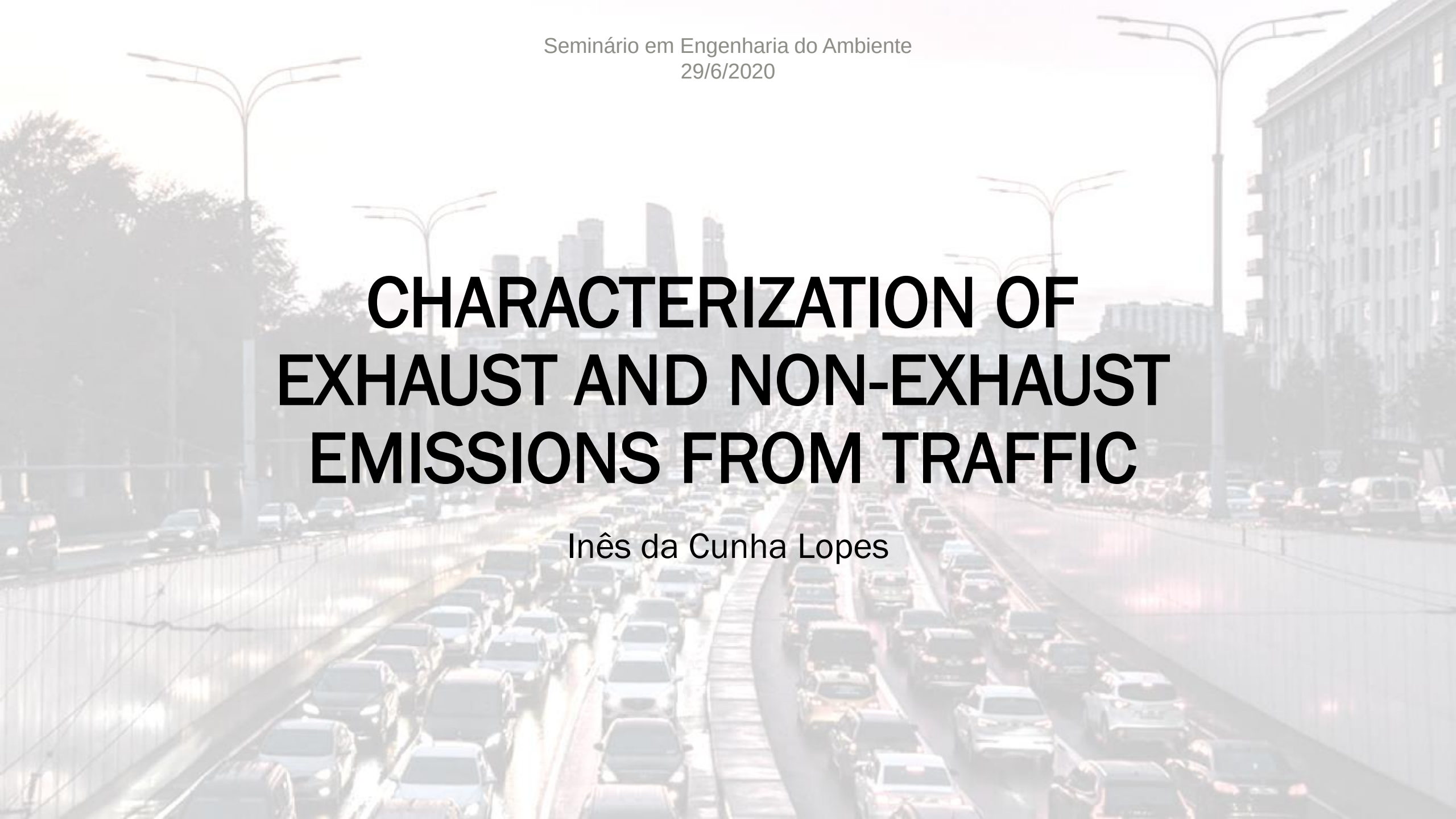
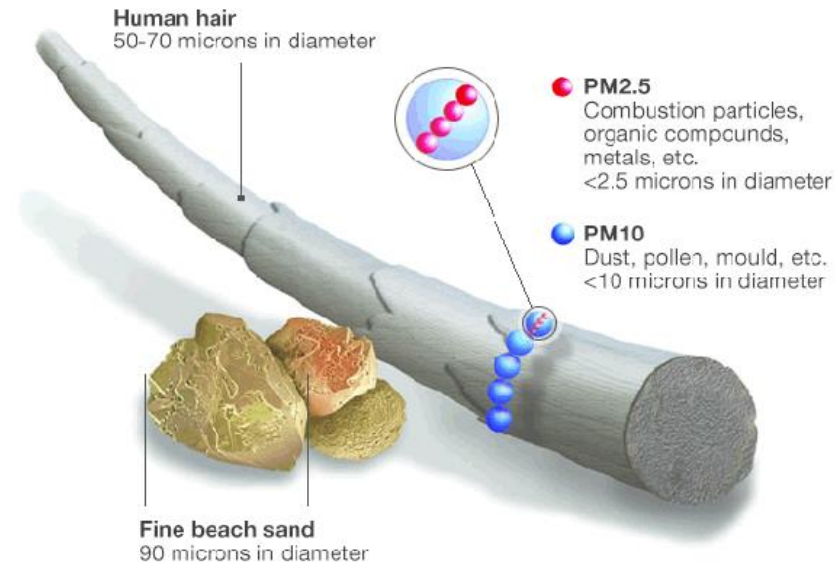


CHARACTERIZATION OF EXHAUST AND NON-EXHAUST EMISSIONS FROM TRAFFIC

Inês da Cunha Lopes

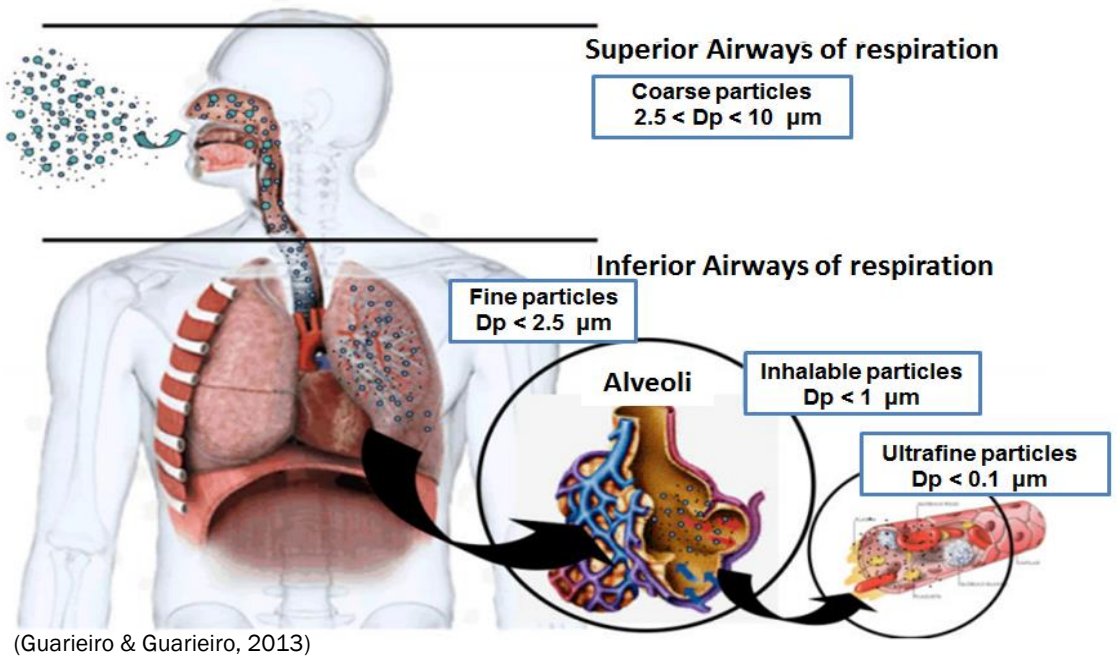
Introduction

Particulate matter (PM)



Source: US EPA

Effect

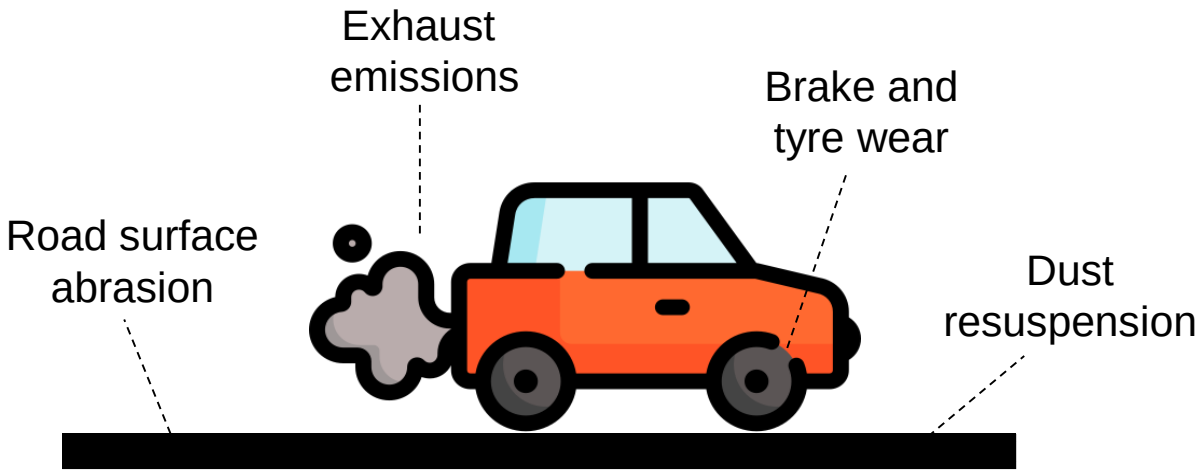


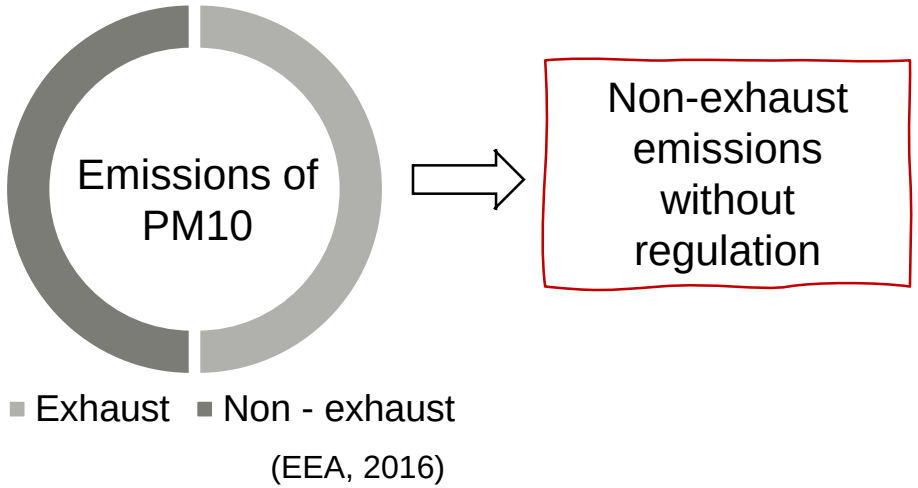
(Guarieiro & Guarieiro, 2013)

In 2016, it was estimated that about 412 thousand people died prematurely due to long-term PM exposure in Europe (EEA, 2019).

- Almost 75% of the European Union´s population lives in **urban areas** (Eurostat, 2016)
- **Vehicle emissions** are one of the main source of air pollutants (Pant & Harrison, 2013)

➢ **Road transport emissions**:





(EEA, 2016)

Methods for direct road traffic emissions analyses:

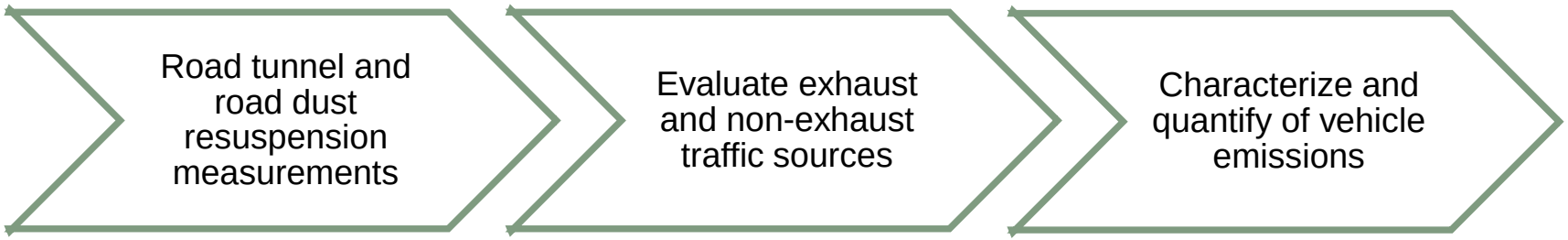
Under controlled laboratory conditions

- Controlled and different test cycles and driving conditions
- Low representativeness for the vehicle fleet
- Analyze exhaust emissions
- E.g.: Chassis dynamometer method

Under realistic driving conditions

- Describe real world emission behavior of on-road vehicles
- High representativeness for the vehicle fleet
- Analyze exhaust and non-exhaust emissions
- E.g.: Road tunnel measurements

Objective of this study:



This real-world particle emissions study will contribute to:

- Define road traffic emission profiles in urban areas
- Provide data to update the European emission inventories
- Evaluate the impact of the traffic generated PM on human health and the environment
- Assess the overall effectiveness of emission control technologies.

Methodology

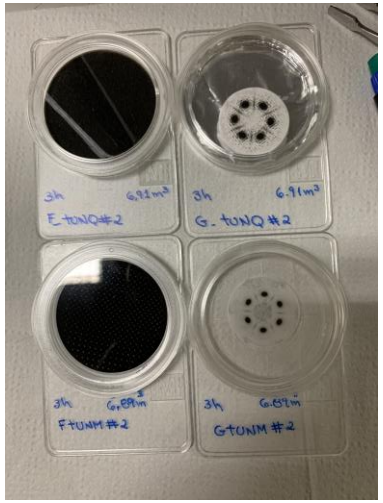
Road tunnel measurements:

- Sampling campaign in the João XXI tunnel and in the background (Lisbon, PT)
- One week of measurements
- Traffic volume by vehicle type through the tunnel was manually counted

Pollutant	Equipment		Type of measure
	Tunnel	Background	
PM2.5 and PM10	PM samplers MVS6 Leckel		Gravimetry
Black Carbon (BC)	Aethalometer AE33	MicroAethAE51	Continuous measurements
NOx	NOx Analyzer		

MVS6 Leckel

Measuring period	
Tunnel	Background
8h – 10h 10h30 – 12h30 14h30 – 16h30 17h00 -19h00	8h – 20h



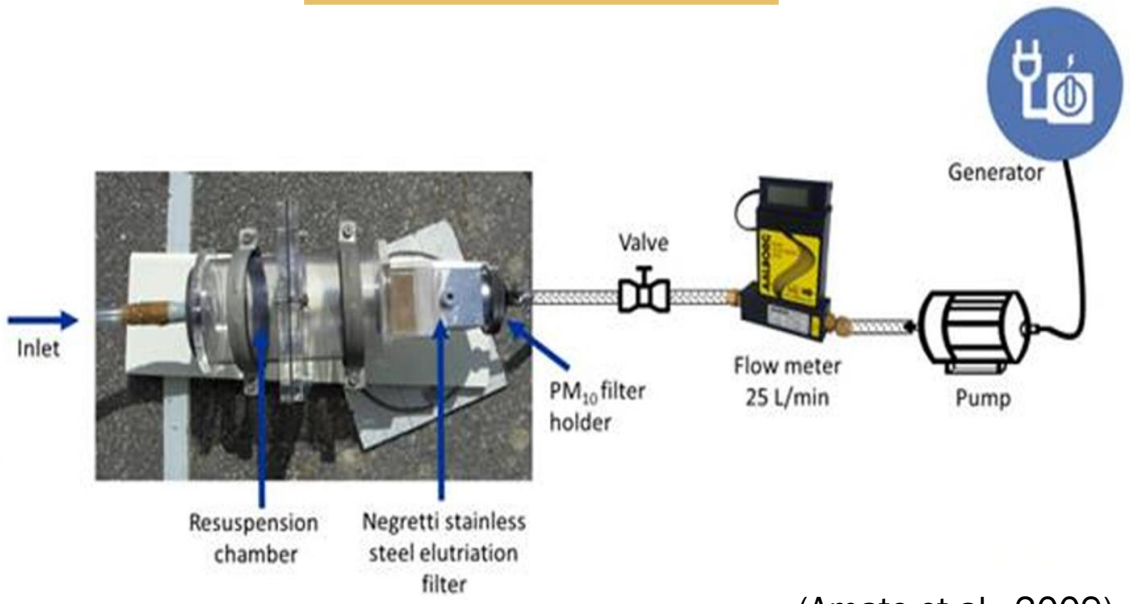
Filters after sampling

Location of the instruments inside the João XXI tunnel

Road dust ressuspension:

- 5 sampling sites in Lisbon with diferente types of paviments
- Measurements are on-going
- In each road: Area = 3 x 1m^2 , Δt = 30 min

Dust sampling device



(Amato et al. 2009)

Data analysis:

- PM mass concentrations → Gravimetry
- Elements, OC/EC → Chemical analysis of the filters (future work)
- **Emission Factors (EF):**

$$\mathbf{EF_x}(\mathrm{mg\ km^{-1}\ veh^{-1}}) = \frac{\Delta\mathrm{Concentration_x} \times \mathrm{D}}{\mathrm{Ntotal}}$$

$$\mathrm{D\ (dilution\ rate)} = \frac{\mathrm{NLDV} \times \mathrm{EF\ NO_xLDV} + \mathrm{NHDV} \times \mathrm{EF\ NO_xHDV} + \mathrm{NMCV} \times \mathrm{EF\ NO_xMCV}}{\Delta\mathrm{NO_x}}$$

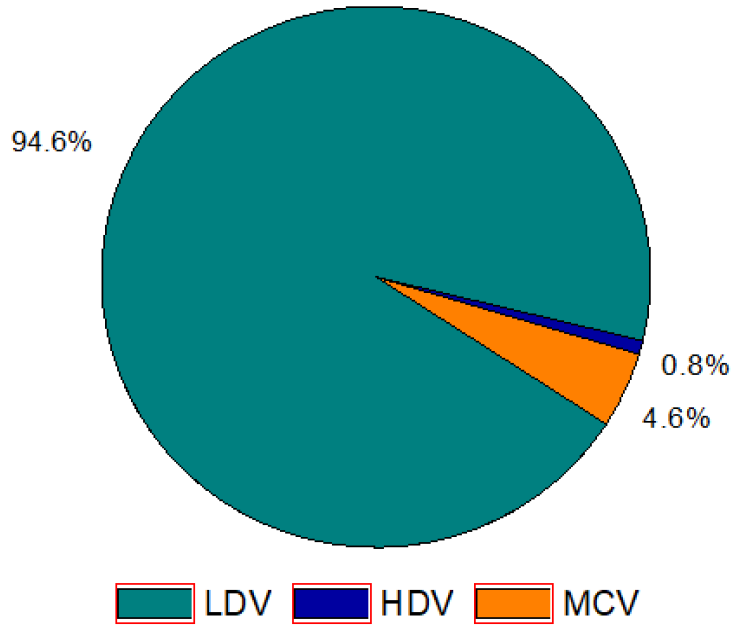
(Pant & Harrison, 2013)

- N – number of vehicles
- LDV - light–duty vehicles
- HDV - heavy-duty vehicles
- MCV – motorcycles
- Δ – difference between tunnel and background

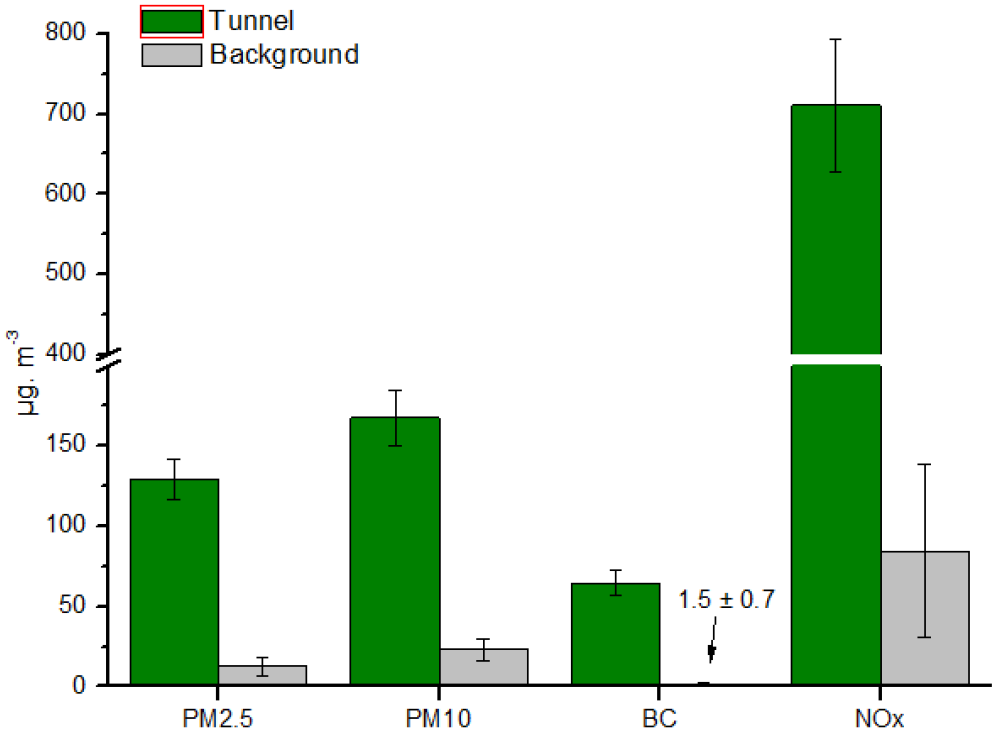
EF NOx (mg km^{-1})		
LDV	**MCV**	**HDV**
549	215	3086

Results and discussion

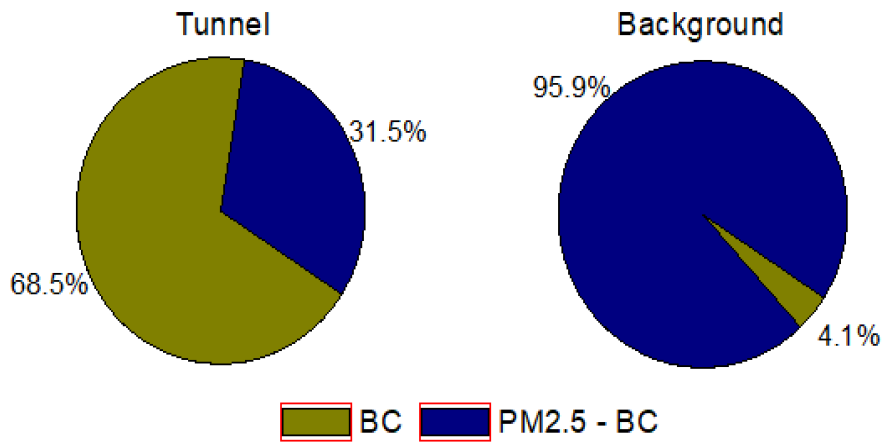
Traffic inside the tunnel



Average pollutant concentration in the tunnel and in the background



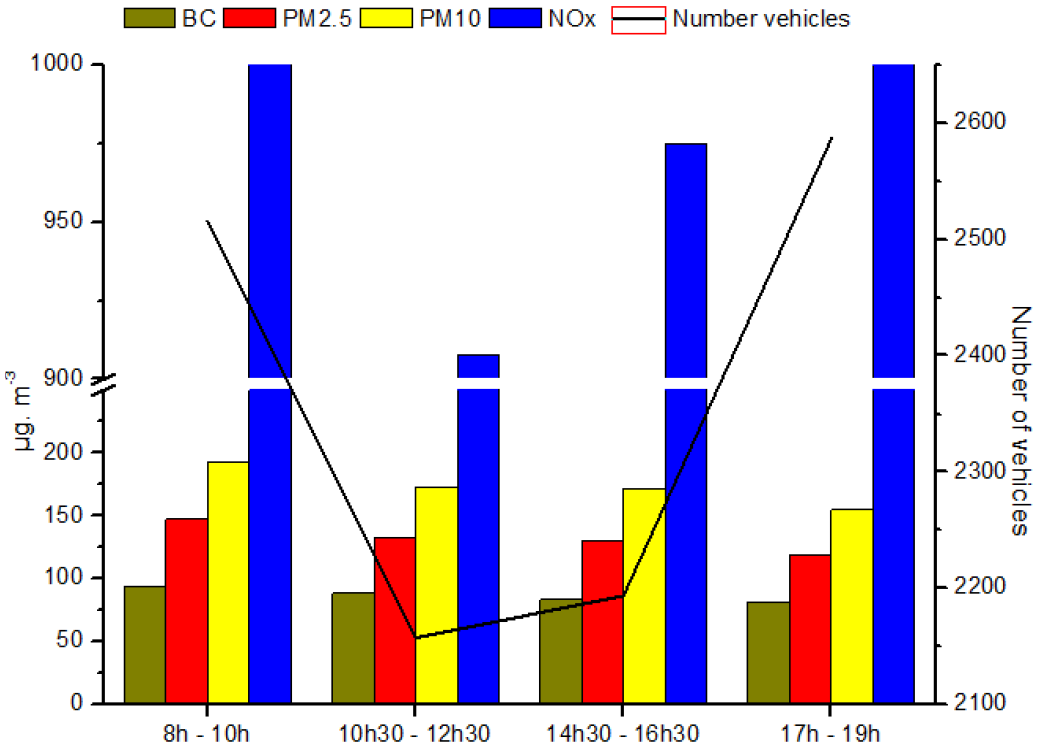
% of BC in PM2.5



- The best indicator of traffic-related PM pollution.
- It comes mainly from incomplete combustion of carbonaceous fuels.

(Moreno et al. 2015)

Variation of the pollutant concentration and number of vehicle by measuring period



Emission Factors:

- EF (PM2.5) = 121 ± 18 mg km^{-1} veh^{-1}
- EF (PM10) = 150 ± 21 mg km^{-1} veh^{-1}
- EF (BC) = 60 ± 12 mg km^{-1} veh^{-1}

Reference	Country	Study Type	PM size range	EF (mg km^{-1} veh^{-1})
Gillies et. al 2001	USA	Tunnel	PM2.5 PM10	52 ± 27 69 ± 30
Handler et al. 2008	Austria	Tunnel	PM2.5 PM10	26 ± 10 62 ± 18
Cheng et al. 2010	China	Tunnel	PM2.5	229 ± 90

EF can be affected by many factors such as:

- Technology, age and maintenance of the vehicle
- Traffic intensity
- Driver behavior
- Modal shares of vehicle types
- Conditions at the sampling site
- Etc.

The analysis of the chemical profile of the PM will be essential to identify the contribution of the exhaust and non-exhaust emissions

Conclusions

- High contribution road vehicle emissions to pollutant concentration in urban areas
- EF is not a consensual value → depend on many factors
- Real-world on-road measurements performed in the tunnels are important because they reflect the actual vehicles emissions in the city

Future work:

- More measurements (road tunnel and road dust resuspension)
- Filters will be chemically analyzed
  - EFs of the elements
  - Source profile

RESULTS

- Characterize and quantify exhaust and non-exhaust emissions
- Update emission inventories
- Review environmental standards
- Identify strategies to reduce pollution levels

Thank you!

Acknowledgements

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