Environmental Science and Policy 81 (2018) 1–9

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

Policy instruments surrounding urban air quality: The cases of São Paulo, New York City and Paris

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ARTICLE INFO

Keywords:
Air pollution
Public policy analysis
Cities
Management

ABSTRACT

Fifteen years of major policies and programs on air pollution control in New York City, São Paulo and Paris were reported in order to draw attention to each city's management tendencies. The study highlighted the strategies implemented, showing that overall levels of atmospheric pollution have decreased in the three cities, but they continue to be above WHO recommendations. While regulatory approaches are commonly embraced to lower air pollution levels, the three cities differ in the way and extent to which they have prioritized control technologies, mobility, public transport accessibility and energy matrix. Despite all sharing the technological capacity to develop cleaner fuels and foster non-motorized transport modes, disparities in transportation options, infrastructure and commuting distance appear to have an impact on the use of privately owned vehicles and pollution levels. This is partly due to the lack of public transportation and to local political choices. The three examples show how regulatory approaches alone are not enough to ameliorate air quality and suggest that each city should incorporate programs that account for people's travel choices. For policymakers, prioritizing air quality offers the potential to have a positive short-term impact on health and on the local environment, particularly in low and middle-income countries.

1. Introduction

While sources and contributions to air pollution vary across the world, in urban centers, they mainly originate from commercial and residential emissions, fixed (industries) and mobile sources (heavy and light duty vehicle emissions) (Hitchcock et al., 2014). From 2008 to 2015, in more than 80% of urban areas, people were exposed to contaminant levels of particulate matter above the WHO[1] recommendations (WHO, 2016). Indeed, air pollution continues to be one of the greatest threats to global health, accounting for 7 million premature deaths worldwide in 2012, of which 3.7 million were attributed to outdoor air pollution (WHO, 2014). The OECD has reported that the health cost associated with air pollution amounts to 1.6 trillion dollars per year, of which 50% is attributed to road transports (OECD, 2014), one of the primary sources of urban air pollution.

Cities concentrate 55% of the world's population and the number of mega-cities (population > 10 million) has jumped from 10 in 1990 to 28 in 2014 (UN, 2014). Given their significance, the role of urban centers in global environmental health degradation and the continuous increase of motorized transports of cars and heavy-duty vehicles in cities has called for action to control health impacts (World Bank, 2014). The negative health effects from exposure to urban traffic-related air pollutants have been demonstrated in extensive research (Colvile et al., 2001; World Bank, 2014; MacDonald-Gibson and Frey Sexton, 2013; Progiou and Ziomas, 2012) and alarming air pollution peaks in cities located in growing economies has raised global and local concern. Scholars have identified that long-term exposure to air pollution can be associated with negative health and birth outcomes, particularly in early-life exposure (Alderete et al., 2017; Brauer et al., 2008; Currie et al., 2014). Cohort studies have associated long-term exposure to traffic-related air pollution with increased mortality, circulatory and respiratory diseases, breast cancer and atherosclerosis (Escamilla-Nunez et al., 2008; Jerrett et al., 2009; Kaufman et al., 2016; Kim et al., 2017). In Ontario, Canada, a study supported the hypothesis that long-term exposure to traffic-related air pollution increases the incidence of mortality from cardiovascular diseases (Chen, 2011).

There is still a critical gap to qualitatively and comparatively assess what kind of initiatives and approaches have been undertaken in cities and the role played by policies to mitigate air pollution. This research examines three major cities to appraise some of the most important policies and approaches developed. The article highlights the initiatives that have most contributed to ameliorating air pollution levels, and

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https://doi.org/10.1016/j.envsci.2017.12.001
Received 8 March 2017; Received in revised form 30 November 2017; Accepted 1 December 2017

those that could be duplicated in other cities, struggling to maintain clean air. It brings a global and local contextualization framework in which these policies have been created, emphasizing the need to incorporate these different dimensions concerning their impacts on air quality.

This research was designed as an in-depth, multiple-case study of the period from 2000 to 2015 of the three cities São Paulo, Brazil, New York, USA and Paris, France. These locations were chosen because:

1) They share a common challenge, in that vehicular emissions are a major source of air pollution. Since 2000, these three cities reduced overall concentrations, although they still face levels above WHO air-quality guidelines (for particulate matter and ozone), and struggle with the global trend of vehicular density and emission growth.
2) Each city has been innovative in developing public policies, strategies and programs that make them unique and potentially replicable cases.

Observing policy choices surrounding air pollution control is essential to identifying best practices that could lead the way to growing cities lacking policy instruments to cope with alarming levels of air pollution and increasing motorized transport.

2. Profile of studied cities

São Paulo, the capital of São Paulo State, Brazil has a population density of 7858 people/km^2. It is the 11th most populated city in the world, with 11.9 million inhabitants (IBGE, 2013) in 1521 km^2. Greater São Paulo has approximately 20 million people, being the third largest metropolis in the world, after Mexico City and Mumbai. It holds the nation's greatest job center and economic hub. The automobile industry in Brazil accounts for 65% of the GDP and is the eighth largest worldwide (MDIC, 2014).

Like São Paulo, New York City is the largest city of its state and, combined with Newark, makes the world's ninth largest metropolis (UN, 2014). Its five boroughs – Manhattan, Bronx, Queens, Brooklyn and Staten Island – have a population of 8.5 million inhabitants in 789 km^2, with a density of 10,800 people/km^2. Although food, education, professional and technical services employ the greatest number of people, it is actually securities, commodities contracts and investment jobs that register the highest average annual income in New York City ($405,000) (NYC Dept. of Labor, 2015).

Paris, the oldest of the three cities, is the smallest, with 105.4 km^2, and the highest population density, 21,289 people/km^2. The capital of France, Paris, is located in the Île de France region. The center city of Paris, or "Paris intra-muros," had a population of 2.3 million in 2014, similar to 1999 (French census), when it totaled 2.1 million. Over the last fifteen years, Paris' demographic profile has remained unchanged, with the largest share of its population over 65 years old. In Paris, transport, services and commerce represent 68% of jobs (INSEE, 2013) (Fig. 1).

3. Frameworks surrounding air quality

3.1. Historical legal context

The first and most important regulatory action passed was the Clean Air Act (1963) in the United States, followed by Europe, which established standards for vehicle exhaust emissions in 1970. With evidence that air pollution crossed borders, the international community adopted, in 1979 the Convention on Long-Range Transboundary Air Pollution (LRTAP), hosted by the UNECE.[2] The LRTAP formalized the fact that sources of air pollution might be distant from where the pollution ends up, which forced both global and local communities to address the issue. The Convention was signed by 51 member-countries and became the genesis of most protocols that guide local regulations and policies.

In the 1980s and 1990s, UN Protocols helped set global awareness to reduce emissions of pollutants, such as the 1985 Helsinki Protocol on the reduction of sulfur and VOCs,[3]; the 1987 Montreal Protocol on substances that deplete the ozone layer; the 1988 Sofia Protocol on nitrogen oxide emissions control or their transboundary fluxes and the Gothenburg Protocol in 1998 on acidification, eutrophication and ground-level ozone (UNEP, 1987; UNECE, 1988, 2014). It was only in 1997 that the Kyoto Protocol established the UN framework on climate change (UN/FCCC, 1997), currently outdated by the Paris Climate Agreements to regulate greenhouse gases (UN/FCCC, 2015).

In Europe, the revision and development of emission standards came in the early 1990's, implementing standards for heavy and light-duty vehicles (Fig. 2). In 1996, the European Commission adopted the 96/62/EC Directive on Ambient Air Quality (EUR_LEX, 1996), followed by what is known as the "four daughters' directive&#8221[4]; establishing limits for some of the most harmful air pollutants.

The above directives, in turn, guided French regulations and led to the 1996 Federal Law on Rational Use of Air and Energy (LAURE), followed by the 1998 Federal Law on conditions for air pollution alert procedure (Legifrance, 1997). LAURE established the conditions of air quality surveillance and information that created local monitoring agencies, such as Airparif for the Île de France region and Paris. LAURE fostered several additional French plans on air quality and mobility.

Another major European guideline is the 2001 EU Directive on National Emissions Ceilings, and the EU Directive on Air Quality Standards, that generated the Clean Air for Europe Program in 2008 (EUR_LEX, 2008). The 2008 directive followed the WHO air quality guideline reviews of 2005. Two major sets of United Nations global goals are worth citing: the 2000 UN Millennium Development Goals and the 2030 Sustainable Development Goals, as they bring to countries' agendas the need to address poverty and environmental quality, such as clean air (UN, 2000, 2015)

French regulations are bound to European legislation. The different EURO standards applied to vehicle emissions, from the 2004 and 2008 directives, have a direct impact on the French regulations that use the EURO VI standards since 2014. Other important French laws are Grenelle I and II, addressing the federal environmental engagement of 2009 and 2010. New vehicles in Paris follow the EURO 6 Norm. In 2012, 52% of the fleet was equipped with the EURO 4 Norm (Airparif, 2013). The Grenelle laws originate several federal and regional plans on environmental health, climate and energy.

In France, the alert for air pollution episodes was reviewed and adopted in 2014, motivated by Paris' recent critical air pollution peaks. The 2015 Energy Transition Law enabled France to focus on cleaner sources of energy for vehicles and new programs, such as circulation restriction of Heavy-Duty Vehicles (2015), air quality certificate for vehicles (2015) and the revision of the PPA.,[5] Similarly to United States and Brazil, France established transport laws such as the 1982 Domestic Transport Act, legalizing the right to low-cost public transport and encouraging urban transport plans.

The United States was the first of the three countries to regulate air with the 1963 Clean Air Act and 1970 National Ambient Air Quality Standards. The 1977 and 1990 amendments to the Clean Air Act provided two measures for air quality: the New Source Review, for industries, and the banning of leaded gasoline for motor vehicles (EPA, 1977). Importantly, the state of California has been a pioneer in

[2] United Nations Economic Commission for Europe

[3] Volatile Organic Compounds

[4] European commission legislation

[5] Plan de Protection de l'Atmosphère, French for Air Protection Plan