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Urban air pollution: risks and
alternatives

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Abstract:

Urban pollution is a great risk for the global security, health and economy. Although the developed countries are starting to take measures against pollution, the developing ones are still in a situation of great vulnerability.

Keywords:

Urban air pollution, development, emissions, security, health.

* **NOTE:** The ideas contained in the Opinion Documents are the responsibility of their authors, without necessarily reflecting the thinking of the IEEE or the Ministry of Defense.

Introduction

The concern for the environment in the field of security studies is at an all-time high and it keeps growing. Environmental risks have occupied a central role in the last editions of the World Economic Forum's Global Risks Report¹, NATO has created departments and working groups whose main focus is the protection of the environment², and in Spain, the National Security Strategy (NSS) 2017 justifies this concern stating that «in recent years, the effects of climate change have become so significant that they warrant an analysis from a security perspective»³.

One of the most important global risks is the air pollution, this is a problem not just in the cities but also in rural communities. However, cities are much more vulnerable since it is there where there is a greater concentration of pollutants in the air, which is a great risk for the health of the people living there.

According to data of the World Health Organisation (WHO), the 88% of the world population living in urban areas is exposed to air quality levels that exceed the limits set by the WHO⁴. Since 54,3% of the world population lives in cities and this number is expected to reach 70% by the year 2050⁵, if this problem is left unresolved, it will get much worse over time as the population density and Greenhouse Gas emissions per km² rise.

On the other hand, it is important to note that this is a problem that is unevenly distributed across countries, so that the least developed and developing ones are facing a greater risk. While in the developed countries 56% of the urban population lives in areas exposed to air quality levels that exceed the WHO's limits, in the least developed or developing countries this percentage rises to a 98% of the population. This difference is caused by the fact that the less developed countries use fuels that are more pollutant, such as coal, and that they don't have effective policies against pollution.

In order to face these challenges, the UN stated in the 11th Sustainable Development Goal the necessity to develop better policies against air pollution, climate change and the inefficient use of resources in urban areas. The UN also deems as very important to

¹ World Economic Forum (2018). «The Global Risks Report 2018, 13th Edition». Geneva: World Economic Forum.

² NATO (2014). «Environment – NATO's stake». Link: https://www.nato.int/cps/en/natohq/topics_91048.htm#

³ National Security Strategy 2017. A shared project, by all and for all. Madrid: Presidencia del Gobierno, 2017, p. 75.

⁴ WHO (2016). «Air pollution levels rising in many of the world's poorest cities». Link: <http://www.who.int/mediacentre/news/releases/2016/air-pollution-rising/en/>

⁵ OECD (2012). «OECD environmental outlook to 2050: the consequences of inaction». OECD publishing.

«support least developed countries, including (...) financial and technical assistance, in achieving this goal»⁶.

This paper analyzes the risks that urban air pollution entails for the global economy, health and security. In addition, it also reviews some of the policies that are being developed in different countries across the world in order to solve this problem.

Health, economic and security impact

The most important air pollutants in cities and indoor spaces are ozone (O₃), nitrogen dioxide (NO₂), sulphur dioxide (SO₂) and particulate matter (PM). According to the World Health Organization (WHO) these pollutants can severely damage the health of the people exposed to them, causing heart attacks and other cardiovascular diseases, lung cancer, among other types of cancer, and respiratory diseases⁷.

Air pollution is the 4th most frequent cause of death in the world, it is estimated that in 2013 it caused 5,5 million premature deaths⁸, which amounts to the 10,1% of that year's deaths⁹. On the other hand, that same year 103.1 million of healthy life (DALY)¹⁰ were lost because of particulate matter¹¹.

Furthermore, it is important to emphasize that the health impact of pollution causes high economic costs due to sanitary expenses for the treatment of diseases related to pollution, as well as the opportunity costs related to the loss of productivity because of the diseases caused by pollution¹². Besides that, there are other indirect costs such as the fact that cities with very high pollution levels have a greater difficulty to attract tourism, companies and foreign employers¹³.

⁶ UN (2015), «Resolution adopted by the General Assembly on 25 September 2015». Objective 11.c.

⁷ WHO (2013). «Outdoor air pollution a leading environmental cause of cancer deaths». Link: [http://www.who.int/mediacentre/factsheets/fs313/es/](http://www.euro.who.int/en/http://www.who.int/mediacentre/factsheets/fs313/es/). Accedido por última vez el 15/01/2018.

⁸ This data refers to the whole world, not just urban areas.

⁹ World Bank. (2016). «The cost of air pollution: strengthening the economic case for action». Washington, D.C.: World Bank Group.

¹⁰ Daly (Disease-Adjusted Life Years) is a variable used by the WHO, which measures the number of years of healthy life lost in a period of time because of some health-related problem.

¹¹ Cohen, A. J. et. al. (2017). «Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015». The Lancet, 389(10082), 1907-1918.

¹² WHO, OECD (2015). «Economic cost of the health impact of air pollution in Europe: Clean air, health and wealth». Copenhagen: WHO Regional Office for Europe, p. 21.

¹³ World Bank. (2016). «The cost of air pollution: strengthening the economic...». Op. cit.

According to the World Bank, air pollution has caused losses of 3,552 billion US\$ in the whole world¹⁴. The regions with higher economic costs are Asia, specially China and India in which pollution related costs were a 9.9% and 7.8% of their GDP respectively; but also Eastern European countries such as Russia and Ukraine both with costs amounting up to 8.3% and in Hungary 8.9% of their GDP. In the Sahel countries such as Mali or South Sudan these costs were 7.3% and 5% of their GDP respectively, and to a lesser extent the countries of Sub-Saharan Africa, such as Congo or Cameroon for whom these costs amount up to 5,5% and 4,6% of their GDP respectively¹⁵.

The countries with higher costs are the lower middle-income ones, in which these costs amount on average up to 6,7% of their GDP, and the upper middle-income countries, in which these costs were on average 6,1% of their GDP. The reason for this is that the developing countries use more energy and natural resources than the least developed ones, but they have poor infrastructure, which is more polluting than the one in the most developed countries.

According to the WHO, 87% of the deaths caused by air pollution happened in the developing or less developed countries. In these countries, household air pollution is also a great problem, caused by the combustion of coal and other polluting energy resources. The magnitude of these problems is sometimes underestimated, but in 2013 in sub-Saharan Africa, air pollution caused more deaths than childhood underweight, unsafe sanitation and unsafe waters¹⁶.

Air pollution also has an important impact in global security. According to the Spanish National Security Strategy (NSS) 2017¹⁷, the emission of greenhouse gases and other pollutants not only affects the health and wellbeing of the population, but also increases the likelihood of natural disasters, desertification and the rise in temperatures.

Air pollution can also reduce food availability. Specifically, Sulphur Dioxide, Nitrogen Oxides, Ozone and Particulate Matter can adhere themselves to the surface of plants, reducing the amount of light they receive. This has reduced China's wheat harvests from 6 to 12% each year and the soy harvests from 21 to 25% each year. On the other

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Roy, R. (2016), «The cost of air pollution in Africa», OECD Development Centre Working Papers, No. 333, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5ilqzq77x6f8-en>.

¹⁷ National Security Strategy 2017... Op. cit.

hand, these emissions have caused acid rain which has caused a loss of 30 thousand ¥ in China just in agriculture¹⁸.

According to the NSS, these environmental problems can intensify migration flows. Besides that, they can also increase the competition for the natural resources, specially water and food. In turn, this would increase political, economic and social instability of the more vulnerable countries, which would hamper governance in these areas and allow radicalization. This is a risk about which the Global Risk Report 2018 also has talked about in some detail¹⁹.



Picture 1. Air Pollution reduces agricultural output

This is a problem that the developing and least developed countries have to face, since they are the ones with higher levels of air pollution. However, in some regions such as the Sub-Saharan Africa and, to a lesser extent, the Middle East, there is very little data concerning the air quality, which makes it difficult to measure the actual size of this problem.

Measures against urban air pollution

Urban air pollution is a widely spread problem, and although it is more noticeable in some cities than others, such as the ones where there is smog, the truth is that it affects

¹⁸ World Bank. (2016). «The cost of air pollution: strengthening the economic...». Op. Cit.

¹⁹ García Sánchez, I. (2018). «Una aproximación disímil al 13er informe del Foro Económico Mundial sobre los riesgos globales». IEEE, Documento de Análisis 15/2018.

the 88% of the urban population in the whole world²⁰. For this reason, public policies against air pollution should be more widely spread.

Policies against urban air pollution have the advantage of having very little trade-offs between environmental sustainability and economic growth, as they improve the citizens' wellbeing, increase energy efficiency and they can make the urban environment in which they are applied more attractive to tourists and companies²¹.

Even though environmental problems seem to be a recent concern, the truth is that this kind of policy has a long history. The great smog of London in 1952 «brought traffic and people to a standstill»²², and was responsible for many deaths and an increase of 23% in hospital admissions for respiratory problems. As a reaction to this problem the Parliament of the UK passed the *Clean Air Act*, which created smokeless zones, where only smokeless fuels could be burnt. It stated that the heating systems should shift to cleaner coals, electricity and gas, and relocated the power stations away from the cities.



Picture 2. London, the great smog of 1952.

This part of the article studies the different measures that have been applied in different countries, and classifies them according to which economic sectors they affect. This approach has been inspired by the Spanish National Security Strategy (NSS) 2017, which established the need for an «all sectoral planning, with the goal of promoting the

²⁰ OECD (2010), «Executive Summary», in *Cities and Climate Change*, OECD Publishing, Paris.

²¹ Ibid.

²² Zhang, D., Liu, J., & Li, B. (2014). «Tackling air pollution in China—What do we learn from the great smog of 1950s in London». *Sustainability*, 6(8), 5322-5338, p. 5324.

least polluting actions, so as to better adapt to the impact—both physical and economic—of climate change»²³.

Measures focused on industry

According to the WHO²⁴, this kind of policies have the objective of promoting «clean technologies that reduce industrial smokestack emissions». These measures are especially important in the developing countries, where one of the main causes of air pollution is combustion. However, in these countries these measures would need to apply, not only to the industry, but also to the households, since they also use coal and other very polluting energy sources.

The Chinese government has driven reforms of these kind under Xi Jinping presidency. These measures aim to update their industries' infrastructure for a less polluting one and has promised to reduce the use of coal a 15% by 2020²⁵. However, these measures are not being always successfully implemented²⁶.

The European Union (EU) has passed some directives of this kind. The Directive 2010/75/UE states that the facilities of the sectors related to energy, production and processing of metals, chemical industry, waste management, paper production or the intensive rearing of cattle will only be able to continue performing their activities if they have a permit, which will only be granted if these industries are using the best available techniques, these are of course the ones that have a smaller impact on the climate²⁷.

On the other hand, the Directive (EU) 2015/2193 regulates the facilities of the medium combustion plants and establishes a pollution limit which takes into account the kind of pollutant emitted and the state of these facilities. This measure will come into force in December 2018 for the new facilities and in 2025 or 2030 for the old ones depending on their size²⁸.

²³ National Security Strategy 2017... Op. cit., p. 17.

²⁴ WHO (2016), «Ambient (outdoor) air quality and health». Link: [http://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](http://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health).

²⁵ Higuera, G. (2017). «El nuevo orden chino». IEEE, Documento de Opinión 58/2017.

²⁶ Ibid.

²⁷ Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) Text with EEA relevance. Official Journal of the European Union L 334, pp. 17–119.

²⁸ Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants (Text with EEA relevance), Official Journal of the European Union L

Measures focused on energy

As we have seen above, many of the policies focused on the industry aim to reduce emissions by using less polluting energy sources and renewable energies²⁹. However, sometimes they have a broader objective which goes beyond the industrial sector. For example, Madrid's local government has established a goal to reduce a 20% the demand of fossil fuels by 2020³⁰.

Measures focused on transport

According to the WHO this kind of policies have the objective to promote the use of less polluting vehicles and fuels, it is especially important to reduce the emission of sulphur oxides and dioxides. This kind policy is also focused on promoting alternative transport systems, such as bicycles and public transport and making it easier to walk across the city³¹.

There are too many policies about this topic in the EU to cover them all, for this reason we are just going to talk about the most important ones. The Directive 98/70/CE states that only the petrol and diesel fuels that comply with the environmental specifications of that directive will be able to access the European Single Market³². On the other hand, the Regulation 715/2007 states that the countries must «refuse to grant their authorisation to vehicles that do not meet the emissions or fuel consumption standards, within the authorised deadlines relating to each vehicle category»³³. Lastly, the regulations 510/2011 and 443/2009 stated that when a vehicle's emissions exceed the limits, its manufacturer must pay a fine calculated according to how much did they exceed the limits^{34 35}.

Local governments have developed many policies against urban air pollution. Among these measures are bans on street parking, promote the use of bicycles, traffic

313, pp. 1–19.

²⁹ WHO (2016), «Calidad del aire ambiente (exterior) y salud». Link: <http://www.who.int/mediacentre/factsheets/fs313/es/>

³⁰ Lázaro-Touza, L. (2011). «Ciudades y cambio climático: retos, oportunidades y experiencias (ARI)», Real Instituto Elcano.

³¹ WHO (2016), «Calidad del aire ambiente (exterior) y salud». Op. cit.

³² Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC, Official Journal of the European Union L 350, p. 58–68.

³³ European Union (2016), *Reducing pollution from light motor vehicles*, EU legislation summaries.

³⁴ European Union (2014), *Reduction of carbon dioxide emissions from light commercial vehicles*, EU legislation summaries.

³⁵ European Union (2015), *Reduction in CO₂ emissions of new passenger cars*, EU legislation summaries.

restrictions, speed limits, subsidy on registration tax on environment-friendly vehicles, the creation of low emission zones, updating the public transport vehicles so that they pollute less, discouraging the use of private cars creating high-occupancy vehicle lanes, bicycle lanes, encouraging teleworking...^{36 37}. These measures have been applied in many cities of the EU, Japan, Australia, USA, Mexico, Singapore and China among others.

In Barcelona the renewal of the public transport vehicles has reduced significantly the nitrogen levels (NO₂) and Particulate Matter³⁸. Another measure that is quite widespread is *congestion charging*, which is a fee that vehicles need to pay in order to get into certain parts of the city. Congestion charges are being applied in many cities in developed countries such as the USA and the EU, but also in several cities in developing countries such as Beijing, São Paulo and Singapore.

The fees usually have to be paid daily, but usually there are some exemptions, discounts and surcharges that are applied depending on how much pollutes each car. The fees can vary a lot, from £11.5 in London³⁹, to 5€ in Milan⁴⁰. In Singapore there is a variable price system in which the fee varies according to the pollution levels⁴¹.

Generally, these measures have been quite successful and have managed to reduce the CO₂ emissions between 10% and 20% in Milan and Stockholm⁴², while in London CO₂, NO_x and Particulate Matter has been reduced (PM₁₀) 16.4%, 13.4% and 6.9% respectively⁴³. These policies are necessary in order to reduce urban air pollution since traffic is one of its main causes in most cities.

Measures focused on urban planification

According to the WHO the urban planification policies when focused on environmental problems have the objective of reducing the emissions of greenhouse gases by

³⁶ Lázaro-Touza, L. (2011). «Ciudades y cambio climático: retos, oportunidades...». Op. cit.

³⁷ Gulia, S., Nagendra, S. S., Khare, M., & Khanna, I. (2015). «Urban air quality management-A review». *Atmospheric Pollution Research*, 6(2), 286-304.

³⁸ Ibid.

³⁹ Transport of London's Website. Link: <https://tfl.gov.uk> Accedido por última vez el 15/01/2018.

⁴⁰ Milan City Council's Website. Link: <https://www.comune.milano.it/> Accedido por última vez el 15/01/2018.

⁴¹ Singapore's Traffic Department's Website. Link: <https://www.lta.gov.sg> Accedido por última vez el 15/01/2018.

⁴² OECD (2014), «Cities and Climate Change: National governments enabling local action. Policy Perspectives». OECD Publishing, Paris.

⁴³ Gulia, S., Nagendra, S. S., Khare, M., & Khanna, I. (2015).... Op. cit.

increasing the energy efficiency of buildings and cities more compact⁴⁴. These measures are based on the idea that cities will be more efficient in their use of energy if they are more compact, especially because of the benefits in traffic⁴⁵ and the construction sector⁴⁶.

Many studies have proved that the emissions of CO₂ tend to rise as the population density decreases⁴⁷. For example, Japanese cities are 5 times denser than the Canadian ones and they spend 40% less energy. However, it is more interesting to compare cities with similar climate conditions so that there is no bias. For instance, Danish cities are 4 times denser than Finnish, and they spend 2.4 times less energy.

Lastly, in New York live 8.54 million people, while in Los Angeles only 3.98, and not only are both cities part of the same country, from which we would expect that their population have the same culture, but New York has a colder climate. However, despite all this, Los Angeles has a much more CO₂ emissions than New York⁴⁸. For this reason, policies aimed to reduce the *urban sprawling* are very important.

Developing countries should focus more in this kind of measures because their cities are growing very fast. Since the 1950s the OECD have doubled their urban territory, while the developing countries have multiplied it by 5. Most of this growth is happening in the outskirts of the cities. This situation of urban sprawling is happening in 66 out of the 78 biggest cities of the OECD; we don't have data about this situation in the developing countries, but we expect the urban sprawling to be smaller there because city centres are still growing. However, this urbanization will lead to a rise in the energy consumption and CO₂ emissions in Asian and African cities⁴⁹.

The aforementioned measures have been implemented in some developed countries such as the United Kingdom, Japan and the Netherlands, which have developed a set of measures known as «Eco-Compact City»⁵⁰. These measures have long-term impact, this is a great problem since most policy-makers are encouraged by the electoral system to adopt measures with a short-term impact.

⁴⁴ WHO (2016), «Calidad del aire ambiente (exterior) y salud». Op. cit.

⁴⁵ Lázaro-Touza, L. (2011). «Ciudades y cambio climático: retos, oportunidades...». Op. cit.

⁴⁶ OECD (2010), «Executive Summary»... Op. cit.

⁴⁷ OECD (2014), «Cities and Climate Change: National governments...». Op. cit.

⁴⁸ Ibid.

⁴⁹ Ibid.

⁵⁰ Ibid.

Measures focused on waste management

This kind of policies have the objective of improving the waste management systems so that they have a smaller environmental impact. This can be achieved by promoting the recycling and reuse of residues and by improving the «methods of biological waste management such as anaerobic waste digestion to produce biogas, are feasible, low cost alternatives to the open incineration of solid waste. Where incineration is unavoidable, then combustion technologies with strict emission controls are critical»⁵¹. Another measure which is less widespread, but is very effective, is imposing a tax on non-recyclable materials. In San Francisco, these measures have managed to reduce by a 70% the amount of waste that ends in a landfill⁵².

Measures focused on natural resources

These policies are focused on the management of the cities' natural resources, specially by creating green areas and planting more trees in the city. This may not seem like a very impactful measure, but not only is it aesthetic and cheap, but it can moderate the temperatures, reduce CO₂ levels and the city's impact on the land⁵³.

One good example of this kind of measure taken seriously is in the Korean city of Sejong, where half of the city's surface area will be reserved for parks, greenbelts and waterfronts. Another example is New York, whose «PlaNYC Climate Plan includes a goal of planting an additional one million trees by 2030, and filling all available spaces for trees»⁵⁴.

⁵¹ OMS (2016), "Calidad del aire ambiente (exterior) y salud". Link: <http://www.who.int/mediacentre/factsheets/fs313/es> Accedido por última vez el 15/01/2018.

⁵² Lázaro-Touza, L. (2011). «Ciudades y cambio climático: retos, oportunidades...». Op. cit.

⁵³ Ibid.

⁵⁴ OECD (2014), «Cities and Climate Change: National governments...». Op. cit., p. 118.



Picture 3. Sejong

Conclusions

Air pollution is a problem that directly affects very seriously the climate change, the health of urban population and the economy of most cities. However, indirectly it affects the global security as air pollution can promote desertification, as well as water and food scarcity, all of which increases instability and radicalization in the less developed countries.

Besides that, it is observed that measures against urban air pollution are being implemented in the developed countries and the developing ones. In the developed countries the main challenge is increasing the political determination to fight climate change and doing more impact analysis and more research about which are the best methods and possible solutions against air pollution.

Among the developing countries, China and the countries of Southeast Asia have reached a higher level of pollution than anywhere else in the world. However, they also stand out for the amount of measures against pollution, which is much higher than in

any other developing country. Although these policies haven't always been completely implemented⁵⁵, their situation is expected to improve if they continue the effort.

On the other hand, when it comes to the less developed countries, such as Sub-Saharan Africa, the Sahel countries and, to a lesser extent, North Africa and the Middle East, have a huge gap compared to the rest of the world, as there are very few air quality controls and almost no significant policies against air pollution.

A good example of this is that out of the 2.972 cities in WHO ambient air pollution database, only 39 were in the Sub-Saharan Africa and 84 in north Africa and Middle East. Together they only represent a 0.04% of the data. In 2012 ambient air pollution caused 211 000 deaths in Sub-Saharan Africa and 194 000 in North Africa and the Middle East⁵⁶.

If we also take into account, the fact that these countries are growing really fast⁵⁷, we can conclude that these regions are extremely vulnerable, and they don't have a good prospect. For this reason, as the 11th Sustainable Development Goal⁵⁸ states, it is really important to help the most vulnerable countries to develop effective measures against climate change in order to improve their population's health, their environmental security and their economy.

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⁵⁵ Gulia, S., Nagendra, S. S., Khare, M., & Khanna, I. (2015)... Op. cit.

⁵⁶ WHO (2016). «Ambient air pollution: a global assessment of exposure and burden of disease». World Health Organization.

⁵⁷ World Bank. (2016). «The cost of air pollution: strengthening the economic...». Op. cit.

⁵⁸ UN (2015), «Resolution adopted by the General Assembly on 25 September 2015». Objective 11.c.