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AIR POLLUTION POLICIES AND PROGRESS
The case of United States, Mexico, European Union, Russia and China

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Abstract: Air pollution is a serious problem affecting public health and nature, for that reason, it is important to know the pollution levels that are handled in each zone, to be able to control the emissions of pollutants. Due to the great interest there are air monitoring stations in 3000 cities and towns, and the World Air Quality Index concentrates this information. This study analyze the case of New York, Mexico City, Madrid, Moscow and Shanghai. Observing that the highest rates of pollution are found in Shanghai, according to the Average AQI, but the most polluted city in particulate matter is Madrid
Keywords: Environmental economics, Air pollution, Sustainability.

INTRODUCTION

The quality of the environment has a direct impact on our quality of life and life in general. Almost all living creatures depend on the air as the major requested factor to survive - people can only keep alive four minutes without breathing, three days without water and around 3 weeks without food. The advantages of having a clean environment range from an optimal physical condition to a better mental health. A reason to make air pollution a separate subject of research is to apply an integrated approach that covers the whole chain of social and economic effects clean air brings.

Although Air is a rich mixture of gases and aerosols that make up the atmosphere surrounding the Earth, the main gases composing air include nitrogen (78%) and oxygen (21%) and together they make up over 99% of the lower atmosphere (EEA, 2013). Nitrogen is inactive and does not affect most living organisms; however, all living beings need oxygen to survive. The quality of the air may be affected by natural causes like: volcanoes, wildfires, dust storms and sea salt spray, but mainly by human activities such as: transport, power plants, industry, households, agriculture and waste treatment.

Ambient air refers to outdoor air, besides it is one of the key elements of natural ecosystems and is what humans and all living beings require to survive. The composition of this sort of air can vary from place to place depending on the weather conditions in a region, as well as on a type and scale of economic activities, but in general, standards of ambient air (maximum allowable concentration) should be about the same everywhere relating to basic sanitary-epidemiological characteristics.

Air pollution is not only an outdoor problem. The air in enclosed spaces can also be polluted, by the same pollutants emitted in the interior, especially due to cooking, as those contaminants that have penetrated in the exterior.

IMPORTANCE OF AIR QUALITY IN THE WORLD

Air pollution is a serious problem affecting both public health and nature, being one of the leading causes of death in the world[1], significantly damaging biodiversity, generating disturbances in the climate, affecting agriculture and the food industry and causing indirect damages by spreading pollution to water and soil. That is why it's treated as a priority task by the United Nations (UN), Organization for Economic Co-operation and Development (OECD), World Health Organization (WHO), and many other international organizations. The World Health Organization made an attempt to measure the negative consequences of air pollution to human health; table 1 presents facts and figures.

The harmful impacts of air pollution on public health and nature also cause high economic costs. Diseases derived from

1. 1 in 8 deaths in 2012 could be attributed to air pollution according to the report "7 million premature deaths annually linked to air pollution" (WHO, 2014)

Facts		Figures
Public health	Premature deaths in the world	3 million deaths in 2012 (attributable to ambient air pollution)[a] 4.3 million deaths in 2012 (attributable to household air pollution)[b]
	Bronchitis	12 million cases per year for children aged 6 to 12 in 2010[c] 3.5 million cases per year for adults in 2010[c]
	Asthma	3.6 million children aged 5 to 19 in 2010[c]
	Lost working days	1 240 million number of days in 2010[c]
	Restricted activity days	4 930 million number of days in 2010[c]
Nature	Change in glacier mass	-17,080 millimeters by 2014 respect 1980[d]
	Number of threatened species	6442 threatened species by 2015 with respect to 2010[d]

Table 1: Facts and figures of air pollution

Source: [a] WHO "Ambient (outdoor) air quality and health", 2016; [b] WHO "Burden of disease from Household Air Pollution for 2012"; [c] OECD "The economic consequences of outdoor air pollution", 2013; [d] United Nations Environment Programme, 2016.

environmental pollution such as: asthma, cardiovascular diseases and lung cancer in the medium/ long term require extra expenses on hospital treatment, while in the sectors of the economy the cost of the missed working days could be measured by losses in production level and reduction in labor productivity. Actually, in 2015 OECD estimated the healthcare costs of outdoor air pollution in USD 21 billion, although in the report "The economic consequences of outdoor air pollution" OECD experts divided the cost in market and non-market costs and estimate the total market impacts add up to USD 330 billion in 2015 and non-market impacts such as the premature deaths and the costs of pain and suffering from illness add up to USD 3440 billion (OECD, 2016). But these estimates may vary because they only focused on mortality, morbidity, and agriculture, excluding other health impacts and losses in biodiversity, which also have economic implications for both government and business.

In the case of the United States, the US EPA in 2011 has evaluated the benefits and costs of the regulations established by the 1990 Clean Air Act, but they analyzed the outlook compared to what is believed to have occurred in the event of non-application of these regulations. They found that implement the 1990 Clean Air Act amendments other than: emissions reductions, air quality improvements, health improvements and visibility improvements; also in billions of dollars exist positive net benefits in comparison with the costs of implementation of the program. Whereas the cost associated with the implementation of Clean Air Act in the United States are expected to range an annual value of USD 65 billion by 2020, the economic value of these improvements is projected at almost USD 2 trillion for the same year (EPA, 2011).

In addition, air pollution relates to climate change; because some air pollutants, such as: particulate matter, ozone, nitrous oxide and methane also turn to short-term drivers of global warming. Vice versa, recent studies show changing climatic conditions, also influence concentrations of air pollution, so there is a mutual relationship: climate change disturbs air quality and vice versa. (SOER, 2015) Supplementary (to a certain extent) characteristics of pollution and climate change processes advocates for a common (or an integrated) approach in monitoring and reporting of pollutants and GHG emissions. For example the US federal government has been legally attending to the Air pollution by Clean Air Act and the regulation of greenhouse gas emissions are included since 1990 (EPW, 2004); also the European Commission in 2010 wrote a report that consider combining policies about air pollution and climate change and provides enhanced benefits where medium-term efforts to regulate air pollution will help long-term strategies of climate change (Law, 2010).

Air pollution mostly has local and regional consequences, because the resulting pollutant concentrations vary over space, and also because the fraction of solar energy redirected from the Earth back into space (albedo effect) that causes the earth to warm up when the surfaces are dark instead of clear, because the absorbed radiation is greater (Yamamoto & Tanaka, 1972). But it is also a global problem because air pollution does not respect borders and that it is the reason why global solutions are also needed and countries need to work together to create effective policies, aiming at reducing pollution levels, and change to a reliable, sustainable and modern energy services, as well as developed countries that should also make an effort to develop polluting technologies. Inside the environmental problems that countries need to work together on we can find: ozone layer destruction, large quantities of particulate matter abatement reduction and climate change. And since it is a global problem, different international and national organizations have approached the environmental pollution as a priority area, with a numerous attempts to value air pollution by cost-benefit analysis for government and pollution abatement cost for industry, one of the biggest efforts that has been realized is "The 2030 agenda for sustainable development" of the United Nations which includes 17 goals and 169 targets, for sustainable development but 4 goals included are engaged to improve the quality of the air (UN, 2015).

Figure 1. Goals from the 2030 agenda for sustainable development related with air pollution.

Source: 2030 Agenda for Sustainable Development.

The first three goals above are related to all kinds of pollution and urban development, because this agenda stipulates an integrated approach to improve the quality of the environment, for what it contemplates the pollution of the air, water and soil, which have been generated due to the human activity, which has introduced pollutants that are dangerous to the safety and health of humans and natural world. Because though the world has been experiencing improvements in the life expectancy and in the health, these advances meet disappearing by an extensive variety of environmental dangers. The growth of the population and consequently of the economic activity it increases in a dramatic way giving more pressure on the resources and natural systems, which cause high degradation.

Equally, the climate change also has been caused by human activities that result in emission of greenhouse gases, especially by the production of energy on the basis of fossil fuels, which also carries to the appearance of infectious and epidemic diseases, because of the excessive monsoon rainfall and high humidity identified as a major influence, enhancing infectious agents vary greatly in size, type and mode of transmission. One example is the malaria that has shown increases around five-fold in the year after an El Niño event, because now the mosquito is breeding and survive, the same case happens with the dengue, chikungunya and zika, and other examples of diseases are: schistosomiasis, helminthiasies, river blindness, cholera, cutaneous leishmaniasis, among others (WHO, 2003). In fact in the report made by WHO in 2003 about Climate Change And Infectious Diseases shows a malaria modeling that demonstrates how small temperature increases can greatly affect transmission potential, a temperature increases of 2°c or 3°c globally, would increase the number of people who are at risk of malaria by around 3 to 5 percent and also, the seasonal duration of malaria would increase in many endemic areas. Climate change also affects agriculture, because is highly dependent on the climate, more extreme temperature and precipitation can inhibit crops from growing and as has been seen in recent years, extreme events such as floods and droughts, damage crops and reduce yields according IPCC. For what on these goals having been attended in an integrated way would expect to obtain better results that will lead to sustainable development.

In adherence of these goals a series of targets have been established to be monitored. Those which are more directly related to the air pollution are enumerated below (UN, 2015):

- 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
- 11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste.
- 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, and significantly reduce their release to air, water and soil.
- 12.c: Rationalize inefficient fossil fuel subsidies, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts.
- 13.b: Promote mechanisms for raising capacity for effective climate change related planning and management in least developed countries and small island developing States.

There are other targets that also have an impact on air quality, such as those related to improvement in energy efficiency, climate change, urban development (sustainable cities) and transportation systems, due to their intimate relationship with air pollution; their agreement contributes to improving the air quality indexes.

Although the sustainable development goals are not legally binding, countries should take possession and establish a national framework for achieving the goals which will be reviewed using a set of global indicators, like: countries should implement and report on Systems of Environmental Economic Accounting (SEEA) accounts, report the mean urban air pollution of particulate matter, proportionate a transparent and detailed, deep decarbonization strategy, reliable with the 2°C -global carbon budget, and with GHG emission targets for 2020, 2030 and 2050, among others (UN, 2015).

However, for achieving air pollution goals, countries have different tools; regulations are one of the most significant utensils, because they can apply to individuals, companies, government, non-profit institutions, or others. Some basic regulations that have been introduced to reduce air pollution by transport are: to eliminate long duration idling, continuous inspection and maintenance in onroad vehicles, shift of transportation of goods from truck to rail transport, truck replacement, fuel switching, and for industrial plants one of the major tasks is to provide reduction of emissions of main pollutants such as CO, CO_2, NO_2, SO_2, O_3, and PM. To ensure that environmental requirements are met, in some places, such as the European Union, have established penalties, like penalty payment for excess emissions that establish the manufacturer has to pay an excess emissions premium for each car registered; €5 for the first g/km of exceedance, but €95 for the fourth g/km and subsequent (EEA, 2015), in Mexico the urban transport that do not correspond to the vehicle verification, have to pay around USD 70 (SEDEMA, 2016), in China the penalties range from €1,500 to €7,000 per violation, and there is an over 99 percent compliance rate across the emission trading scheme (Swartz, 2016). In the other hand, in the United States, Detroit Diesel for violations of the Clean Air Act had to pay a USD 14 million civil penalty for selling heavy-duty diesel engines that were not certified by EPA and did not meet applicable emission standards (EPA, 2016). Instead in Russia Pollution charges are subject to environmental permits. They are imposed for 214 air pollutants, among mobile sources but private cars, the biggest contributors to air pollution in urban areas, were excluded from the system (OECD, 2006).

The important thing about this agenda is that the goals are universal and apply to all countries, in addition the goals cover the three dimensions of sustainable development: economic growth, social inclusion and environmental protection, providing concrete policies and actions to support its implementation. This agenda resolve between 2016 and 2030 to ensure the permanent protection of the planet and its natural resources, taking into account different national realities, capacities and levels of development and respecting national policies and priorities that involve developed and developing countries (UN, 2015).

POLICIES AND PROGRAMS FOR AIR POLLUTION IN THE UNITED STATES, EUROPEAN UNION, MEXICO, CHINA AND RUSSIA

There is no one size fits all procedure for reducing the impacts of air pollution as there are large differences between countries in terms of predominant pollutants and sources. That is why although the commitment with "The Sustainable Development Agenda" and Multilateral environmental agreements (MEAs) exist different policies for the air quality in each country or region are applied, so in each case there are different: air quality standards, automobile emission standards, fuel quality standards, and emission taxes, and different regulations to control them. Therefore, in order to contrast the policies that are being implemented to reduce environmental pollution in different parts of the world, this study will analyze the package of policies implemented, as well as the progress obtained from its implementation in 5 regions: United States of America (USA), Mexico (MX), European Union (EU), China (CHN) and Russia (RUS).

In the table below, you can see how these 5 regions implemented environmental programs; United States was one of the pioneers with the execution of Clean Air Act in 1970. Compared with the United States, the European Union, Mexico, China and Russia came late to the regulation of air pollutants; in the European Union the Air Quality Limit Values (AQLV) began one decade later and 8 years later - in Mexico, while in China the concern about air pollution is a more recent issue but with a stricter policies. Nevertheless United States had previously acted as the primary driver behind the adoption of environmental policies and most multilateral environmental agreements since the 1970s, with the EU largely following the United States lead, in recent years, US has lagged behind the European Union in its ratification and implementation of MEAs. For a better understanding of the challenges, policies and programs implemented in each region, a summary is shown in Table 2. It is important to consider that for the implementation of environmental programs United States, Mexico and European Union combined public health and nature unlike Russia where is a separate task.

	United States	European Union	Mexico	Russia	China
Environmental legislation	1969 [A] National Environmental Protection Act (NEPA) 1970 Clean Air Act	1980 [B] Air Quality Directive (Directive 2008/50/EC) 1996 Air Quality Framework Directive	1988 [C] General Law of Ecological Balance and Environmental Protection (LGEEPA)	2002 [D] On Protection of Environment	1979[E] Environmental Protection Law Environmental Protection Plan in Five-Years since 2001
Authority	US Environmental Protection Agency (EPA)	National authorities	Ministry of the Environment and Natural Resources (SEMARNAT)	Ministry of Natural Resources and Environment of the Russian Federation-Federal Service for Supervision of Use of Natural Resources (Rosprirodnadzor)	Ministry of Environmental Protection (MEP) and the State Environmental Protection Administration (SEPA)
Current standards	National Ambient Air Quality Standards (NAAQS) [F]	Air quality limit values (AQLVs)	Official Mexican Environmental Standards (NOM)	Maximum Allowed Concentrations (PDK)	Ambient Air Quality Standard

Emission Ceilings	CO NO_2 SO_2 O_3 $PM_{2.5}$ PM_{10} Pb	$PM_{2.5}$ PM_{10} SO_2 NO_2 Pb CO As Cd Ni O_3 C_6H_6 PAHs	SO_2 CO NO_2 O_3 $PM_{2.5}$ PM_{10} Pb TSP	$PM_{2.5}$ PM_{10} SO_2 NO_2 Pb CO As Cd Ni O_3 C_6H_6 PAHs	$PM_{2.5}$ O_3 CO SO_2 NO_2 PM_{10}
Targets	Reduce interstate transport of fine particulate and ozone pollution to help states meet the new 8-hour ozone and fine particle NAAQS.	Part of the challenge for the EU has therefore been to harmonize not only AQ standards, but also the national systems in place for assessing and monitoring AQ	25% reduce their emissions of greenhouse gases (GHGs) and Short-Lived Climate Pollutants (under BAU) 2030. This commitment involves a 22% reduction of greenhouse gases and a 51% Carbon Black [G]	Reduce 15 percent of the country's territory suffers from exposure to high levels of ambient pollution. In many industrial centers the rates of morbidity and mortality exceed , 1.5-3 times the national average	Reduce the annual average concentrations of PM_{10}, SO_2, NO_2, $PM_{2.5}$ in the air by 10%, 10%, 7%, and 5% respectively, in 117 cities in 13 major regions and strengthens regional air quality monitoring and management
Types of Enforcement Actions	Civil Administrative Actions Civil Judicial Actions Criminal Actions	Civil actions Criminal penalties (Directives generally leave the form of sanction to the discretion of Member States) [H]	Civil actions Criminal actions Administrative actions	Civil liability Disciplinary liability Criminal liability	Stricter penalty [I] Civil actions Criminal penalties
ECOinovation	The competitive State Innovation Grant Programme provides funding to help states explore innovative approaches in three areas of mutual interest, namely environmental permitting, environmental management systems and performance-based leadership programmes The Energy Policy Act authorized $5 billion over five years in tax incentives to encourage investments [J]	A European Trust Fund for Eco-Entrepreneurship A Technology Platform for Resource-light industry A Deep Renovation Programme for existent buildings in Europe [K]	The Mexican government has been offering companies tax credits for R&D since 1998. Companies now get a tax credit equal to 30 percent of their annual IDT expense, regardless of size or industrial sector [J]		The State Council Steering Group for Science, Technology and Education is a top-level coordination mechanism, which meets two to four times a year to deal with strategic issues. [J]

Table 2. Programs and challenges in emissions on United States, European Union, Mexico, China and Russia.

Source: [A]EPW (2004), [B] EEA (2016), [C] Ley general del equilibrio ecológico y la protección al ambiente de México (2016), [D] OECD (2016), [E] Horiba (2013), [F] EPA (2016), [G] INECC (2016), [H]European Commission (2015), [I]Goldman Sachs Global Investment Research (2015), [J] OECD (2008), [K]European Parliament (2009).

There are general pollution controls to maintain a standard of purity of air, like the implementation of pollutant control programs, for example Command-And-Control policies (CAC) that relies on regulation such as permission, enforcement and prohibition and are taken for air pollution control in most countries. For example in the case of United States there have been a commonly used method for the fulfillment of the environmental regulations and NAAQS, where each state is required to develop a plan for how they will control air pollution within their jurisdiction, there for their process starts with setting, reviewing, and revising the standards, continue determining whether areas meet the standards and finish attaining and maintaining the standards, but there are other approaches like: market-based incentives, voluntary initiatives and hybrid approaches. In the European Union and Mexico an integrated framework for these policy interventions exists that combines command and control measures, market based instruments and awareness raising. But over the past 20 years, especially the past decade, United States and the rest of the countries with environmental legislation began to use a much broader array of tools to manage environmental quality, like market-based economic incentives because of the perceived advantages and effectiveness, these incentives can be pollution charges, fees, taxes, deposit-refund systems, trading programs, subsides for pollution control, liability approaches, information disclosure and voluntary programs. This approach provides an opportunity to address sources of pollution that are not easily controlled with traditional forms of regulation as well as providing a reason for polluters to improve existing regulatory requirements (EPA, 2001).

But since air pollution is not the same everywhere, designing and implementing policies to address this complexity are not easy tasks, that is why there are different legislations inside the mentioned regions, in the case of European Union the countries are required to develop local or regional plans compatible with current European air-quality legislation, in United States each State is necessary to develop a plan for how they will control air pollution, this plans are called State Implementation Plan (SIP) and are harmonious with their jurisdiction. In the case of Mexico the normative is national, but the States have the faculty to formulate and direct ecological regional programs. In China, in order to prevent air pollution the Ministry of Environmental Protection is in charge unlike the water pollution and detoxifying trash which is responsible State council.

For this purpose in every region an authority in order to be in charge of the execution of these environmental programs has been designated, as the US Environmental Protection Agency (EPA) in United States, the European Environment Agency (EEA) in the European Union (although each country has his own national authority), the State Environmental Protection Administration (SEPA) in China and the Ministry of the Environment and Natural Resources (SEMARNAT) in Mexico. While environmental policies are typically set nationally, the execution and enforcement of policies are usually delegated to the state level in federal countries like United States and Mexico, in the case of European Union apart from the European environmental legislation, to accomplish with this the EEA works closely together with the National Focal Points (NFPs), typically national environment agencies or environment ministries in the member countries. In conformity with pollutant control programs in every region Air Quality Standards (AQS) exist who have to be compliments to federal level for not affect the environment of a region, and air continues being good for public health, for protection of plants and animals and for visibility by what they are designed specifically for every region, but to achieve these goals were underpinned by concrete targets at State level in Mexico and United States and at country level inside the European Union. The AQS re similar in the observed regions, and in all the cases exist emission ceiling for the criteria air pollutants recognized by the EPA, in Mexico in addition there are monitored the Total Suspended Particles (TSP) and in European Union also observe the levels of: Arsenic, Cadmium, Nickel, Benzene and Polycyclic Aromatic Hydrocarbons. (For more information about the air quality standards in each region see annex 7-10).

AIR POLLUTION REPORTS BY MONITORING STATIONS IN UNITED STATES, EUROPEAN UNION, MEXICO, CHINA AND RUSSIA

As one of the measures to reduce air pollution, it is important to know the pollution levels that are handled in each zone, to quantify and be able to control emissions of pollutants. Due to the great interest in these regions, as well as many other countries in the world, there are air monitoring stations in 3000 cities and towns, and the World Air Quality Index (WAQI) project is a site that concentrates this information which is provided by each country respective Environmental Protection Agency (but they don´t publish amateur low-cost sensors based Air Quality data except for research purposes, but, even, it is not mixed with the official data set). Those official data are monitored using professional BAM and TEOM-like Air Quality monitoring stations.

Figure 2, 3, 4 and 5 show the results of each monitoring station reporting to the WAQI in the United States, Mexico, the European Union, Russia and China, (due to the fact that in Russia only monitoring stations have been reported in Moscow, the same image is shown for the European Union and Russia). The Air Quality Index (AQI) starts with a good level that is green and ends with a hazardous level with maroon (See Annex 1 for more information).

Taking these considerations into account and because of the diversity of the data, it was decided to do a simultaneous study of air pollution in a representative city of each region. It was carried out for the 6 pollutants considered in the NAAQS (National Ambient Air Quality Standards)[2]. In the case of the United States, New York is considered, for Mexico, Mexico City, in the European Union, Madrid, in Russia, Moscow and in China, Shanghai. Observing that the highest rates of pollution are found in Shanghai, according to the Average AQI, but the most polluted city in particulate matter is Madrid, both in $PM_{2.5}$ and PM_{10} and Shanghai in second place, the second most polluted city is Mexico City, but it is only the most polluted city in CO, followed by Madrid, New York and finally Moscow, these last two cities are the only ones that that according to the selected monitors stations have an average AQI without health risks, as can be seen in Table 3. Despite the fact Madrid, and Mexico City are in the moderate classification of air quality index, this implies that there are only health impacts of people who are extraordinarily sensitive but Shanghai achieves an unhealthy AQI what already implies that everyone may begin to experience health effects. (Annexes 2-6 show the monitored stations as well as the register obtained by WAQI).

Particulate matter is one of the main pollutants that are monitored due to the

2. The NAAQS is a term coined by the EPA, for the 6 "criteria" air pollutants: ground-level ozone (O_3), particulate matter (PM_{10}, $_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2).

Figure 2. AQI:

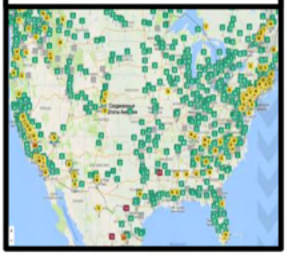

Figure 3. AQI:

Figure 4. AQI:

Figure 5. AQI: China

Source: Air Pollution in the World: http://waqi.info/.

Air pollutants	Russia (Moscow-15:00)		Spain (Madrid-14:00)		Mexico (Mexico city-12:00)		United States (New York-7:00)		China (Shanghai-21:00)	
AQI	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
$PM_{2.5}$	5	46	57	238	5	99	17	143	91	212
PM_{10}	2	13	20	137	4	66			49	136
O_3	2	15	1	22	1	33	1	30	5	85
SO_2	1	1	2	8	2	12			8	57
NO_2	11	32	18	65	8	61	13	35	31	102
CO			0	0	1	29	2	5	8	19
Average AQI	25		61		68		45		198	

Table 3. Air Pollution: Real-time Air Quality Index (AQI) at December 8 of 2016.

Source: Air Pollution in the World: http://waqi.info/

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great damage it generates to public health. It is cataloged according to its size and the two measures that are used are: PM_{10}, to refer to the particles of greater volume that are those that are retained in the airways and affect the respiratory system and $PM_{2.5}$ are the fine particles that have the ability to pass into the bloodstream so they can damage most of our organs. The limits that have been established for this pollutant are intended to be strict, in the case of the United States and Mexico the limits for $PM_{2.5}$ have been Set at 12.0 µg/m^3, while in the European Union it has 20 µg/m^3. For the analyzed day is the pollutant that presents a greater risk for health, having that for Shanghai all the time is located within a unhealthy or very unhealthy level for the Index danger for the Index of the Air Quality for $PM_{2.5}$, Madrid has maximum levels of $PM_{2.5}$ but generally has moderate effects on health, New York reaches unhealthy levels for sensitive groups, but most of the time has moderate effects, Mexico City for PM2.5 handles an AQI between good and moderate and in Moscow there are no potential health risks for this pollutant. And in the case of PM_{10} in the USA, the limit of 150 µg/m^3 per day is used and the EU has set the air quality standard at 50 µg/m^3 per day and at 40 µg/m^3 per year. Limit for the annual PM_{10} is the same, and per day is 75 µg/m^3, in the data analyzed there is no information for New York for this pollutant, but in the case of Moscow PM_{10} the results show that this Contaminant does not generate health impacts for the period studied, in Mexico City and Madrid there are a moderate level of health problems due to this pollutant, and in Shanghai it is reached and unhealthy AQI for sensitive groups (for more information on AQI, see Annexes 2-6 and for more information on emission Ceilings see Annexes 7-10).

Ozone, also known as tropospheric ozone, occurs as a reaction between nitrogen oxides and volatile organic compounds that primarily affects the respiratory tract and although it was previously a serious problem for global health (WHO, 2003). On 8 December 2016 New York, Madrid, Mexico City and Moscow are generally handling a good air quality index for this pollutant criterion, only for Shanghai it is observed that ozone goes from good to moderate, where only extremely sensitive people will be affected. The limit for this pollutant in the United States and Mexico is 0.070 ppm for an annual maximum of the 8-hour moving average, in the European Union the limit is 120 µg/ m^3 for a maximum of 8 hours.

Sulfur dioxide is mainly distinguished as being a component of acid rain when it reacts with moisture, but also has serious health effects such as respiratory and ocular diseases, sulfur dioxide in large quantities can even cause cardiac arrest. At the date observed, there is no information for New York, but in Madrid, Moscow and Mexico City it is in a small proportion in the atmosphere, only in Shanghai it reached the moderate air pollution level. The limits established by the United States are 75 ppb per hour and 0.5 ppm for 3 hours, in Mexico the limits are 0.200 ppm for 8 hours and 0.110 ppm per day and in the European Union it is 350 µg/m^3 per hour and 125 Mg/m^3 per day.

Nitrogen dioxide is essentially caused by cars and mainly affects the respiratory system, but it can also cause burns to the skin and eyes (WHO, 2003). In Moscow and New York for the period analyzed an adequate level of NO_2 was observed in the air, but in Madrid and in Mexico City levels varied between good and moderate, and in Shanghai extended to unhealthy for sensitive groups. Given that the emissions ceiling for this pollutant in the United States is 100ppb per hour, 200µg/m^3 in the European Union and 0.210ppm in Mexico City.

Carbon oxide is also mainly caused by vehicles with gasoline engines and is dangerous because it combines rapidly with hemoglobin, leading to anemia and lack of oxygen in the tissues. But due to the mortality generated by this pollutant has been controlled in the 4 cities monitored with data available reported a good AQI is observed, so it does not represent a health hazard in these areas (for Moscow there is no data available). The emission ceilings for this pollutant, as an 8 hour mobile average, are 9ppm in the United States, 10mg /m^3 for the European Union and 11.0ppm for Mexico City.

Due to the lack of some data a conclusive conclusion cannot be made, but according to the monitoring stations observed and the date studied, to a greater extent there is an Air Quality Index that represents a moderate danger to health, especially in relation to particulate matter, so there must be more control measures to ensure that these pollutants do not continue to exceed the emission ceilings established by each region. Shanghai is the city that has bigger problems, because it exposes more to its population to health risks.

It is also worth mentioning that this study was only carried out for a specific time for only one city per region, so it is unknown if this is the general behavior of these zones, because in contrast with the available information on OECD particulate matter, the records show that $PM_{2.5}$ levels in Russia are above the average for OECD countries including: Mexico, Spain and the United States. On average, $PM_{2.5}$ concentrations are at 14.05 micrograms per cubic meter in OECD countries. In the case of Shanghai, there is no information to compare because it does not report data to the OECD (OECD, 2015).

According to the information available in the OECD, the average annual $PM_{2.5}$ levels is lower in the United States with 10.7 micrograms per cubic meter, followed by Spain with 11.6 micrograms per cubic meter, Mexico with 11.9 micrograms per cubic meter and Russia with 14.2 micrograms per cubic meter. In contrast in the sample taken, $PM_{2.5}$ higher levels are found in Madrid, followed by Shanghai, New York, Mexico City and Moscow. Therefore, in order to obtain conclusive results regarding an area, it is suggested to monitor during different periods. Because one of the recommendations for achieving and maintaining adequate air quality levels for human health is to improve accountability mechanisms and improve the priority setting process.

CONCLUSIONS

An optimal combination of specific approaches and an integrated approach in regulation and control, it is necessary in order to achieve optimum levels of air quality, because although some emissions have been able to submit the emission ceilings for not affecting the environment, in relation to particulate matter and carbon dioxide there is still a long way to go considering that one of the main causes of public health problems is particulate matter and carbon dioxide is the main agent of global warming that is why is still importance establish regulations and policies for environmental pollution that protect the health and the environment, because air pollution compromises the overall health of the present and of future generations. As a first step towards this, in the 5 regions analyzed, there is already an environmental legislation that establishes environmental responsibilities for each country.

Based of appropriate use of CAC (Command and Control policies) and market-based incentives in an integrated framework it has been demonstrated that are the policies more efficient for the reduction of emissions, reason why they have to continue focus to reach optimal levels of air quality because the efforts made by United States, European Union, Mexico, China and Russia have been oriented towards this and have shown advantages in terms of the impact on the health of people in these regions, but the levels set in the Air Quality Standards are not yet reached.

Due to the serious consequences air pollution has now it is increasing importance on the international plane, an example of this is "The 2030 Agenda for Sustainable Development" which has been supported by all members of the United Nations, it is expected as scheduled by the agenda for 2030 will reduce air pollution and the consequences it entails. For this, it is necessary information that allows monitoring the levels of air quality in each region, as well as studies that let know the evolution of the emissions by region to be able to diminish the negative effects that is causing the air pollution, as: premature deaths, respiratory diseases, loss of labor productivity, reduced yields and changes in biodiversity.

As a recommendation that must be taken into account in these countries in order to have optimum levels of air quality is to encourage pollution prevention, energy efficiency and renewable energy and because higher emission levels are related to the use of transport, it is necessary to support transportation and land use scenario planning and integrate air quality planning into land use, transport and municipal development plans. In addition, as already mentioned during the article, it is important to combine air pollution policies with climate change policies to obtain better results. And finally to be able to achieve all this, it is recommended to offer incentives for voluntary and innovative land use, energy, and transportation approaches and develop platforms to reduce public demand for polluting activities.

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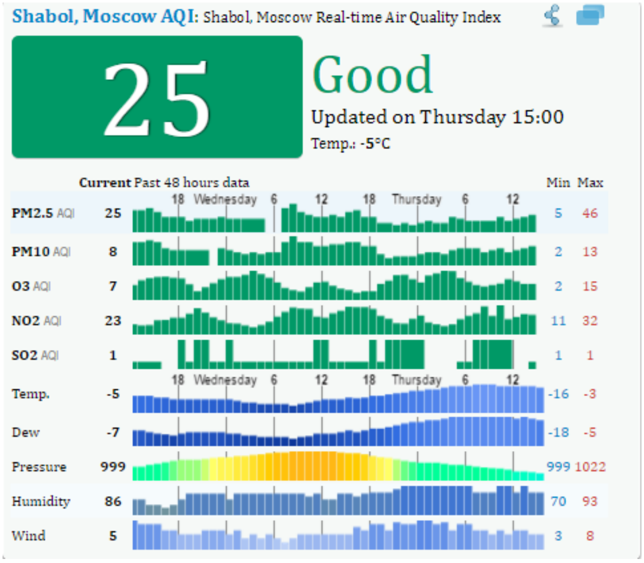
ANNEXES

AQI	Air Pollution Level	Health Implications
0 - 50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk
51 -100	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
101-150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
151-200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects
201-300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.
300+	Hazardous	Health alert: everyone may experience more serious health effects

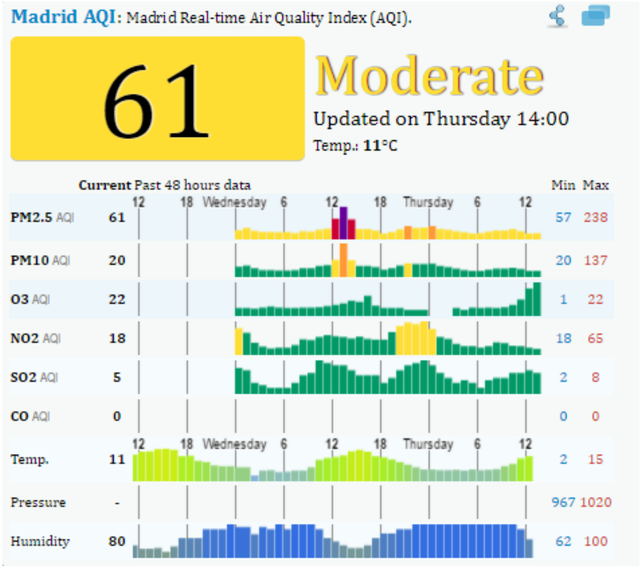
Annex 1: Air Quality levels.

Source: https://www.airnow.gov/index.cfm?action=aqibasics.aqi.



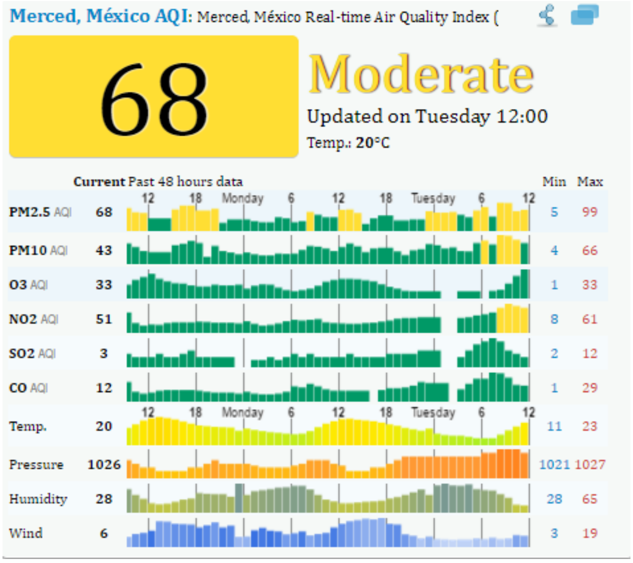
Annex 2: Real-time Air Quality Index for Moscow on December 8, 2016.

Source: http://aqicn.org/city/moscow/shabol/



Annex 3: Real-time Air Quality Index for Madrid on December 8, 2016.

Source: http://aqicn.org/city/madrid/



Annex 4: Real-time Air Quality Index for Mexico City on December 8, 2016

Source: http://aqicn.org/city/mexico/mexico/merced/

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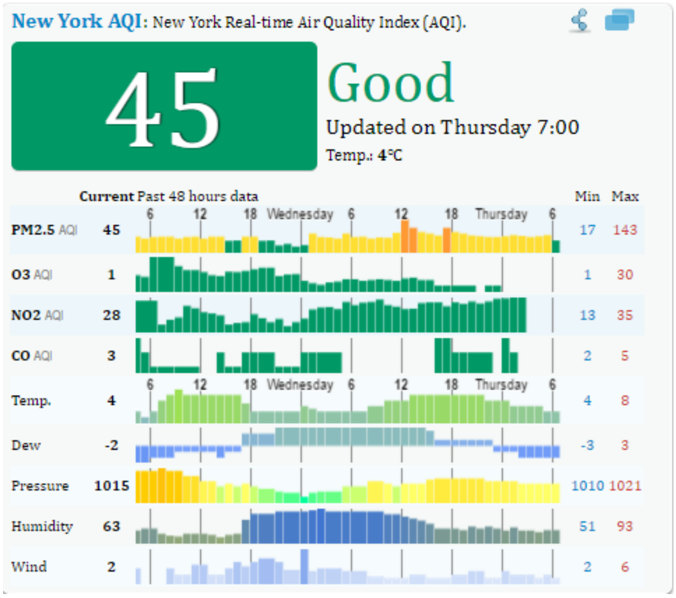
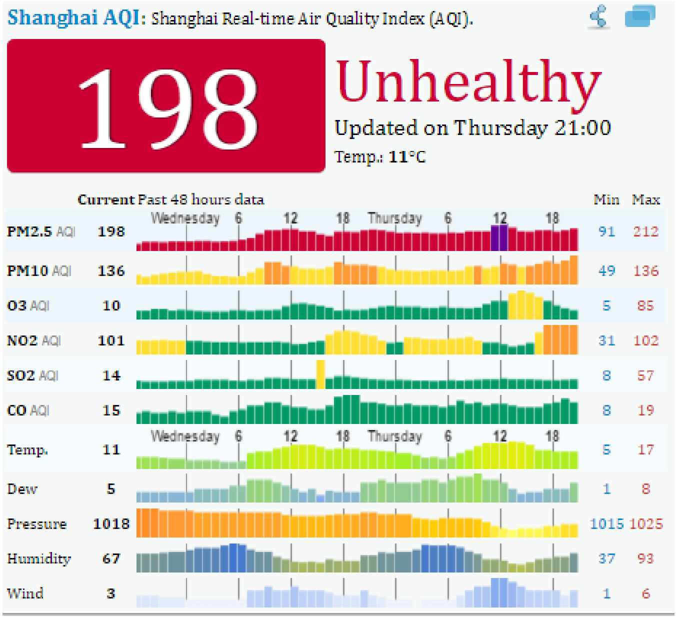


Annex 5: Real-time Air Quality Index for New York on December 8, 2016

Source: http://aqicn.org/city/usa/newyork/is-143/



Annex 6: Real-time Air Quality Index for Shanghai on December 8, 2016

Source: http://aqicn.org/city/shanghai/

Pollutant [links to historical tables of NAAQS reviews]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 μg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 μg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 μg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Annex 7: Emission Ceilings in United States.

Source: https://www.epa.gov/criteria-air-pollutants/naaqs-table

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Pollutant	Concentration	Averaging period	Legal nature	Permitted exceedences each year
Fine particles (PM2.5)	25 µg/m3***	1 year	Target value entered into force 1.1.2010 Limit value enters into force 1.1.2015	n/a
Sulphur dioxide (SO2)	350 µg/m3	1 hour	Limit value entered into force 1.1.2005	24
	125 µg/m3	24 hours	Limit value entered into force 1.1.2005	3
Nitrogen dioxide (NO2)	200 µg/m3	1 hour	Limit value entered into force 1.1.2010	18
	40 µg/m3	1 year	Limit value entered into force 1.1.2010*	n/a
PM10	50 µg/m3	24 hours	Limit value entered into force 1.1.2005**	35
	40 µg/m3	1 year	Limit value entered into force 1.1.2005**	n/a
Lead (Pb)	0.5 µg/m3	1 year	Limit value entered into force 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; and a 1.0 µg/m3 limit value applied from 1.1.2005 to 31.12.2009)	n/a
Carbon monoxide (CO)	10 mg/m3	Maximum daily 8 hour mean	Limit value entered into force 1.1.2005	n/a
Benzene	5 µg/m3	1 year	Limit value entered into force 1.1.2010**	n/a
Ozone	120 µg/m3	Maximum daily 8 hour mean	Target value entered into force 1.1.2010	25 days averaged over 3 years
Arsenic (As)	6 ng/m3	1 year	Target value enters into force 31.12.2012	n/a
Cadmium (Cd)	5 ng/m3	1 year	Target value enters into force 31.12.2012	n/a
Nickel (Ni)	20 ng/m3	1 year	Target value enters into force 31.12.2012	n/a
Polycyclic Aromatic Hydrocarbons	1 ng/m3 (expressed as concentration of Benzo(a)pyrene)	1 year	Target value enters into force 31.12.2012	n/a

Annex 8: Emission Ceilings in European Union.

Source: http://ec.europa.eu/environment/air/quality/standards.htm

Contaminante	NOM	Publicación	Descripción
Dióxido de azufre (SO_2)	NOM-022-SSA1-2010	8 de septiembre de 2010	0.110 ppm, máximo promedio de 24 horas 0.200 ppm, segundo máximo anual como promedio móvil de 8 horas 0.025 ppm, promedio anual
Monóxido de carbono (CO)	NOM-021-SSA1-1993	23 de diciembre de 1994	11.0 ppm, máximo anual como promedio móvil de 8 horas
Dióxido de nitrógeno (NO_2)	NOM-023-SSA1-1993	23 de diciembre de 1994	0.210 ppm, promedio horario
Ozono (O_3)	NOM-020-SSA1-2014	19 de agosto de 2014	0.095 ppm, promedio horario 0.070 ppm, máximo anual del promedio móvil de 8 horas
Partículas suspendidas totales (PST)			Derogado
Partículas menores a 10 micrómetros (PM_{10})	NOM-025-SSA1-2014	20 de agosto de 2014	75 µg/m^3, promedio 24 horas 40 µg/m^3, promedio anual
Partículas menores a 2.5 micrómetros ($PM_{2.5}$)	NOM-025-SSA1-2014	20 de agosto de 2014	45 µg/m^3, promedio 24 horas 12 µg/m^3, promedio anual
Plomo (Pb)	NOM-026-SSA1-1993	23 de diciembre de 1994	1.5 µg/m^3, en un periodo de tres meses como promedio aritmético

Annex 9: Emission Ceilings in México,

Source: http://www.aire.cdmx.gob.mx/default.php?opc=%27ZaBhnmI=&dc=%27Yw==

Proposed China 6 emission standards

Stage	Category	Class	CO	HC	NMHC	NOx	N_2O	PM	PN
			g/km						#/km
China 6a	Type 1		0.500	0.100	0.068	0.060	0.020	0.0045	6×10^{11}
	Type 2	I	0.500	0.100	0.068	0.060	0.020	0.0045	6×10^{11}
		II	0.630	0.130	0.090	0.075	0.025	0.0045	6×10^{11}
		III	0.740	0.160	0.108	0.082	0.030	0.0045	6×10^{11}
China 6b	Type 1		0.500	0.050	0.035	0.035	0.020	0.0030	6×10^{11}
	Type 2	I	0.500	0.050	0.035	0.035	0.020	0.0030	6×10^{11}
		II	0.630	0.065	0.045	0.045	0.025	0.0030	6×10^{11}
		III	0.740	0.080	0.055	0.050	0.030	0.0030	6×10^{11}

Annex 10: Emission Ceilings in China.

Source: https://www.dieselnet.com/standards/cn/ld.php