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# Control and measurement of nanoparticles: developments in Chile and Colombia

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# 1. DPF-SCR-EGR in Chile and Colombia

- The governments of Chile and Colombia have promoted the use of DPF, SCR, and EGR in diesel and gasoline engines to reduce emissions, particularly nitrogen oxides and particulate matter.
- However, significant tampering and removal of devices have been found in the cases of EURO V-VI, and they cannot be controlled by the current periodic inspection systems.

- To address this issue, Chile and Colombia have initiated studies that will enable them to assess the extent of these illegal practices.

# SCR and EGR: Chile and Colombia

Study under development:

*“Generation of technical inputs for the regulation of the surveillance and control of the SCR and EGR systems in Chile and Colombia”*

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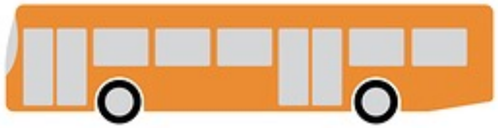
# DPF: public transport buses in Santiago, Chile



The Chilean government is examining the deterioration of DPF units in Santiago's fleet of public transportation buses, and assessing the measurement of the number of particles in these vehicles during their periodic inspections

Study under development

*“Update of General Analysis of Economic and Social Impacts for Measurement Standard for the Number of Particles in Buses, Chile”*

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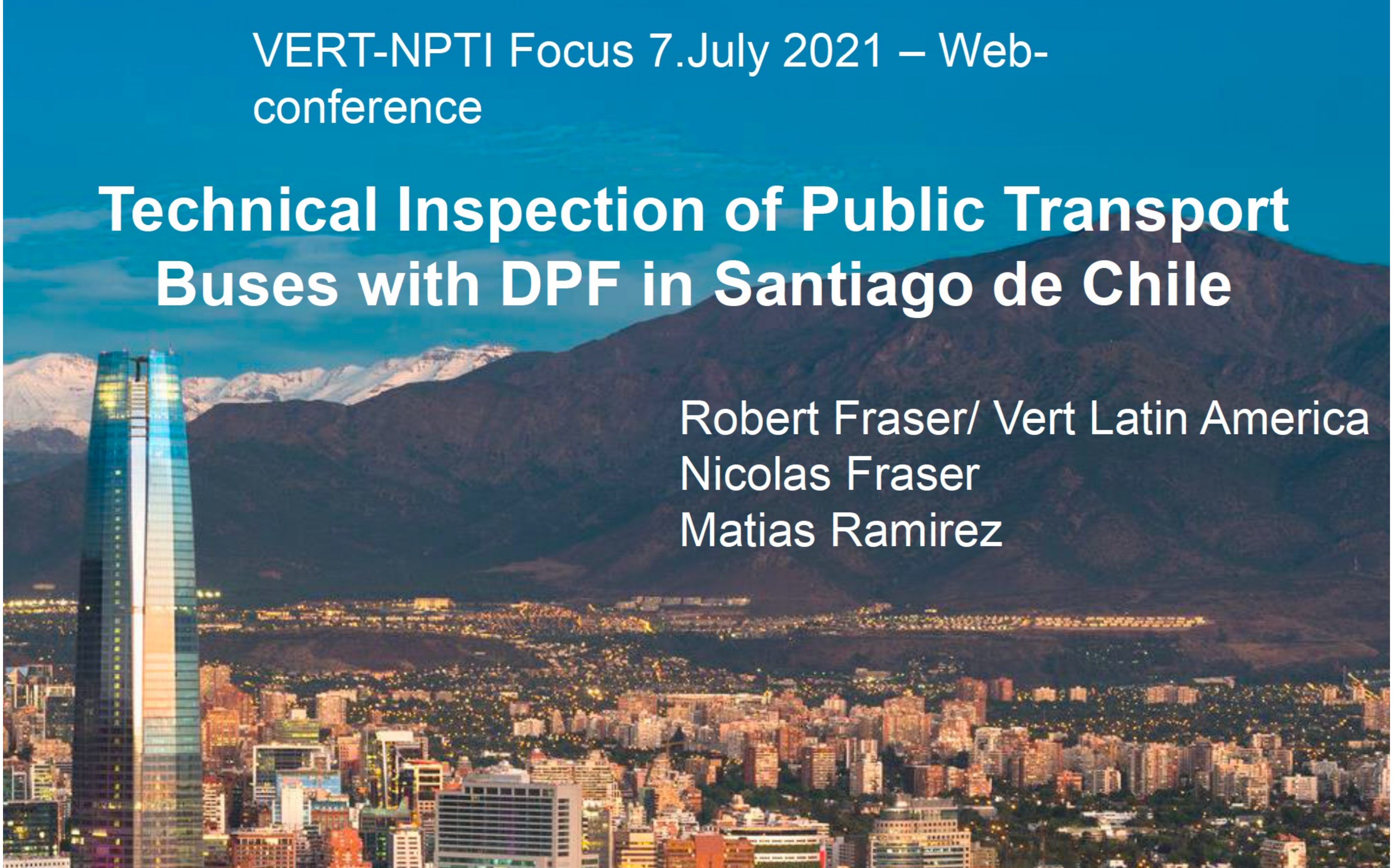


VERT-NPTI Focus 7.July 2021 – Web-conference

# Technical Inspection of Public Transport Buses with DPF in Santiago de Chile

Robert Fraser/ Vert Latin America
Nicolas Fraser
Matias Ramirez

# DPFs in Santiago de Chile

**2004** Santiago starts a DPF pilot program in cooperation with VERT

→ **2007** start of Euro III retrofit with VERT certified DPF

→ **2011** Total: 2000 buses retrofitted

→ **2012** Introduction of Euro V without DPF

→ **2015** Total: 3500 buses with DPF of 6500

→ **2015** 1st Roadside Control study of 400 buses by PN low and high idle

→ **2019** Demonstration Euro VI buses

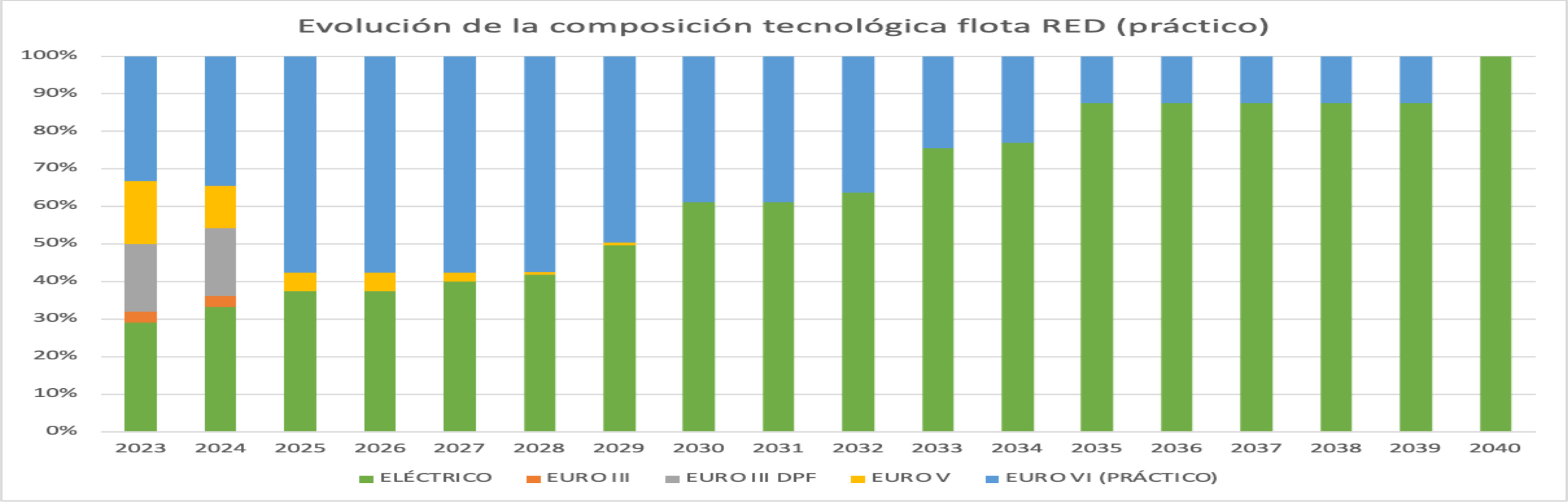
→ **2020** All new buses must be Euro VI or electric

→ **2020** 2nd Technical Control study of 372 buses

→ **2021** 1500 Euro VI which will probably increase to 3500

**FLOTA 2023**

| Año | TOTAL |
|---|---|
| ELECTRICO | 2222 |
| DIESEL | 5442 |
| EPA 98 O EURO III | 229 |
| EPA 98 O EURO III F | 1376 |
| EURO V | 1292 |
| EURO VI | 2545 |
| TOTAL | 7664 |

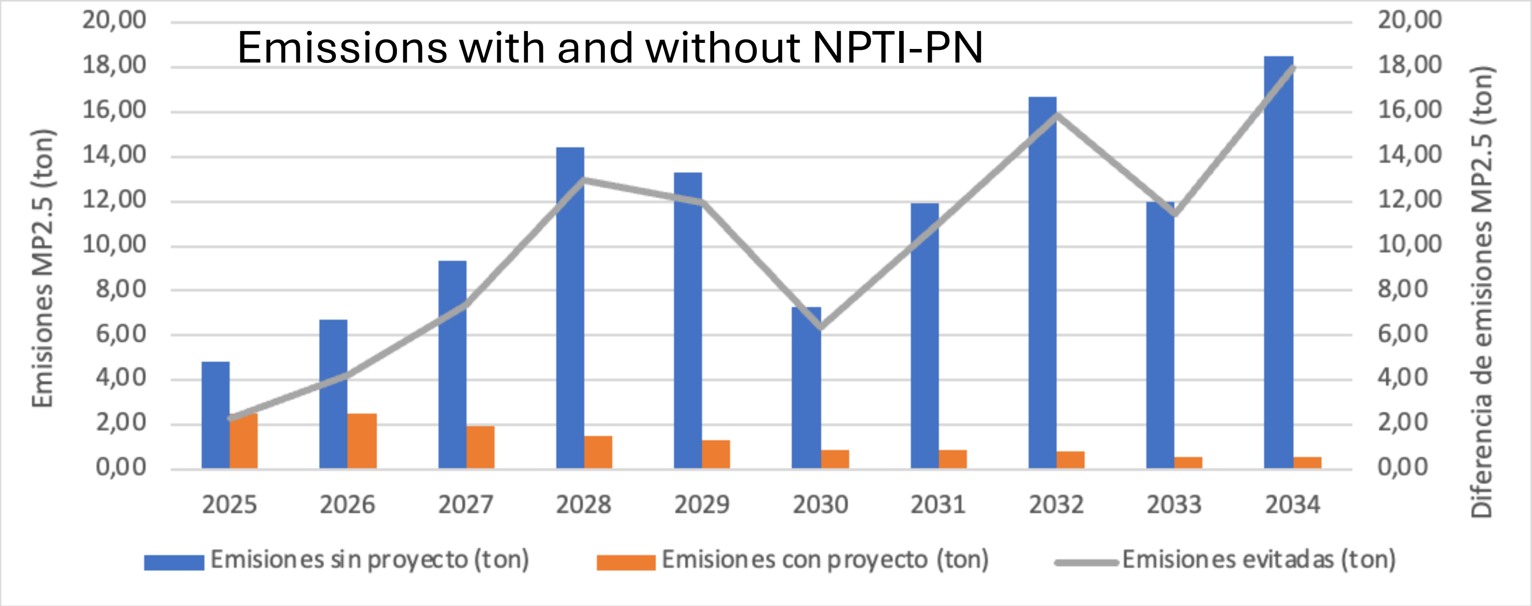


# PM2,5 emission’s projection 2024-2034

| | |
|---|---|
| TASA CONSTANTE DE RECHAZO HASTA 2029 | 7,30% |
| TASA ASCENDENTE DE RECHAZO DE 2029 A 2034 | 10% |

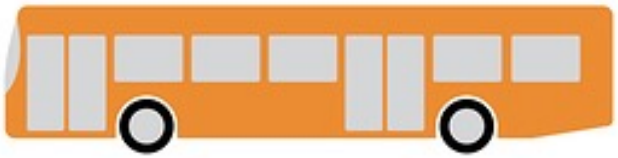
Rejection rate forecast 2025-2034

| AÑO | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|
| FLOTA EURO_VI | 4422 | 4421 | 4413 | 4411 | 3807 | 2980 | 2979 | 2786 | 1877 | 1771 |
| TASA DE RECHAZO | 7,30% | 7,30% | 7,30% | 7,30% | 7,30% | 7,80% | 8,34% | 8,88% | 9,42% | 10,00% |
| BUSES RECHAZADOS | 323 | 323 | 322 | 322 | 278 | 232 | 248 | 247 | 177 | 177 |

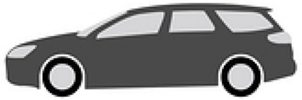



# Potential implications of a work in process…

- Santiago's public transport fleet (RED) should introduce NPTI-PN late 2024-early 2025 (7700 buses, mainly EURO VI and electric)



- All EURO VI diesel vehicles should follow NPTI-PN in Chile: the normative process will begin in April 2024, with complete implementation anticipated by late 2025 or early 2026.
- Chile: 6 MM veh, 135 TI centers (PRT)



- Colombia? Other LAC countries?

# 2. Non-exhaust particles: Chile and Colombia

- The estimation of non-exhaust emissions for Chile and Colombia has been studied, in relation to the increasing use of electric vehicles, whose emissions from tires and brakes continue to increase.
- The period of analysis covers from 1990 until 2050 in both countries, at a national scale.

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# Worlwide Emission Factors

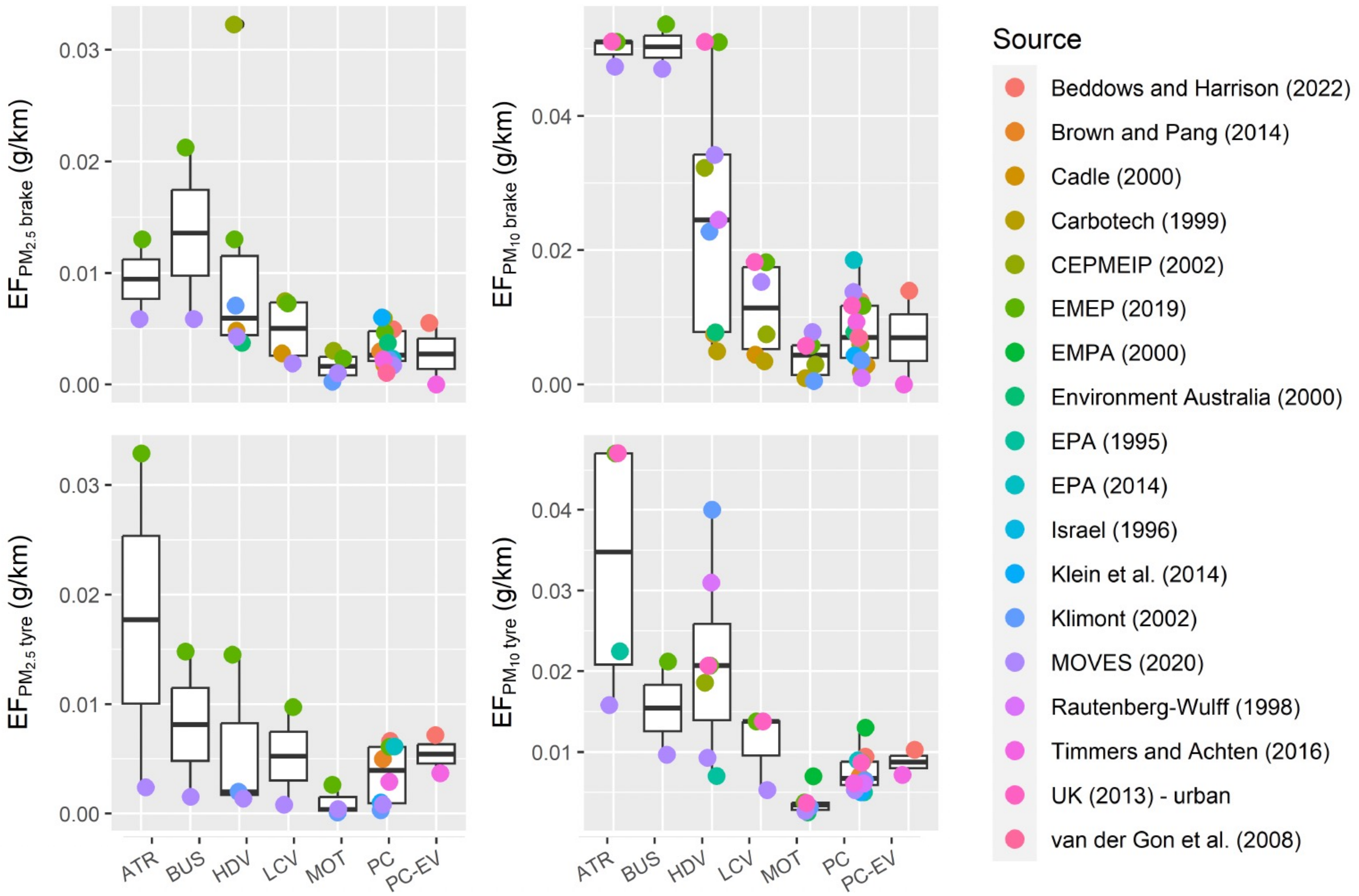


*Figure 4 shows the 1990-2020 time series for countrywide PM2.5 non-exhaust emissions in Colombia. Emission reduction in the late 1990s and early 2000s are explained by reductions in activity and fuel consumption, which were associated with the well-known economic crisis of that period. A reduction by approximately 11% in PM2.5, associated with COVID-19 lockdowns in 2020, is also shown. The variability in total emissions is driven mainly by variability in brake wear emissions, followed by tyre emissions.*

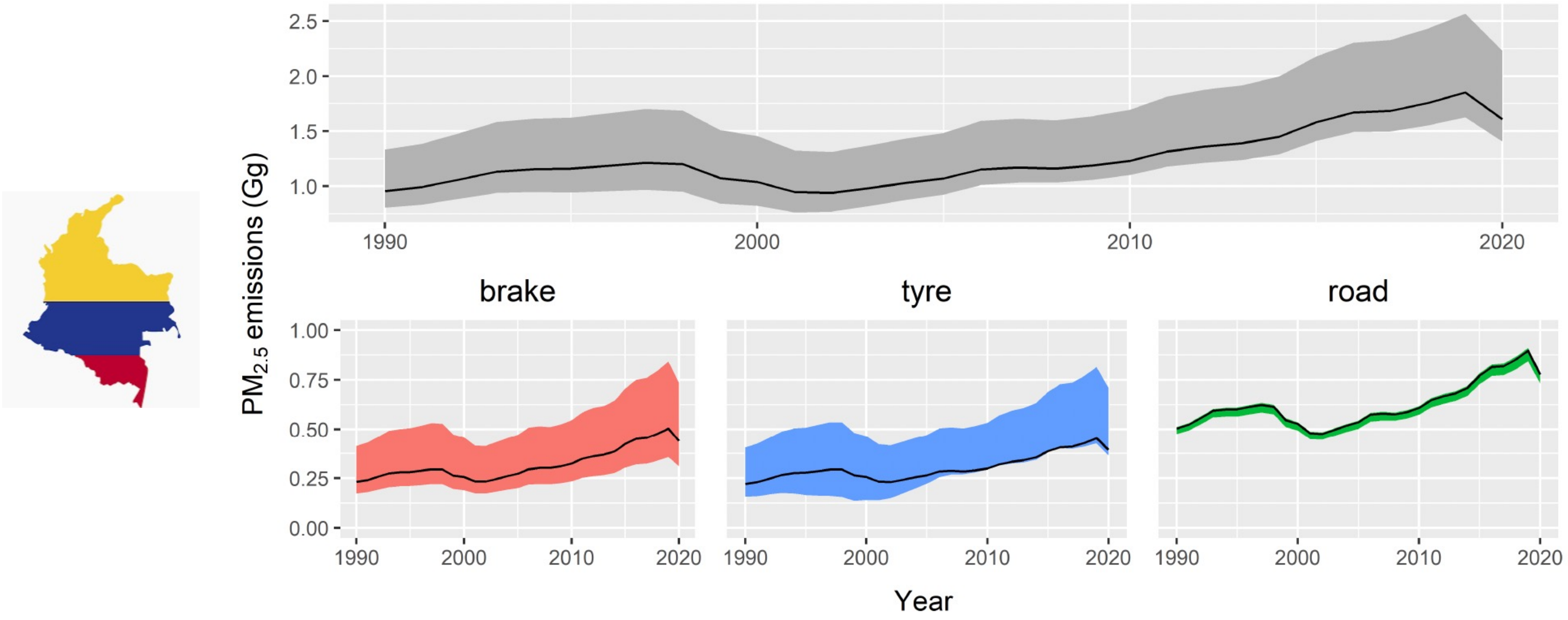



**Figure 4. Road transport non-exhaust $PM_{2.5}$ emissions using the median (black line) and the interquartile range of available emission factors between 1990 and 2020.**

*Time series of the contribution of different sources, i.e. brake, tyre, and road wear, to non-exhaust emissions estimated with median emission factors for all vehicle categories. Road, brake, and tyre wear contributed to 38%, 34% and 27% of non-exhaust PM10 emissions, respectively. Road wear contribution increased to 50% for PM2.5 emissions, while brake wear emissions contributed to 26%, and tyre wear emissions, to 24%. The PM2.5/PM10 ratio was 0.41 on average.*

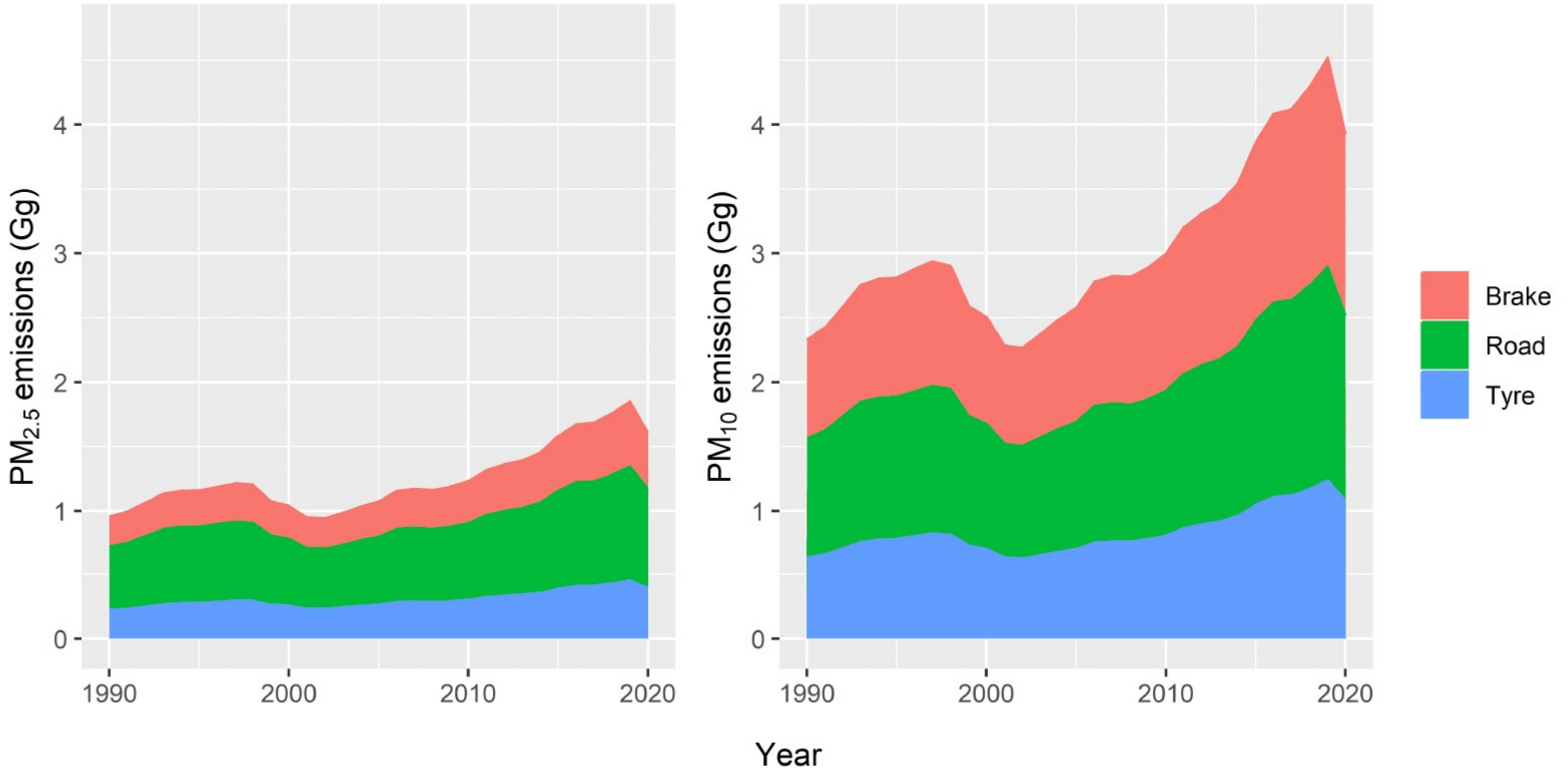



**Figure 5. Road transport non-exhaust $PM_{2.5}$ and $PM_{10}$ emissions contribution by brake, road, and tyre wear between 1990 and 2020.**

Non-exhaust PM2.5 emissions estimated for Colombia are still much lower than their corresponding exhaust emissions. However, the percentage has increased sharply, from 11.5% to 21.4% in the last decade.

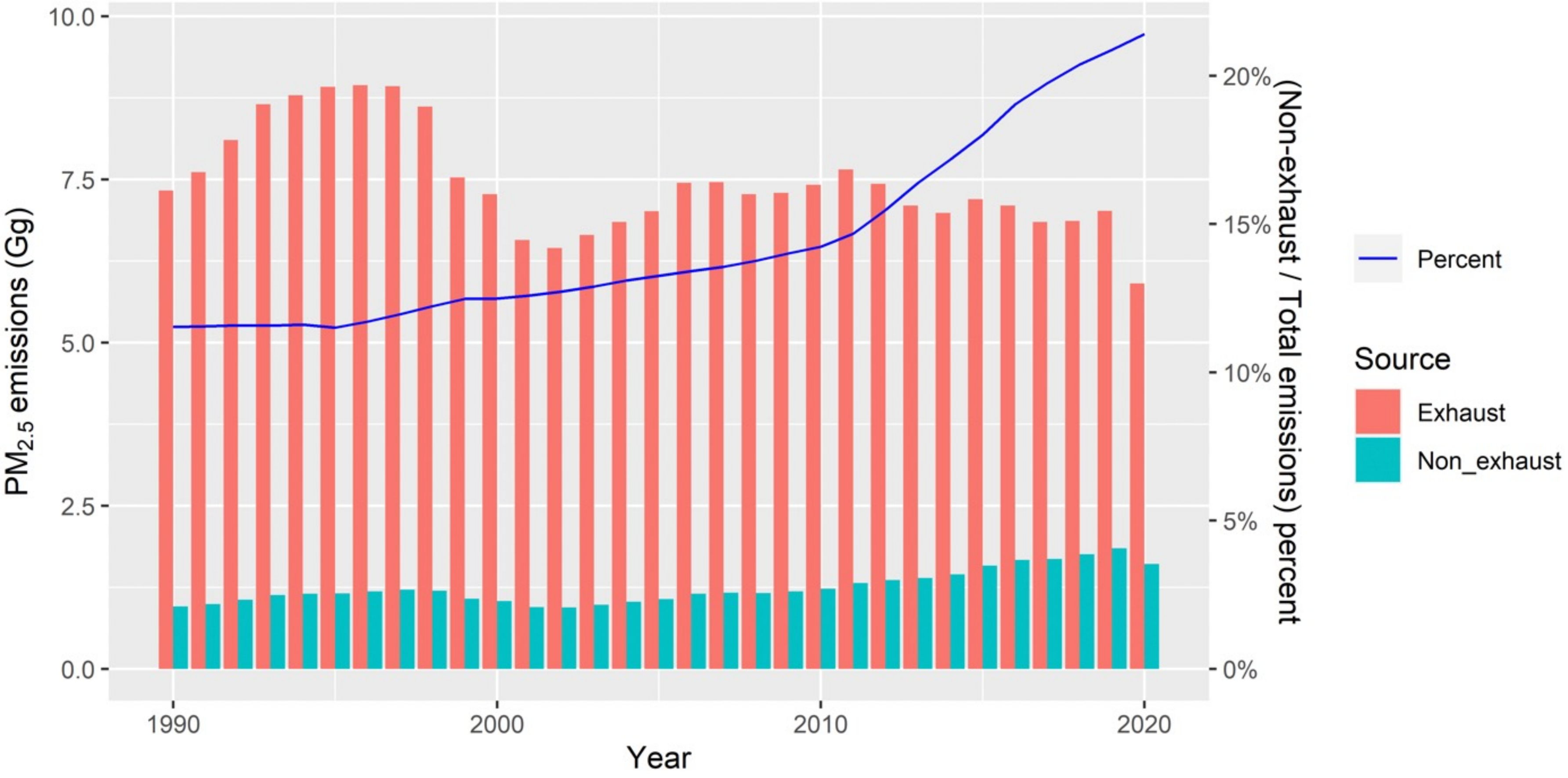
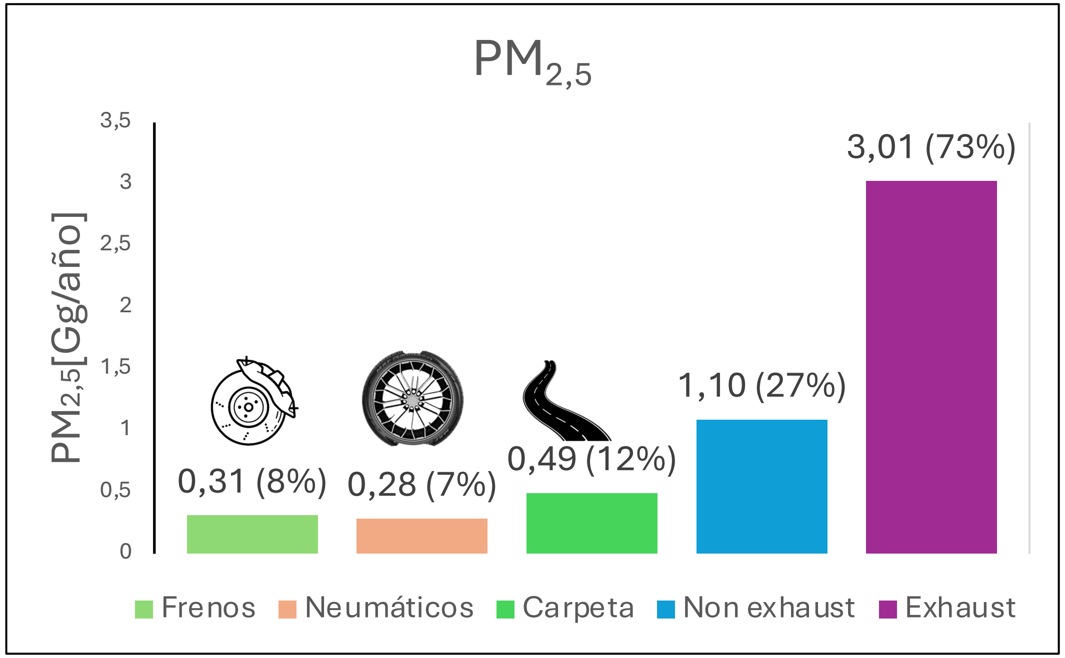
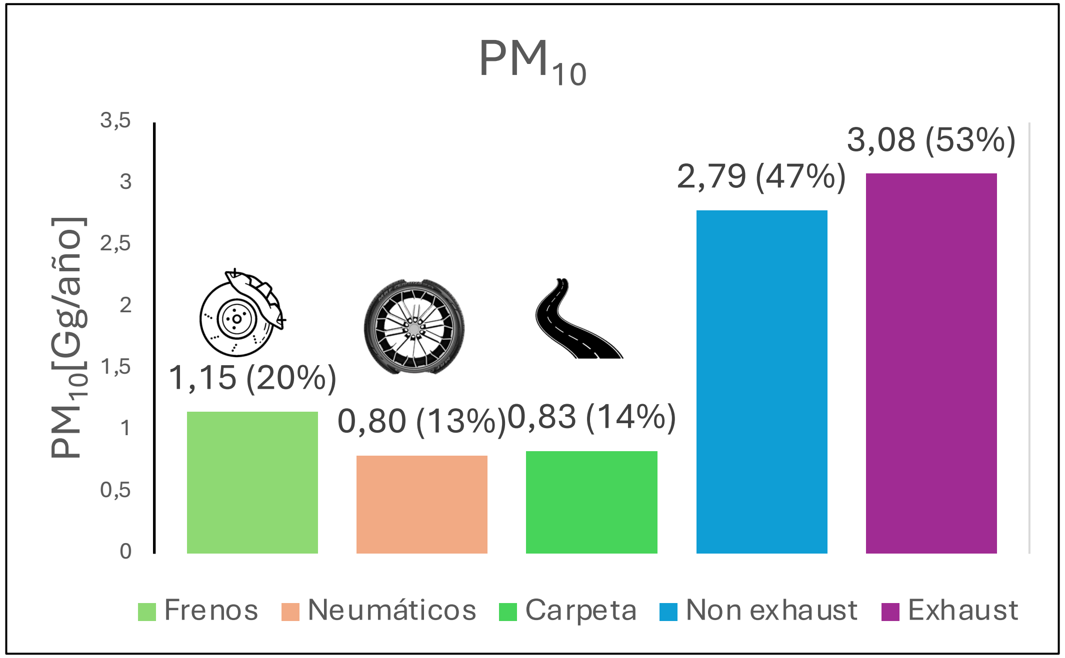



**Figure 6. Comparison of non-exhaust and exhaust $PM_{2.5}$ emissions between 1990 and 2020. The blue line represents the percentage of total emissions from non-exhaust sources.**

# Non Exhaust vs Exhaust

## Resultados: Comparación con emisiones de tubo de escape.



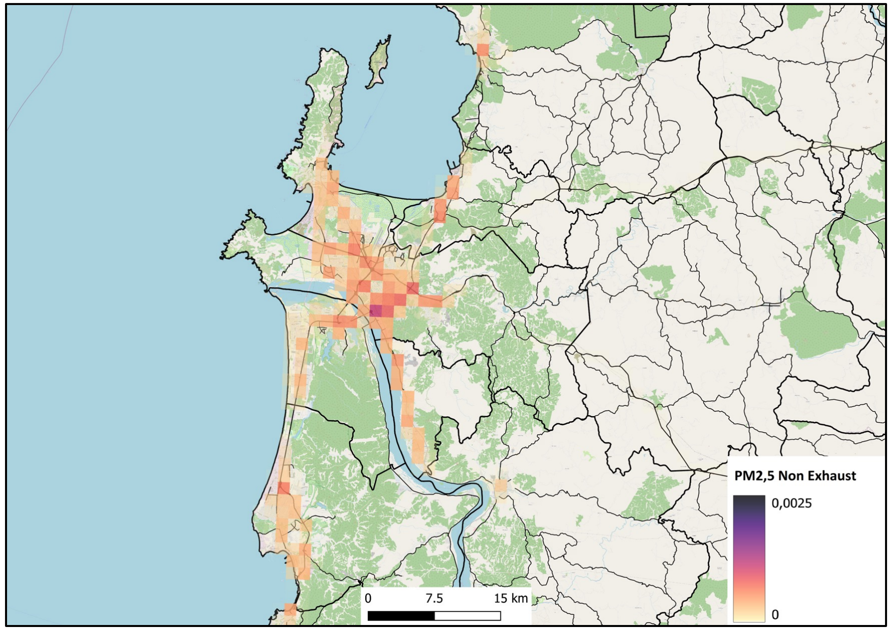



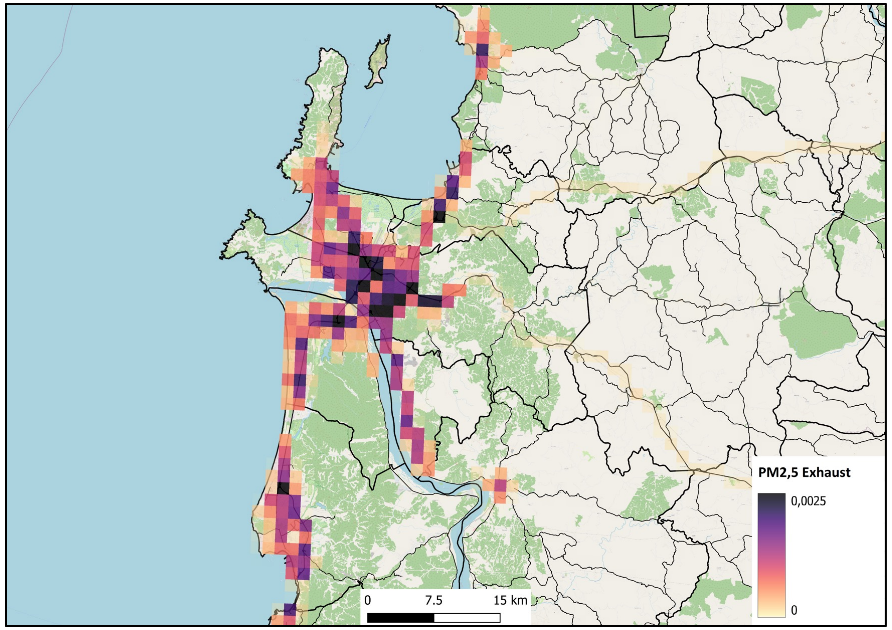

$PM_{2,5}$: EE son 2,8 veces las NEE.

$PM_{10}$: EE son 1,1 veces las NEE.

# Non Exhaust vs Exhaust

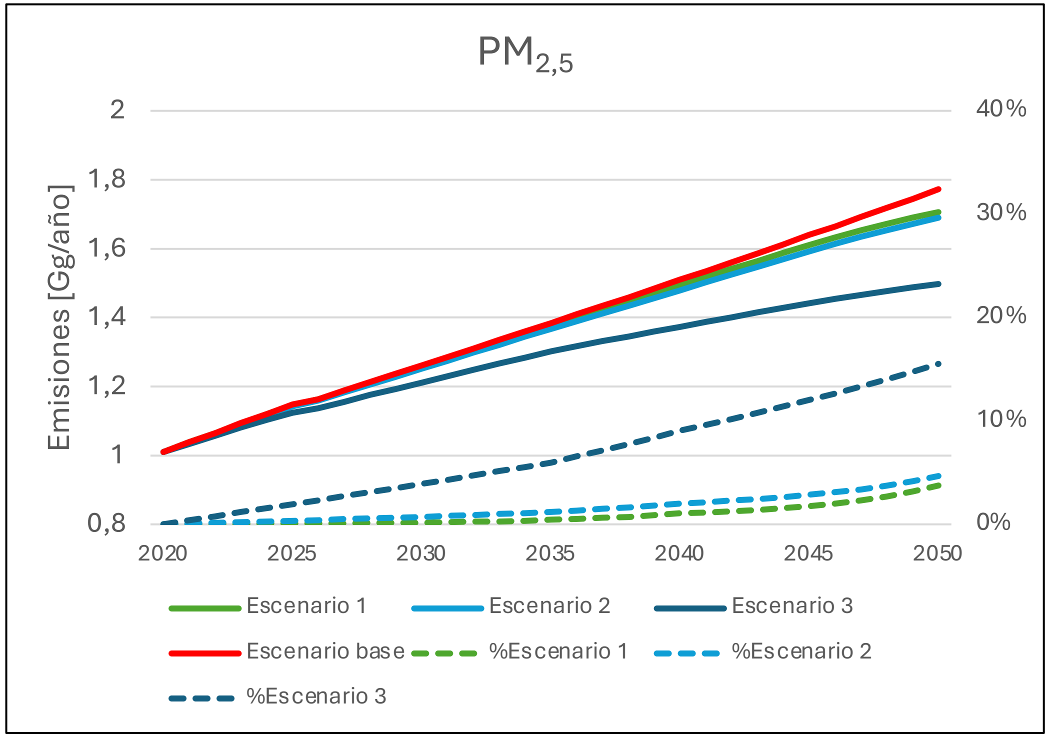
## Resultados: Desagregación espacial.

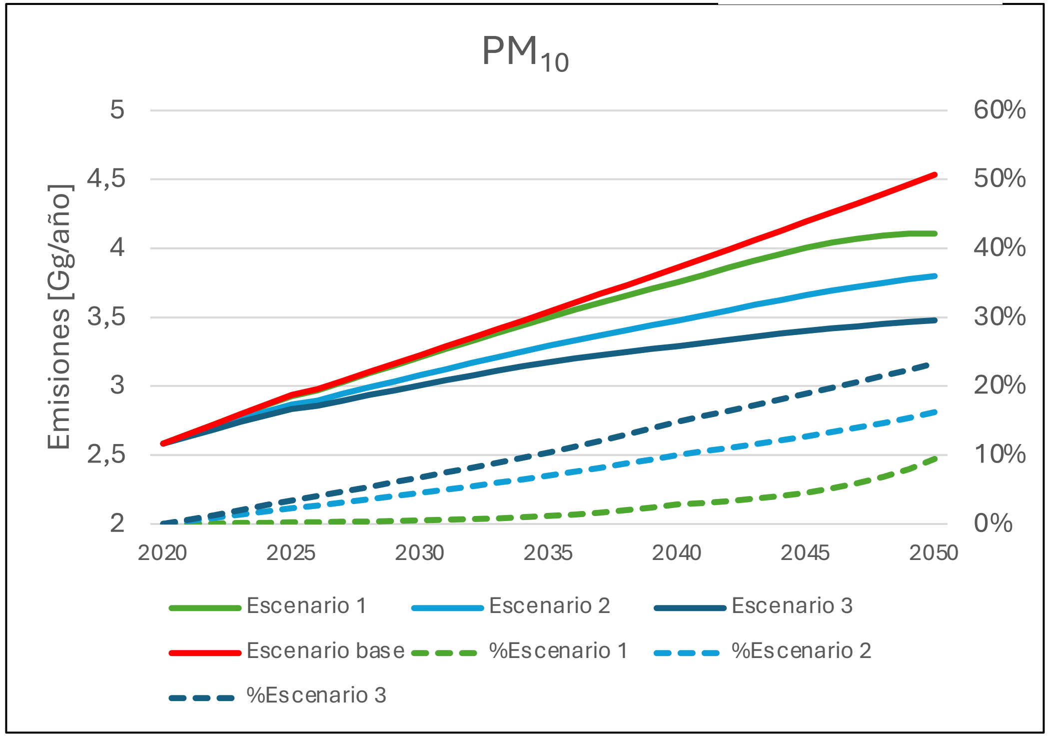


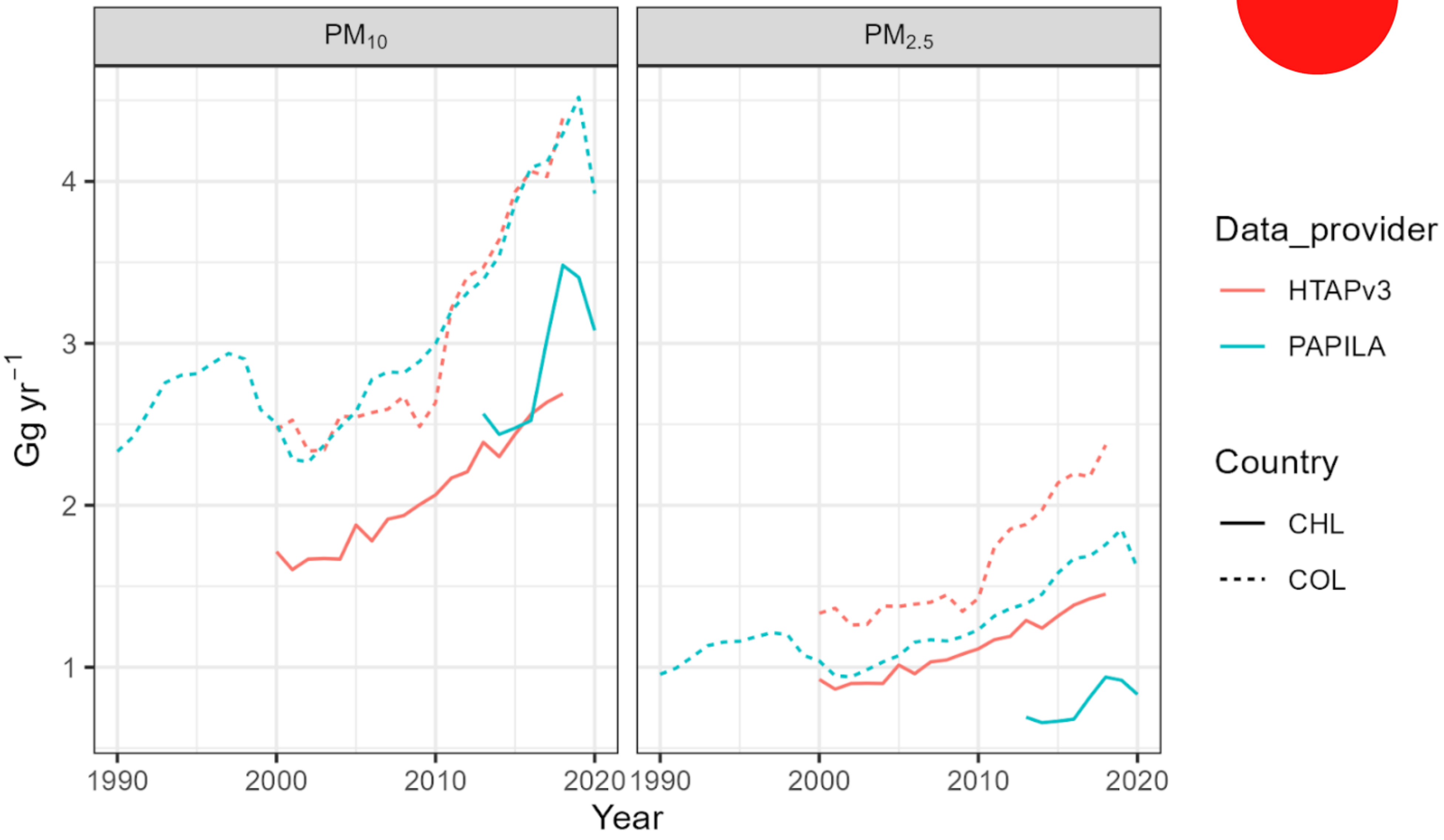
# Proyección de emisiones al 2050

## Resultados: Emisiones 2020-2050.



# Comparison with international database HTAP




# Preliminary findings

- Non-exhaust emissions of particulate matter are related with brake, tyre, and road wear, as well as particle resuspension from the soil.
- Non-exhaust emission factors are usually expressed in g/km or mg/km and depend mostly on the vehicle size and the driving style, but they are less dependent on the vehicle technology than exhaust emission factors.
- Emission inventories in European countries have shown that non-exhaust emissions from road transport are as large or larger than emissions from combustion. However, they have also shown that emission factors are highly variable.
- Therefore, we gathered data from several databases and publications to obtain information about such variability and make an informed decision about the emission factors to be used in our estimates.

# Thank you, mauricio.osses@usm.cl