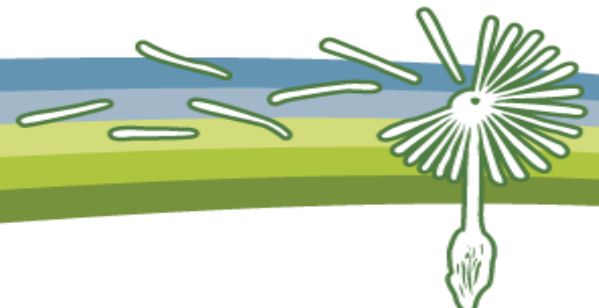


Spatial distribution of non-exhaust particulate matter emissions from road traffic for the city of Bogotá – Colombia

D. Beltrán, **L.C. Belalcázar***, N. Rojas



Outline

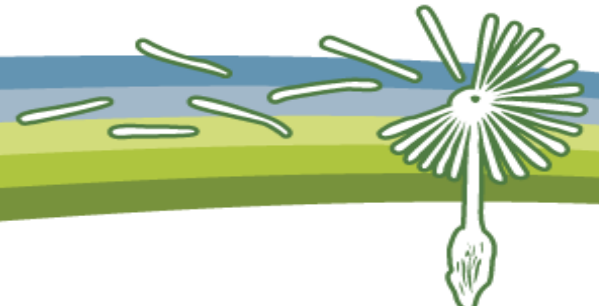
- Background
- Non-exhaust emissions estimation
- Results
- Conclusions



BACKGROUND

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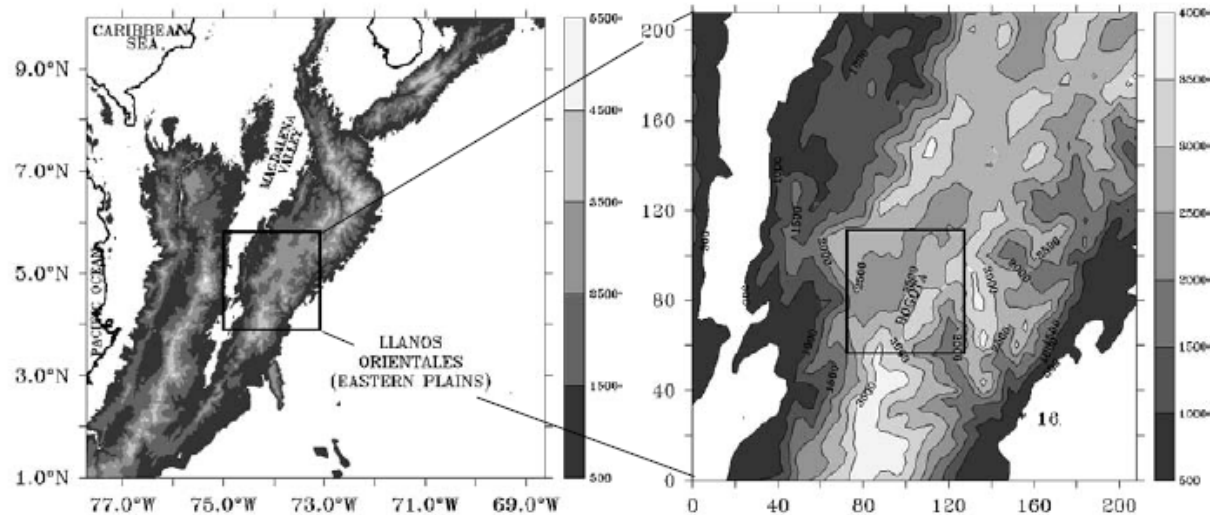
Calidad del Aire



Bogotá



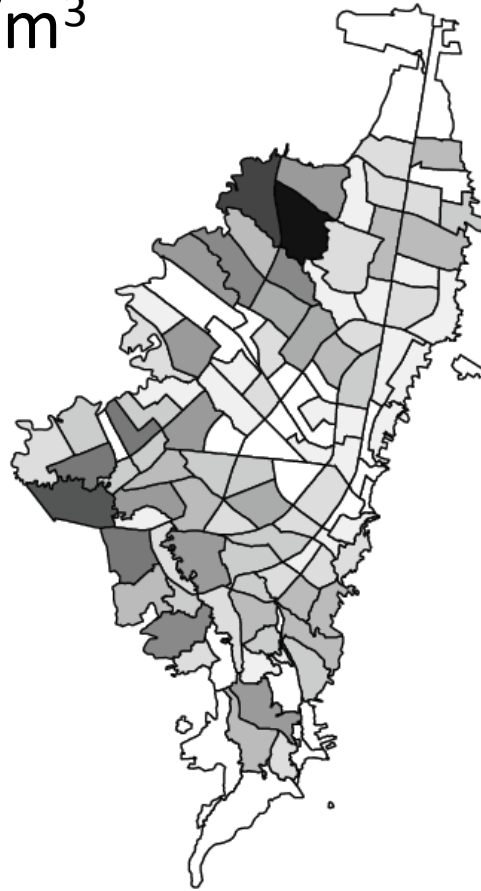
- 2,600m plateau on the Andes
- Avg. T: 14 C (8.9 C - 19.9 C)
- Population: ~ 7.8 million
- 1.4 million vehicles
- 4,000 industries



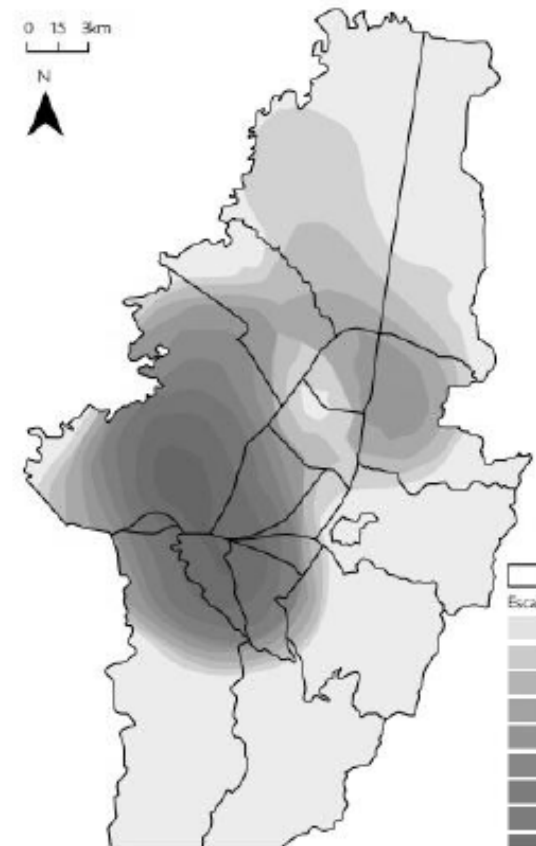
Air quality - PM₁₀

Mean PM₁₀: 60 µg/m³

PM₁₀ in the West: 90 µg/m³
(high population density,
mixed with industry)



Population



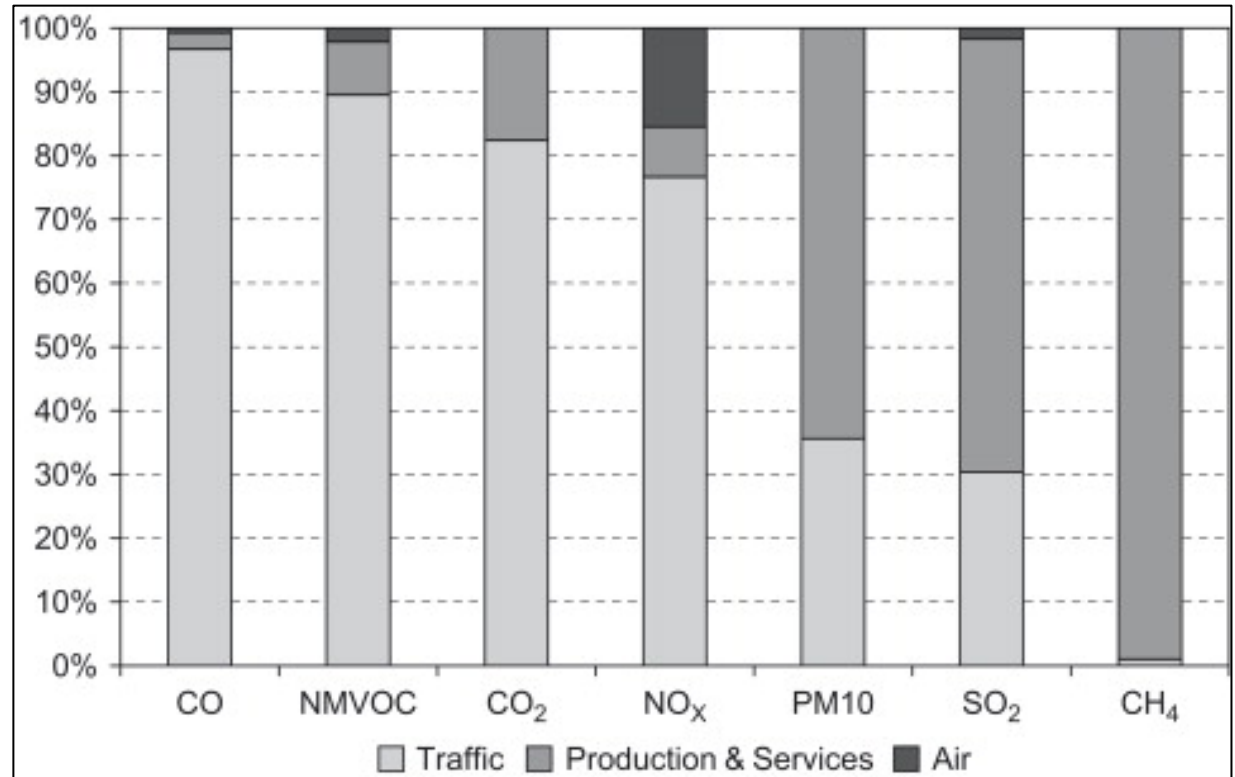
PM₁₀ AQS
exceedance

Emission inventories (Zárate, 2007)

Traditional system



BRT system



Distribution of the emissions by source and pollutant in Bogotá's urban perimeter

Source contribution to PM₁₀ estimated from receptor modeling studies (Adapted from Rivera, 2009; Vargas, 2009; Sarmiento, 2008).

	Receptor area type					
	Residential		Industrial			Mobile source influence
Source	Rivera, 2009	Vargas, 2009	Rivera, 2009	Vargas, 2009	Sarmiento, 2008	Rivera, 2009
Re-suspended dust	60%	9%	42%	21%	47%	52%
Mobile sources	3%	60%	0,70%	35%	31%	29%
Industrial sources	17%		23%		22%	9%
- Non-ferrous foundries				10%		
Nitrate-rich source				21%		
Sulfate-rich source				13%		
Secondary aerosol		13%				
Ion-rich source		18%				
Non-identified source	20%		34%			10%

Rationale

- Dust resuspension **not accounted for** in the city's emission inventories (so far).
- **High contribution** of dust resuspension to PM_{10} and $PM_{2.5}$ from receptor modeling studies.
- **We need to estimate and disaggregate PM_{10} and $PM_{2.5}$ emissions from dust resuspension, tire, break and road wear.**

NON-EXHAUST EMISSION ESTIMATION

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Estimation of the non-exhaust particulate matter emissions

$$E = EF * A$$

EF = emission factors (US-EPA. AP-42, Fifth Edition. Volume I, Chapter 13: Miscellaneous Sources)

A = activity data

Estimation of the non-exhaust particulate matter emissions

- Emission factors: paved roads:

$$EF_{pr} = k * (sL)^{0.91} * (W)^{1.02} * \left(1 - \frac{P}{4 * N}\right)$$

- Emission factors: unpaved roads:

$$EF_{ur,industrial} = k * \left(\frac{s}{12}\right)^a * \left(\frac{W}{3}\right)^b * \left(\frac{365 - P}{365}\right)$$

$$EF_{ur,public\ roads} = \left[\frac{k * \left(\frac{s}{12}\right)^a * \left(\frac{S}{3}\right)^d}{\left(\frac{M}{0.5}\right)^c} - C \right] \left(\frac{365 - P}{365}\right)$$

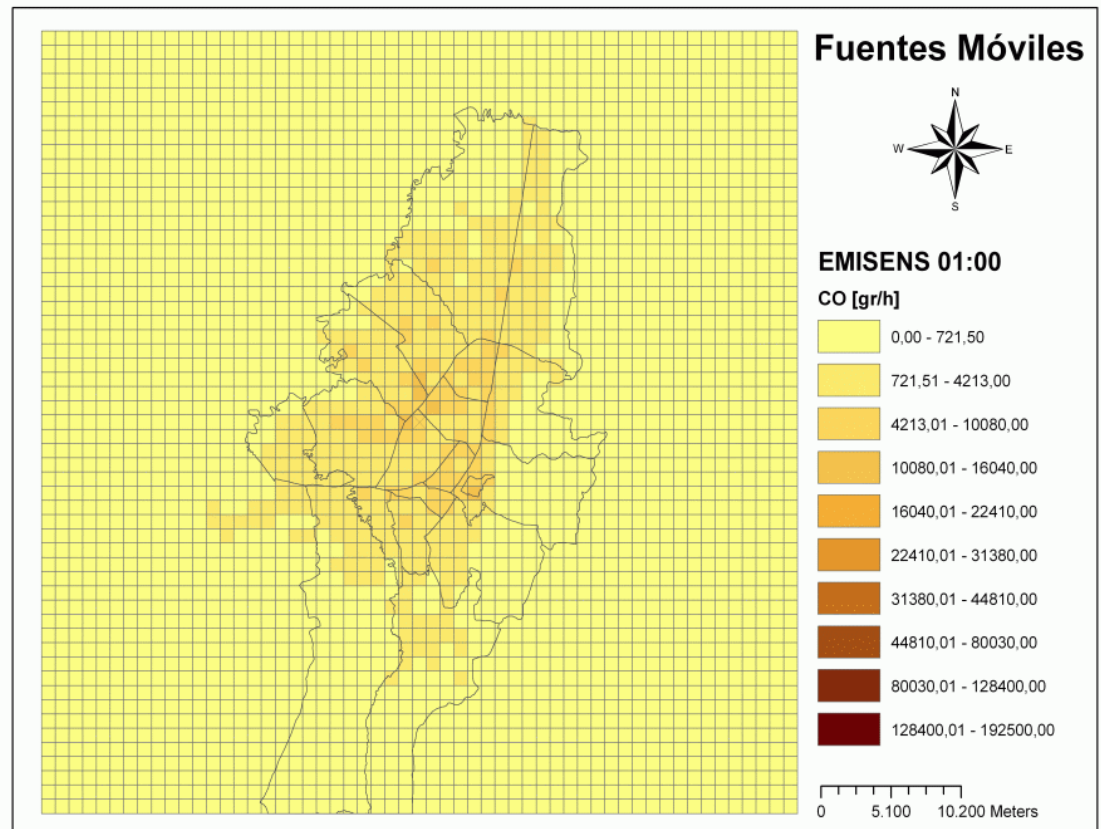
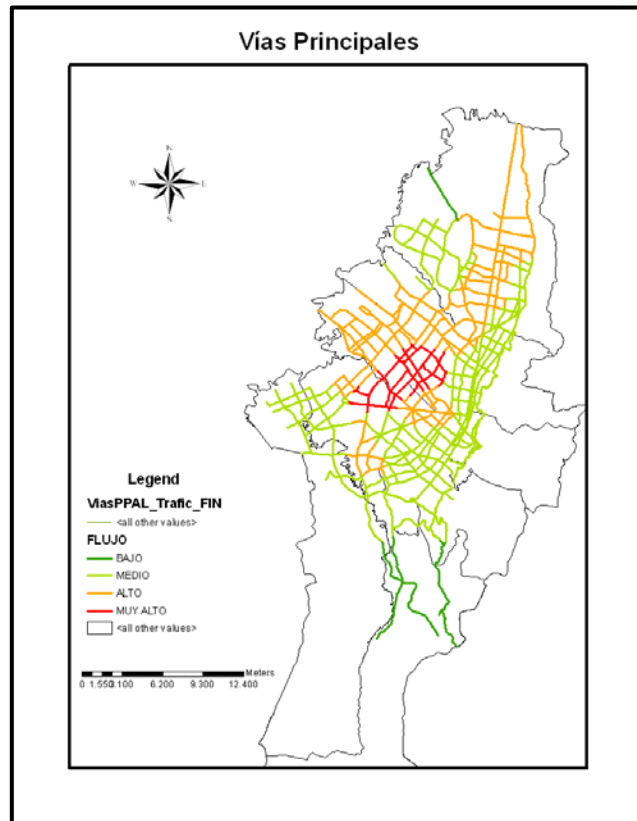
sL and s, not available in the city; from literature:

Road surface silt loading (**sL**): 0.03 to 0.2 g/m²,

Surface material silt content **s**: 4 – 6%

Activity data and spatial disaggregation of emissions

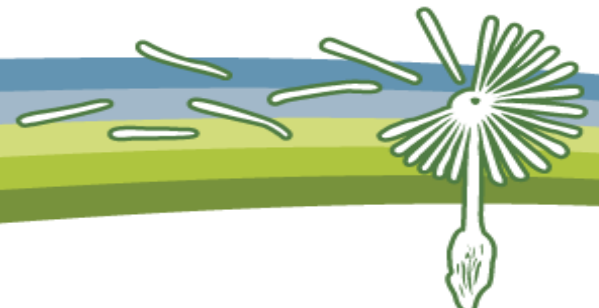
Activity data from a previous study (Peñaloza & Rojas, 2012)



RESULTS

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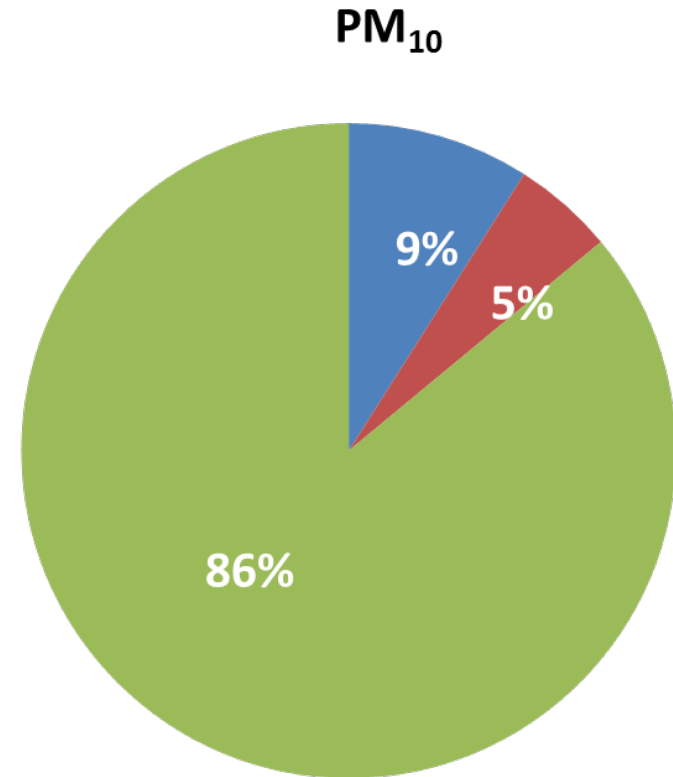
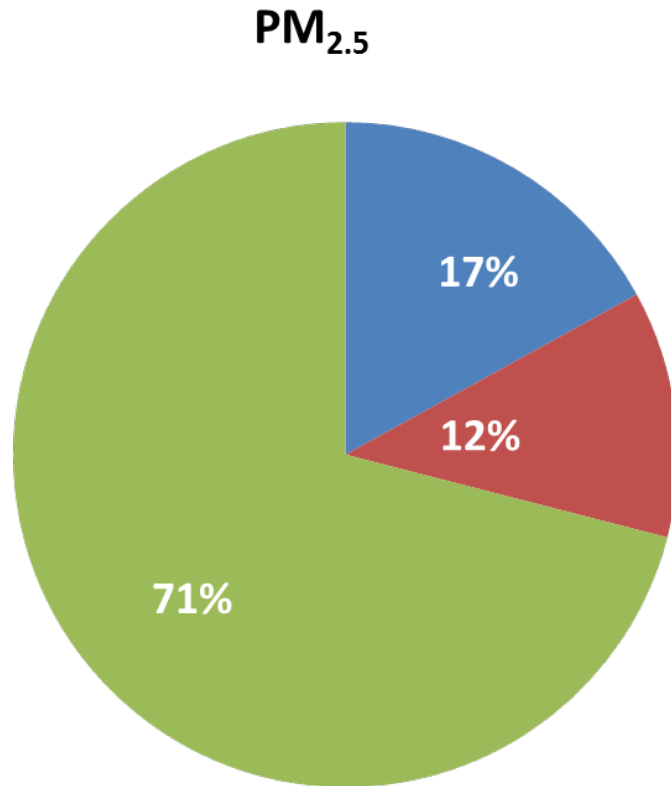
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Estimated PM_{2.5} and PM₁₀ emissions

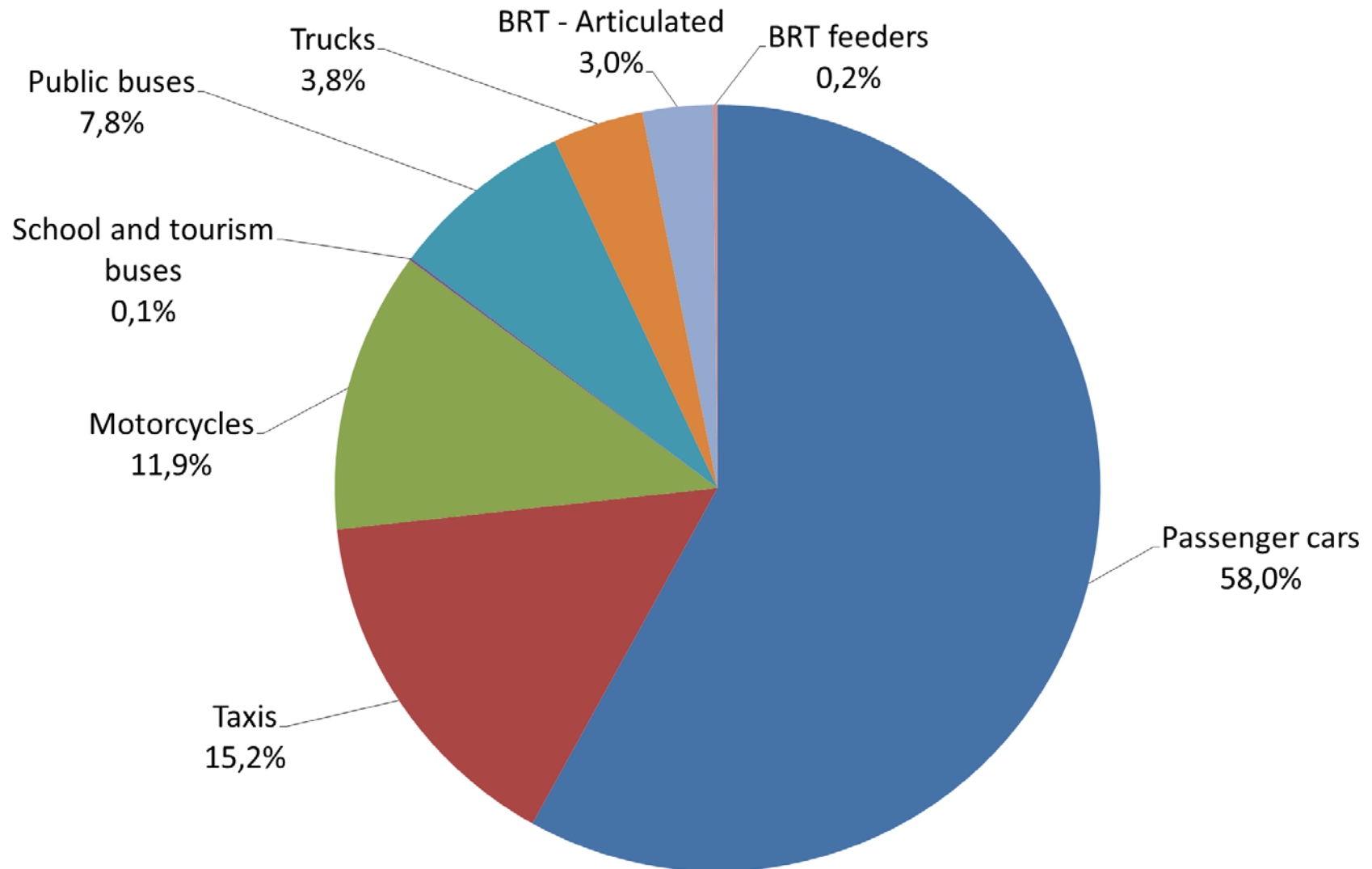
		PM _{2.5} (Ton/yr)	PM ₁₀ (Ton/yr)
Paved Road	Re-suspension	1,160 ± 750	4,830 ± 1,700
	Wear surface	320 ± 50	570 ± 150
Unpaved Road	Re-suspension (industrial)	1,140 ± 250	11,600 ± 1,600
	Re-suspension (public road)	240 ± 150	6,300 ± 1,700
TOTAL		2,860 ± 1,200	23,300 ± 5,000

Non-exhaust emissions by mechanism of production

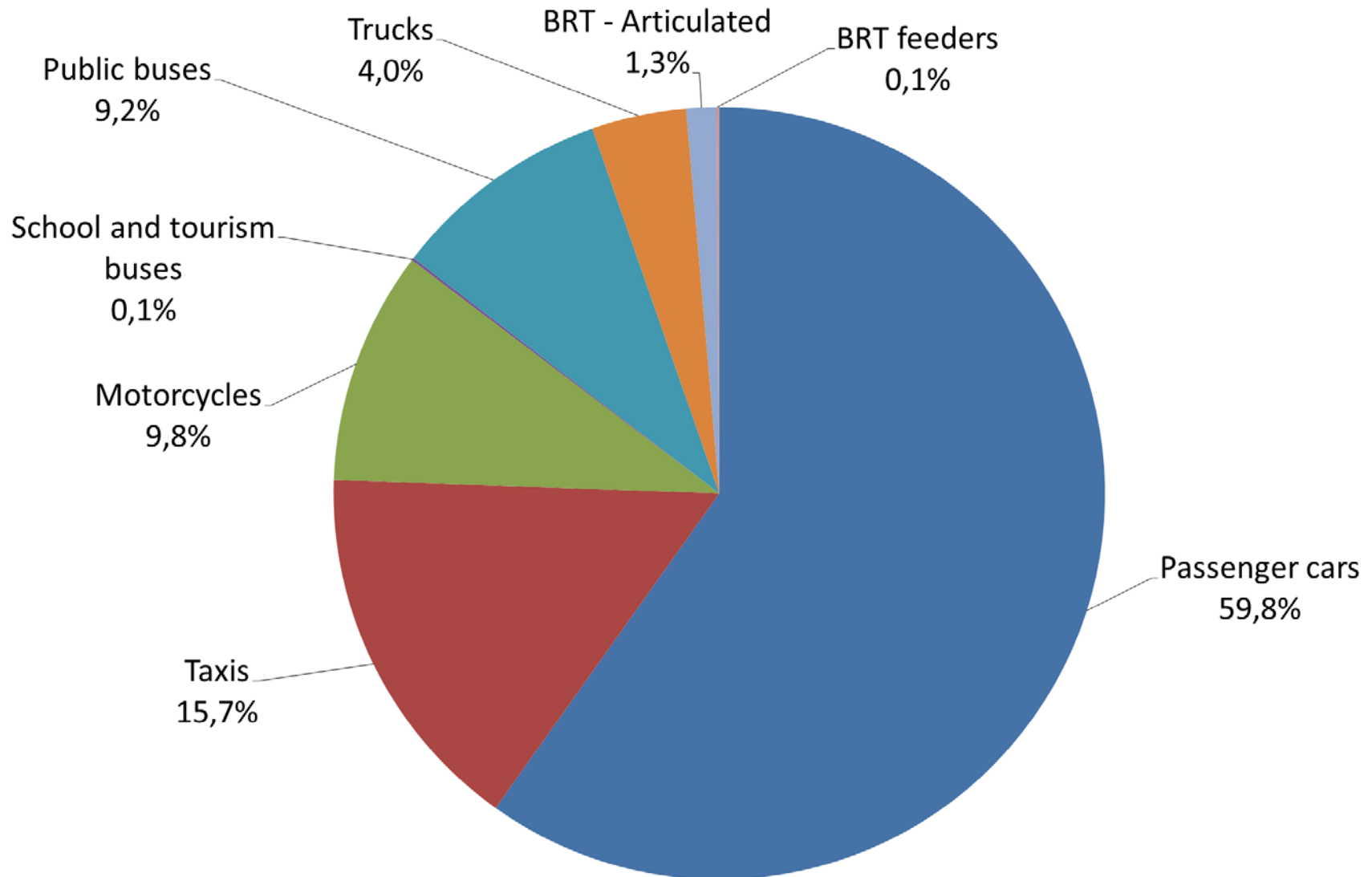


- Particulate matter by tire and brake wear
- Particulate matter by surface road wear
- Particulate matter as resuspended road dust

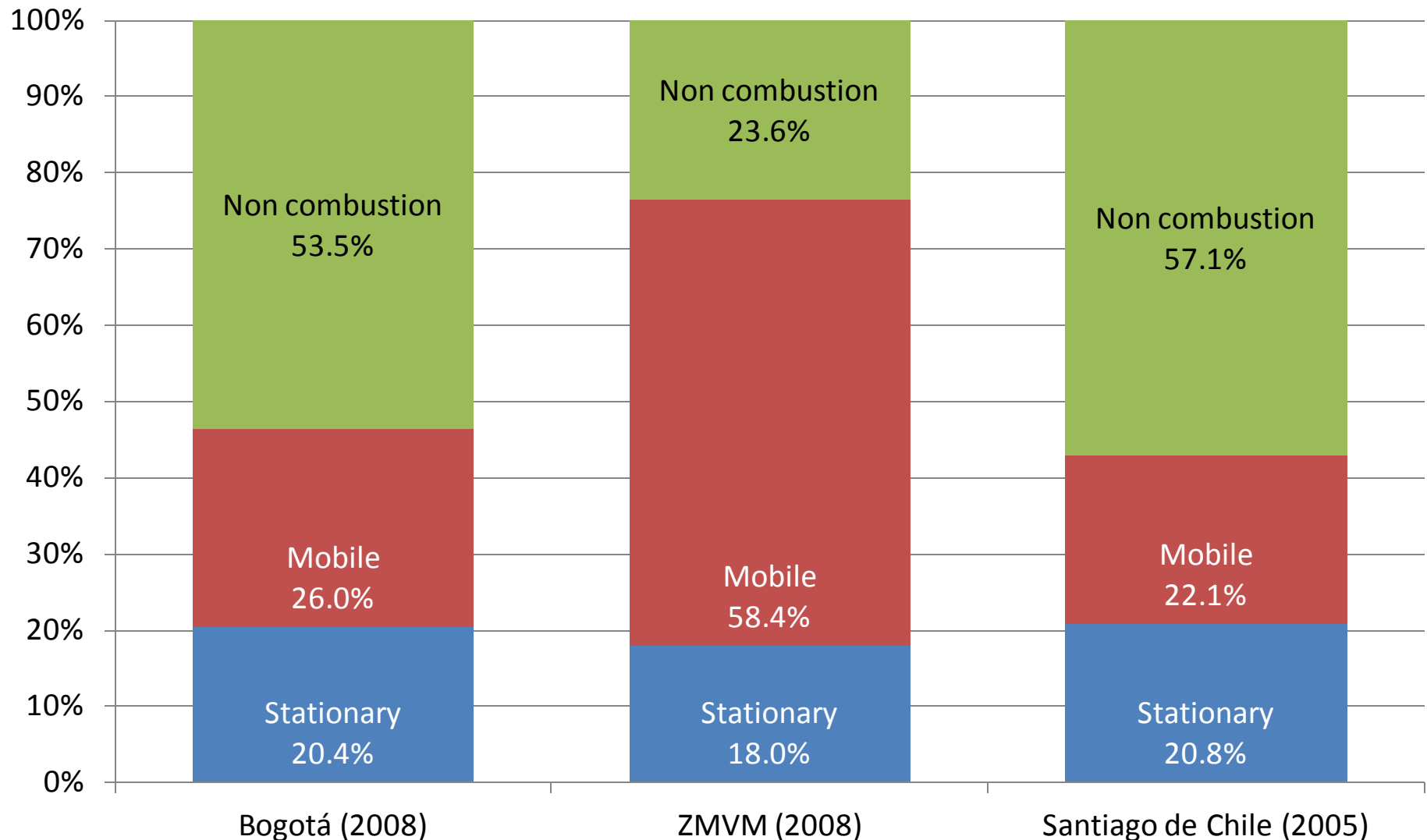
Non-exhaust PM₁₀ emissions by vehicle category



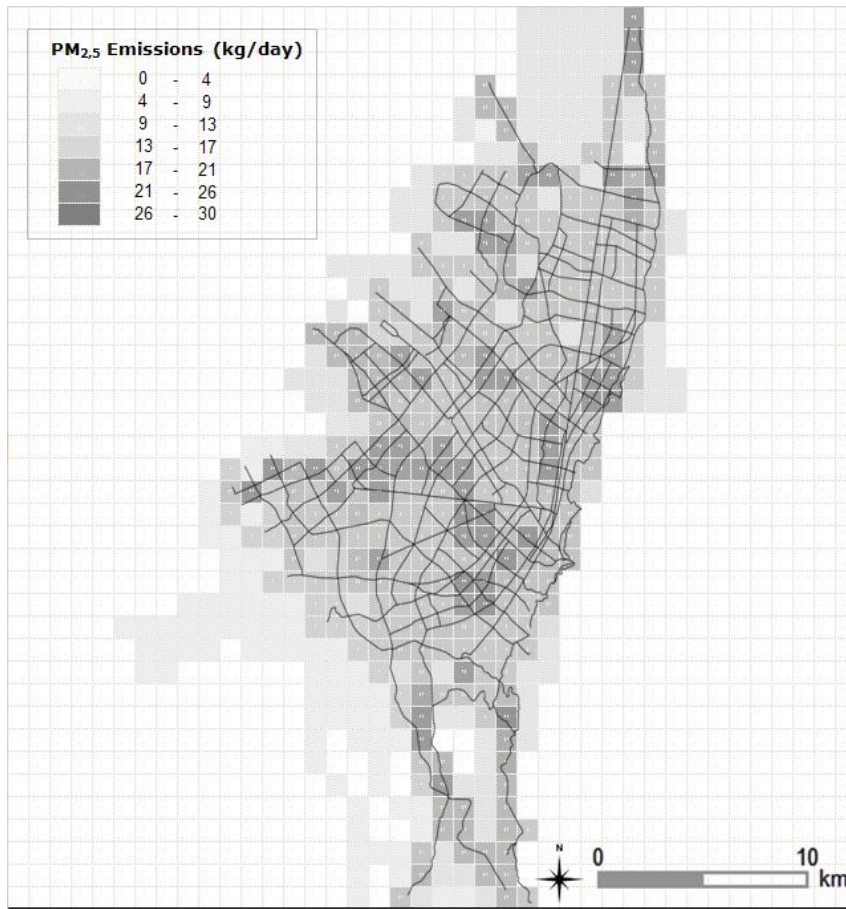
Non-exhaust PM_{2.5} emissions by vehicle category



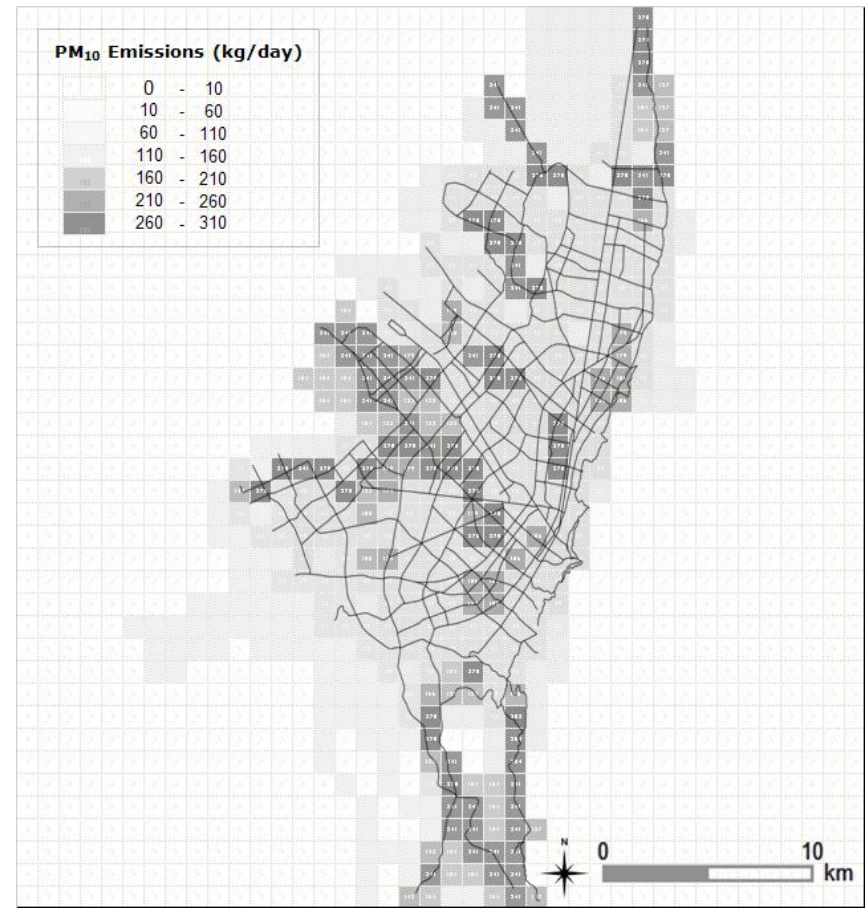
Source contribution to PM₁₀ in Bogotá, México (ZMVM) and Santiago de Chile



Spatial disaggregation of non-exhaust PM emissions



PM_{2.5}



PM₁₀

CONCLUSIONS

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Conclusions (1)

- Particulate matter non-exhaust road emissions (dust re-suspension, road surface wear, tire and break ware) **are very significant** when compared with combustion emissions.
- Light **passenger vehicles and taxi cabs** are the main contributors to these emissions, owing to their high number and intense activity, respectively.

Conclusions (2)

- The highest **PM₁₀ emissions** (not PM_{2.5}) occur in the area with the highest PM₁₀ concentrations.
- Local non-exhaust emission factors would need to be **experimentally validated**.
- Local pollution abatement plans need to include measures to reduce these emissions: **improve road maintenance, re-pave damaged roads**, etc.





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Thank you!

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