Fine Particulate Matter ($PM_{2.5}$) in Air: Measurement and Regulations in Ecuador

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1. Introduction

Chronic exposure to air pollutants is a global threat to public health. The World Health Organization (WHO) estimated that air pollution caused 4,2 million premature deaths, of which 91% occurred in places where WHO standards were not met [1]. Particulate matter ($PM_{2.5}$) are solid or liquid particles with a diameter lower than 2,5 µm.

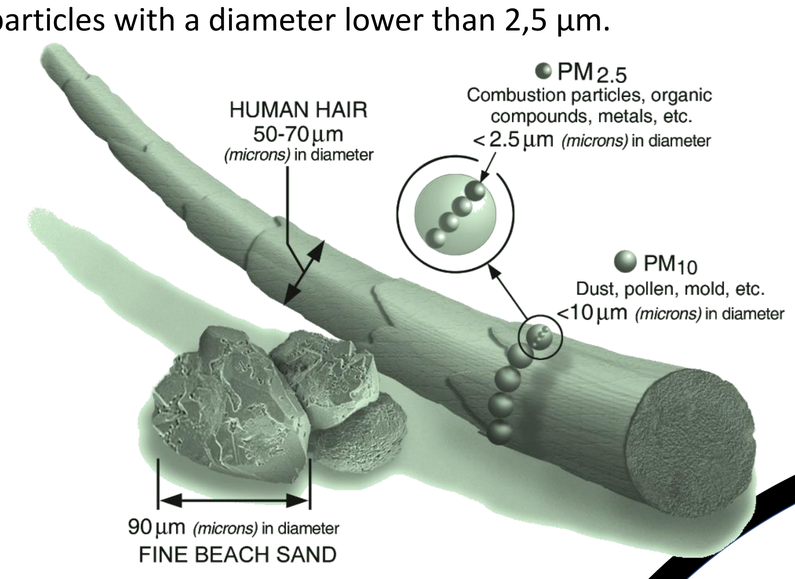

Figure 1. Comparative size of $PM_{2.5}$. Image: EPA [2].

$PM_{2.5}$ is a major environmental and health threat. There is strong evidence that $PM_{2.5}$ causes cardiovascular and respiratory diseases, lung cancer, and stroke [3,4].

2. Sources

Some of the primary sources of $PM_{2.5}$ in Ecuador include transport, power generation, industry, waste management, and volcanic ash. In Quito, low-quality diesel with high sulfur content and public transport are of great concerns. Quito is in the Andes region, where topography make the diffusion of air pollutants more difficult.

3. Monitoring

In Ecuador, Quito (capital) and Cuenca have an air quality monitoring network. In the urban area, Quito has nine remote monitoring stations for CO, SO_2, NO_x, O_3, PM_{10} and $PM_{2.5}$. The network belongs to the Secretary of Environment of the Municipality.

WHO's air pollution repository and other websites (e.g., waqi.info) provide some estimates of the air pollution for countries and cities (Fig. 2).

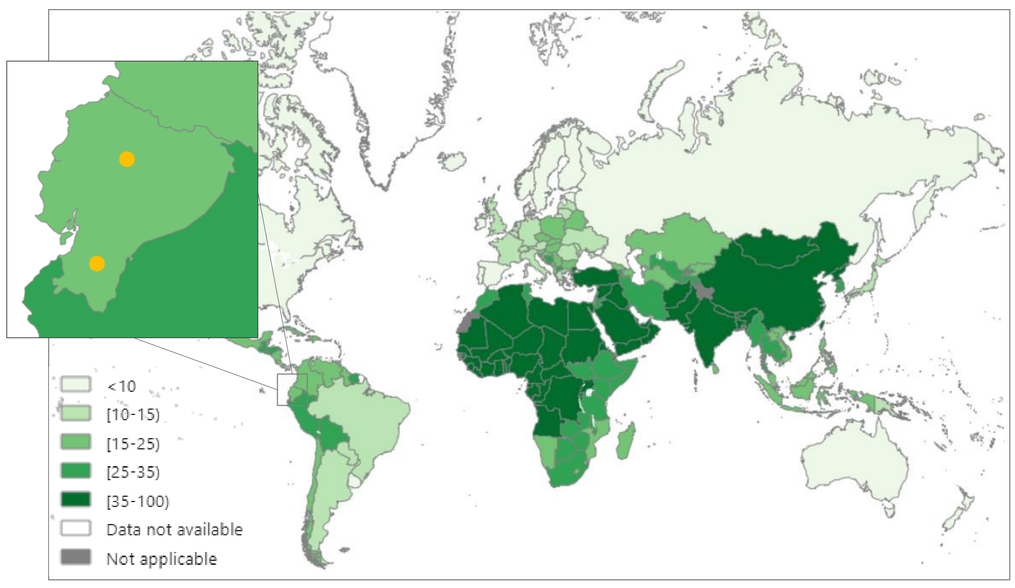

Figure 2. Annual average concentrations (estimates) of fine particulate matter $PM_{2.5}$ for some countries in 2015. Image: WHO[5]. Ecuador (19.55 ± 3.86) µg/m³, Colombia 18.45 µg/m³, Peru 30.46 µg/m³. Yellow dots show Quito (up) and Cuenca (down).

4. Results

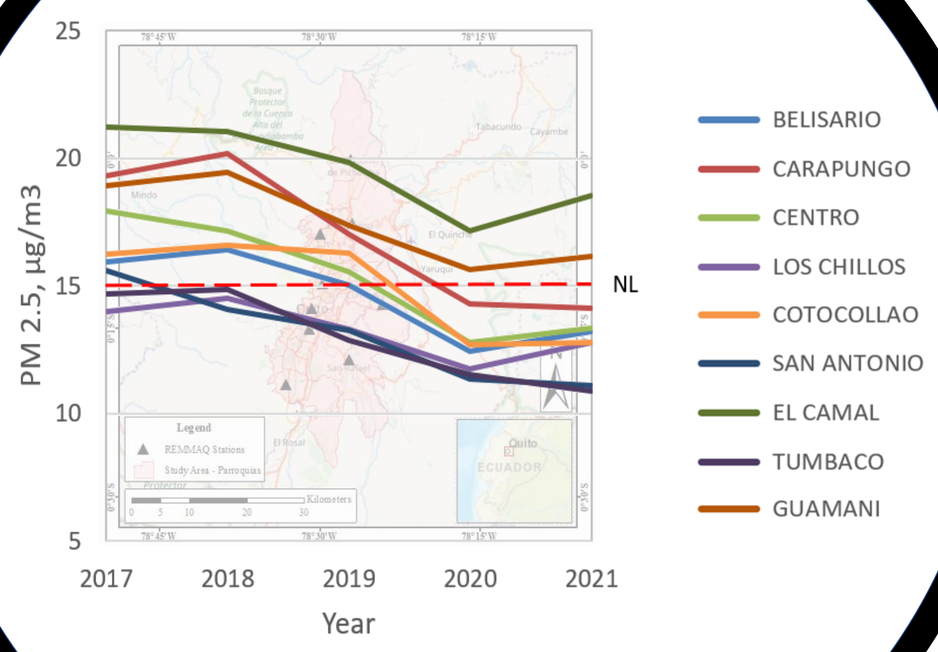

Figure 3. $PM_{2.5}$ annual concentrations at the monitoring stations in Quito, from 2017 to 2021. Data from REMMAQ [6]. NL: national limit.

Check $PM_{2.5}$ in your city:

5. Discussion

During the last five years (Fig. 3), annual $PM_{2.5}$ was above the WHO and, in some cases, above the national limits (e.g., El Camal and Guamaní). A decreasing trend happened for 2017-2020, but in 2021 higher concentrations reappeared. Some factors that could have influenced $PM_{2.5}$ are diesel fuel improvement and the lockdown.

In 2018, the average sulfur content in diesel in Quito was communicated as 227 ppm [7]. Its quality has been improving in recent years. The high content of sulfur in diesel generates particulate matter and restricts the implementation of new engine technologies.

Restricted mobility and reduced fuel consumption may have temporarily improved air quality.

6. Regulations

Table 1. Maximum limits for $PM_{2.5}$ annual and daily averages in µg/m³.

	Annual	24-hour
National legislation (NL)	15	50[b]
WHO ACG[a]	5	15[c]

[a] In addition to the Air Quality Goal (ACG) level, WHO considers four interim targets (35, 25, 15, 10) µg/m³.
[b] 98th percentile. [c] 99th percentile.

WHO[8] published a new version of the global air quality guidelines containing the interim target and goal levels for several contaminants, including $PM_{2.5}$.

The "Annex IV, Book VI: Environmental Quality of the Unified Text of Secondary Environmental Legislation" (TULSMA) establishes the maximum permissible limits of contaminants and measurement methods. The main method described by the national regulation for determining $PM_{2.5}$ is gravimetry with a low-flow sampler. Alternative methods are continuous systems, such as oscillating microbalance and beta attenuation.

For specifications of fuels, the National Authority of Standard established the NTE INEN 935 standard for gasoline and NTE INEN 1489 standard for diesel. The Ministry of Energy and the National Oil Company ensures the national supply and quality of fuels.

7. Last thoughts

During 2017-2021, the Quito air monitoring network showed annual concentrations of $PM_{2.5}$ above the current WHO guidelines and, in some cases, the national regulatory limit.

Air pollution might also exceed these limits in other Ecuadorian cities where monitoring systems are still unavailable.

Improving fuel quality, engine technologies, and public transportation services could improve air quality.

References

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