, 2016.

Impacts of urban mobility on air quality

Road transport is the main means of urban travel in Brazil. In 2018, it was responsible for approximately 63% of commuter displacements in cities with more than 1 million inhabitants.[15]

Emissions caused by motor vehicles are mainly due to their energy source, such as diesel, which is used by 43% of the road category, and gasoline, used by 27%. The main vehicles responsible for particulate matter emissions in Brazil are trucks, cars and urban buses.[16]

Percentage of total particulate matter emissions by vehicle category in 2012



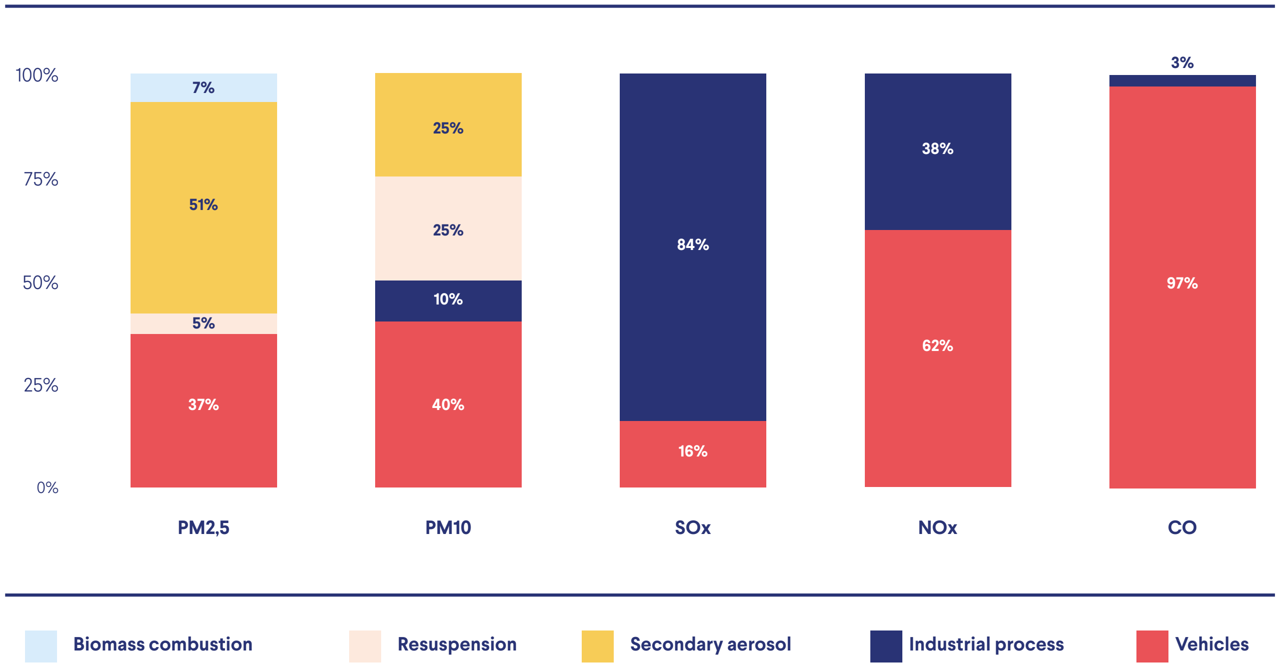
Source: Brazil's Ministry of Environment, 2o Inventário Nacional de Emissões Atmosféricas por veículos automotores, 2013.

Motor vehicles are responsible for a large part of the harmful pollutants in Brazil. In São Paulo, for example, they represent 40% of PM_{10} emissions and 37% of $PM_{2.5}$ emissions.[17] In addition to the emissions generated by the combustion process, another source of air pollution is the resuspension of material deposited on the roads. Called wear particulate matter, this pollutant comes from the wearing of tires, brakes and pavement.

Measures to reduce pollutant emissions in transport encompass several actions, such as combining the plannin of land use and occupation with the improvement of road and transport systems, but it is worth highlighting two main fronts: changes in vehicular technologies and promoting active transportation modes, such as walking and biking. The latter, in addition to improving air quality, contributes to health through physical exercise; it also reduces traffic deaths.

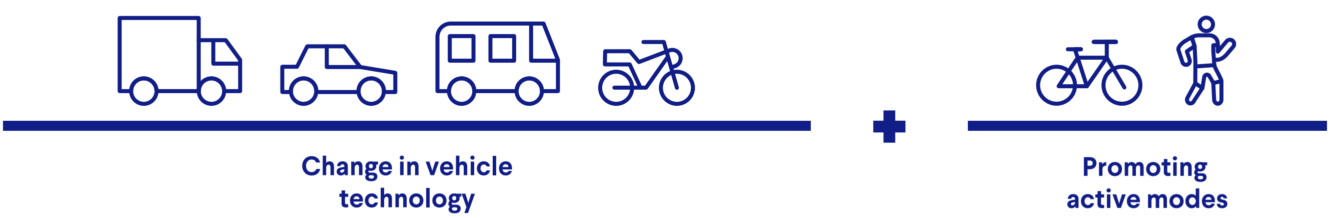
A survey carried out by the Instituto Clima e Sociedade (iCS) revealed that Brazilians are open to change: 67% of the people interviewed were willing to exchange their cars or motorcycles for less polluting transport alternatives.[18]

Relative emissions by type of source in São Paulo



Source: Cetesb: Qualidade do Ar no Estado de São Paulo, 2019.

Measures to reduce transportation emissions



An overview of the Control Program of Air Pollution by Motor Vehicles

In Brazil, the Programa de Controle da Poluição do Ar por Veículos Automotores [Program for Control of Air Pollution by Motor Vehicles] (Proconve) aims to reduce the emission of air pollutants by light (L) and heavy (H) vehicles sold domestically. Based on European standards of excellence for emissions, this program defines emission limits according to phases that grow stricter over the years.[19,20]

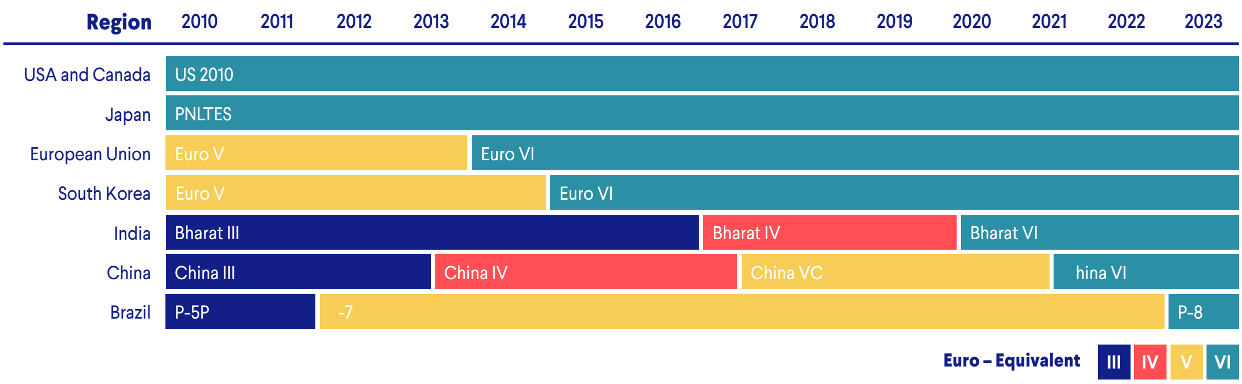
The national market for heavy vehicles is dominated by a large majority of European automakers; the emission control regulations for these vehicles is therefore based on those developed in the European Union. Since 2014, the Euro VI Standard has been in force, with more restrictive emission limits than the Euro V Standard. In 2018, Conama Resolution 490 established the P-8 phase of Proconve, which should come into force in 2022 in Brazil. In 2022, new, more restrictive emission limits will be mandatory for new models of heavy vehicles. In the following year, 2023, these new limits will be mandatory for all models of heavy vehicles.[21]

Among the eight largest automobile markets in the world, Brazil will be the last to implement the Euro VI standard (Proconve P-8). The implementation of the Proconve P-8 has a cost-benefit ratio of US$ 11 in health benefit × US$ 1 in technology costs.[22].

Implementation schedule of PROCONVE standards for heavy vehicles

Standard	Provision	European equivalent	Implementation date
PROCONVE P-1	CONAMA 18/1986	-	1987 (urban buses) 1989 (100%)
PROCONVE P-2	CONAMA 08/1993	Euro 0	1994 (80%) 1996 (100%)
PROCONVE P-3		Euro I	1994 (urban buses) 1996 (80%) 2000 (100%)
PROCONVE P-4		Euro II	1998 (urban buses) 2000 (80%) 2002 (100%)
PROCONVE P-5	CONAMA 315/2002	Euro III	2004 (urban buses) 2005 (mini buses) 2005 (40%) 2006 (100%)
PROCONVE P-6	CONAMA 315/2002	Euro IV	Never implemented, as ultra-low sulfur diesel (ULSD) would not be available. The P-5 remained until 2011
PROCONVE P-7	CONAMA 403/2008	Euro V	2012
PROCONVE P-8	CONAMA 490/2018	Euro VI	2022 (homologations) 2023 (all sales and registrations)

Fonte: ICCT: Norma Proconve P-8 de Emissões no Brasil, 2019.



Source: ICCT: A crise da Covid 19 não justifica o adiamento da adoção de limites de emissão mais rigorosos para os veículos no Brasil, 2020.

Experiences – examples of actions that promote air quality and health

Changes in vehicle technology

One way to improve air quality is to promote the use of zero emission vehicles. In this sense, urban bus systems are one of the main targets of such measures; they are, to a greater degree, under the management of the state, and therefore a more favorable environment in which to encourage technological change. In Brazil, São Paulo did the most to adopt electric buses in the municipal public transport fleet.

Battery electric buses

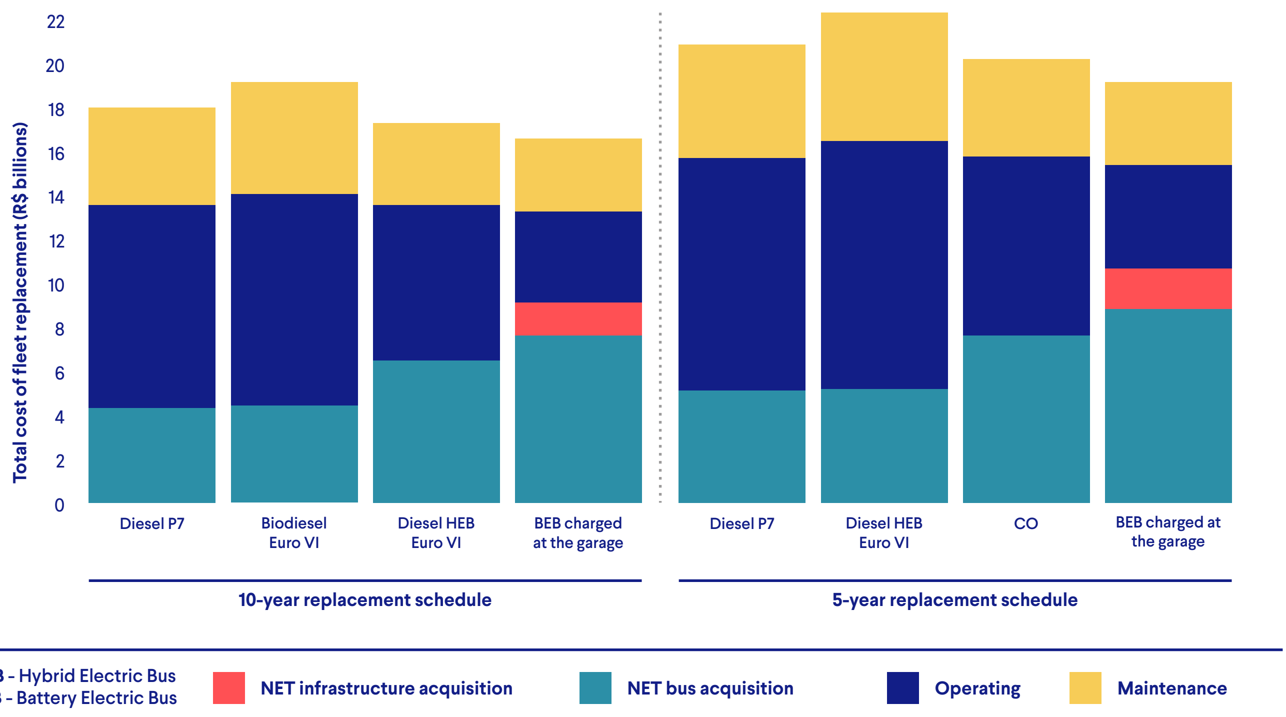
The city of São Paulo has, in its fleet of buses, 15 100% electric battery-powered vehicles, which are operated by the company Transwolff. It is estimated that between November 2019 and September 2020 these buses, which operate on a single line, saved 1,100 tons (1,155,451 kg) of CO_2. Regarding fuel consumption, in that same period more than 430,000 liters of diesel were saved. In addition to not emitting pollutants, they are silent vehicles, with a range of 280 km to 300 km.[23]

Trolleybus

São Paulo's Municipal Trolleybus System consists of a fleet of 200 vehicles. It is the largest fleet and the oldest system in Brazil, having been inaugurated in 1949, which demonstrates the feasibility of using this type of vehicle in public transport. This type of bus, powered by electrical wiring, despite the high initial investment with the acquisition and adaptation of the electrical network, proves to be viable in the long term. Analyzing the total cost, which takes into account the cost of operation and maintenance and the lifespan of the vehicle, it is clear they are more economical than diesel buses.[23]

A study shows that hybrid and battery electric buses have competitive costs when compared to P7 diesel buses for most types of vehicles in the city of São Paulo's fleet.[24]

Total cost of replacing São Paulo's fleet of urban buses for diesel buses, diesel HEBs and BEBs charged at the bus garage, with 10- and 5-year replacement schedules



Source: PROMOB-e: Avaliação Internacional de Políticas Públicas para Eletromobilidade em Frotas Urbanas, 2018.

Promoting active and collective modes

When it comes to investment in active modes of transportation, Fortaleza serves as a national model. Several measures implemented by the municipal government that aim to promote active modes of transport are presented below.

Cycling infrastructure

The city's cycling network jumped from 68 km in January 2013 to 364.9 km in April 2021, an increase of 436%. The strategy adopted for cycling paths on some roads is to promote the narrowing of traffic lanes. A study showed that this narrowing has the potential to reduce crashes with injuries or deaths by 57%. According to the 2019 Pesquisa Origem Destino [Origin/ Destination Survey], 5% of trips in the city are carried out by bicycle; 19% of the cyclists are women.[25]

When assessing access to this network, the ITDP found that 36% of the population lives within 300 meters of some cycling infrastructure. This is the highest PNB (People near Bike Lanes) indicator among the Brazilian capitals.[26]

In addition to the cycle lanes and cycle paths permanently installed, Fortaleza has an additional 21 km of leisure cycle lanes on Sundays, divided across three different routes.[27]

Bike share

Bicicletar was the first bike sharing system in the city of Fortaleza, inaugurated in 2014. In 2020, the system was expanded from 80 sponsored stations in the central area to 191 stations, reaching the outskirts of the city, 111 of which were funded with the resources of the Zona Azul (parking zone). Seventy-five percent of cyclists use the system for their daily commute, to go to work, school or shopping. The Bicicletar system is free of charge for anyone who uses the Bilhete Único (public transport fare card), which corresponds to 96% of users. In 2017, the Mini Bicicletar system was implemented with children's bicycles. Currently, for every 15 Bicicletar stations, a station for use by children is installed. Since the inauguration of the system, more than 4 million trips have been made.[28]

Another system used in Fortaleza is the Bicicleta Integrada [Integrated Bicycle], which consists of a public bicycle share system at public transport terminals for a period of up to 14 hours. This allows for the integration of these modes of transport at the last mile[29].

Bus rapid transit (BRT) and bus lanes

Fortaleza also made large investments in the implementation of public transport corridors. Between 2013 and 2021 there was an increase from 3 km to 117 km of bus lanes and bus rapid transit (10.6 km).

It was possible to verify in one of the city's avenues – Santos Dumont Avenue – that the implementation of a 1.6 km bus lane increased the operating speed from 4.4 km/h to 13.5 km/h during peak afternoon hours, representing a 207% increase in average speed and reducing travel times.

A study evaluated the levels of NO_2, the best indicator of vehicular traffic pollution, on roads with and without bus lanes in Fortaleza. The results revealed lower levels of pollution on roads with bus lanes, even those with higher flow of heavy vehicles.[30]

Traffic calming areas

Traffic calming areas [Áreas de Trânsito Calmo] were implemented around hospitals in Fortaleza. Interventions carried out in these areas include implementation of curb extensions; elevated crosswalks; accessibility ramps; speed humps; and reduction of the speed limit on local roads from 60 km/h to 30 km/h.

In one such area – around the Hospital Albert Sabin – it was found that, before the intervention, 42% of pedestrians (and 50% of children) did not walk on the sidewalks. With the intervention, only 4% of pedestrians (and 0% of children) were found walking on the road.

Belo Horizonte, as well, has traffic calming areas in some parts of the city, the so-called Zonas 30. Unlike Fortaleza, most of the interventions were carried out with elements of tactical urbanism, such as marking the sidewalks with paint, and placing furniture and other mobile elements there. Perception surveys were carried out before and after the implementation of Zonas 30, which made it possible to verify the increase in pedestrians' perception of safety.

Cargo bike services

Fortaleza also promotes the improvement of air quality through the promotion of cargo bike services. The pilot project Re-ciclo aims to test the use of electric tricycles for waste pickers as a way to improve urban logistics, in addition to promoting social inclusion and increasing recycling. The exchange of traditional collection carts for tricycles resulted in gains in the average collection speed.

Congestion charging

There are no examples of urban tolls in Brazil, but it is a measure to be considered to discourage car use and thus promote the reduction of harmful emissions. In London, congestion charging schemes were implemented in 2003 and operate Monday to Friday, from 7:00 am to 6:00 pm, within the city's central perimeter. This measure resulted in an 18% reduction in traffic volume and a 30% reduction in traffic congestion in the first year. Furthermore, studies point to significant reductions in PM, CO and NO levels.[31,32]

Parking management

In 2011 San Francisco adopted an innovative parking management system, SFPark, which prices parking according to demand. This promotes better traffic flow and less time spent in search of a parking space. The system is electronic, which allows the driver to learn the price and availability of nearby spaces. As a result of the system's implementation, there was an increase in the number of bus passengers and a reduction in vehicle traffic in the center of the city.[33,34]

Transit-Oriented Development (TOD)

Transit-Oriented Development (TOD) is a strategy that integrates land use planning with urban mobility, aiming toward compact, connected and coordinated cities. São Paulo's Strategic Master Plan was revised in 2014, adopting TOD principles. It defined urban transformation pillars allowing the city to prioritize urban transformation along transport[35.]

Monitoring progress, measuring impacts

In addition to measures directly related to mobility, it is also important to monitor the progress of air quality and measure the impacts of actions taken with better data. It is also important to make this data accessible to the public.

Better data

The Companhia Ambiental do Estado de São Paulo [Environmental Company of São Paulo State] (Cetesb) monitors and develops studies on air quality in São Paulo. The state has 91 public air quality monitoring stations and is the only one in Brazil to carry out studies that measure the emission of pollutants according to their source allocation.[36]

Accessible data

In addition to monitoring, Cetesb posts on its website hourly data as well as a daily bulletin on pollutants and air quality information.[36]

Communication and dissemination of data

Communication measures are also very important. Through an app and its website, Cetesb communicates real-time information from São Paulo state monitoring stations about air quality levels in relation to WHO standards. The information is also made available on electronic street clocks.

Another good example of communication action is the Boletim Zero Carbono [Zero Carbon Bulletin], which circulates monthly in Belo Horizonte. This aims to inform people about the Greenhouse Gas Emission Reduction Plan (PREGEE), as well as actions developed within the scope of the Committee on Climate Change and Eco-efficiency (CMCE). This is a way to keep the population abreast of advances and the importance of air quality in the city.

Call to action

This section brings together recommendations aimed at accelerating action to improve air quality across three main approaches: public policy, planning and communication. These measures can be implemented at the municipal level, making cities protagonists in the fight to improve health and air quality.

Public Policies

Encourage the use of public transport and active transport

• Encourage the use of active modes of transport through the expansion of cycling networks, taking the necessary steps to ensure the comfort and safety of cyclists; integrate the cycling network and public transportation system, creating adequate parking and public bicycle sharing systems.

• Prioritize pedestrian traffic, ensuring the necessary conditions for comfort and safety on sidewalks and at crosswalks, including the reduction of maximum speed limits on urban roads.

• Public investments must prioritize the improvement of the structural public transportation network, adapting or creating infrastructures with low environmental impact.

• Promote physical and fare integration among transport systems.

• Prioritize public transport, through the implementation of preferential or exclusive lanes.

Promote the use of low emission vehicles

• Encourage renewal of public transport fleets and the use of more environmentally friendly vehicles, such as electric cars, hybrids or those equipped with an emission control system.

• Implement vehicle inspection programs for pollutant emissions.

• Prioritize less-polluting vehicles in the implementation or expansion of public transport networks (such as new bus rapid transit (BRT) corridors).

• Promote services that use electric bicycles or tricycles focused on the last mile of urban logistics.

Disincentivize the use of private vehicles

• Adopt measures to transfer to the individual motorized transport user the indirect costs resulting from the inefficient use of urban space.

• Discourage the use of individual motorized transport through restrictions on access to certain areas, parking policies or congestion pricing.

• Implement mechanisms to transfer resources from individual transport revenue to the development/ financing of improvements in public transport and infrastructure for active modes.

Promote urban environmental management

• Carry out air quality monitoring and adequate data access.

• Conduct source allocation studies to identify the main sources of harmful emissions in the city.

• Establish partnerships with institutions and/or universities to study and quantify both the impacts of air quality on public health and its costs.

• Create social control forums to monitor these measures.

Planning

Promote the densification of central areas and control urban dispersion

- Adopt land use policies that promote denser development along transport axes and near transport stations and restrict the number of parking spaces in these areas.

- Promote the connection of urban facilities, employment opportunities, access to services and leisure via public transport infrastructure.

- Promote the mixed use of land, reducing the distance between residential areas and opportunities for employment, leisure, services and urban facilities.

- Ensure access to housing for low-income populations in well-served areas of transport infrastructure.

Communicating

Promote the dissemination of information on air quality

- Adopt communication, information and awareness measures regarding the impacts and benefits of sustainable mobility measures on air quality, with wide dissemination of air quality monitoring.

- Use arguments related to health benefits promoted by measures to improve air quality and associate them with benefits related to climate change mitigation.

- Communicate the status and evolution of air quality in the city, comparing it with emission reduction targets from existing plans.

- Foster scientific research and data production in partnership with institutions and universities.

Credit: Mariana Gil / WRI Brasil Cidades Sustentáveis

Links to data and information sources

For further information on the subject, see:

- Accelerating City Progress on Clean Air: https://www.vitalstrategies.org/wp-content/uploads/AcceleratingCityProgressCleanAir.pdf

- Debates on the topic with leaders and academic representatives from Brazilian cities

    - Impacts of sustainable mobility policies on air quality: https://www.youtube.com/watch?v=SnH4AgnvrpM&t=2579s

    - Connecting evidence and experiences of mobility, air quality and health: https://www.youtube.com/watch?v=iymLCSJMU5k&t=26s

    - For clean air in Belo Horizonte – convergence of mobility, air quality and health actions: https://www.youtube.com/watch?v=W80haiDsN0g&t=10s

- Mobilidade de Baixas Emissões, Qualidade do Ar e Transição Energética no Brasil [Low Emission Mobility, Air Quality and Energy Transition in Brazil]. A report showing Brazilians' perception of the connection between fossil fuels, air pollution and climate change: https://www.climaesociedade.org/publicacoes?pgid=jjyqp4zj-c6a6d804-37fb-4020-b3a3-69fbe9cf3fb9

- Toward Clean Air Jakarta: Improving Air Quality in Jakarta in the Near- and Long-Term. A report that presents the action plan, supported by Vital Strategies, which is being implemented in Jakarta: https://www.vitalstrategies.org/resources/toward-clean-air-jakarta-improving-air-quality-in-jakarta-in-the-near-and-long-term/

- Hazy Perceptions: A new report on air pollution. A guide that shows how people perceive the problem of air quality: https://www.vitalstrategies.org/resources/hazy-perceptions-a-new-report-on-air-pollution/

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