Determination of road dust loadings and chemical composition using *in situ* and laboratory resuspension experiments

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Several urban areas in Europe do not meet the EU standards for atmospheric particulate matter below 10 µm (PM_{10}). Pollution from traffic comprises not only tailpipe emissions but also non-exhaust emissions because of resuspension of road dust, which can lead to high exposures to hazardous constituents. Despite their burden in urban atmospheres, road dust emissions are uncontrolled and poorly characterised.

Road dust was collected in Liberdade Avenue tunnel, in the city of Braga, Portugal. Two sampling strategies were followed. The first methodology for collecting PM_{10} samples directly from road pavement consisted in using a field resuspension chamber (Amato *et al*., 2011). Road dust samples were also collected by broom sweeping the tunnel lanes. Procedures for collection and analysis of road surface dust samples in this study are described by the USEPA in AP-42 documents (USEPA, 2003a,b). The experimental laboratory system for simulating the resuspension of road dust obtained by sweeping was designed according to Martuzevicius *et al*. (2011). Road dust PM_{10} samples were then analysed for organic (OC) and elemental carbon (EC) by a thermo-optical technique and acid digested for the determination of trace and major elements by ICP-MS and ICP-AES.

Both sampling strategies gave comparable road dust loadings: 0.58±0.05 mg m^{-2} (*in situ*) and 0.62±0.14 mg m^{-2} (laboratory resuspension chamber). These loadings are within the values reported for Zürich (0.2-1.3 mg m^{-2}) and much lower than those obtained in the Spanish cities of Girona (1.3-7.1 mg m^{-2}) and Barcelona (3.7-23.1 mg m^{-2}) (Amato *et al*., 2011).

Based on the empirical relationship between deposited loadings (RD) and the PM_{10} emission factors (EFs), $EF = 45.9\ RD^{0.81}$, derived by Amato *et al.* (2011), a rough estimation of PM_{10} emissions from road dust resuspension was made. Using this formula, an average EF of 30 mg veh^{-1} km^{-1} was obtained. Reentrained road dust emissions were also estimated using the equation from AP-42A (USEPA, 2011) for paved roads, considering an average vehicle weight of 1.5 tons and a silt loading of 0.059 g m^{-2}, which was determined by sieving the swept road dust through a 200 mesh. A PM_{10} EF of 33 mg veh^{-1} km^{-1} was derived from the EPA methodology.

OC and EC contributed to around 11 and 5% of the resuspended PM_{10}, respectively. The chemical analyses of samples revealed a main mineral composition (SiO_2, Al_2O_3, Fe_2O_3, etc.) representing, on average, 56% of the PM_{10} mass. Carbonates accounted for 3% of the road dust loading. The dominant elements were Si, Al, Fe, K and Ca. Enrichment factor calculations showed very high enrichments of Sb, Sn, Cu, Fe and Zn, with respect to average crustal abundances, indicating the presence of brake and tyre wear components.

Although both methodologies conducted to similar road dust loadings and PM_{10} EFs, some significant compositional differences between samples were observed (Table 1).

Table 1. Mean loads of major and trace elements in PM_{10}

	In situ (ng m^{-2})	Lab chamber (ng m^{-2})		*In situ* (µg m^{-2})	Lab chamber (µg m^{-2})
Sb	108	18	Al_2O_3	18.2	58.7
Sn	210	31	Ca	4.6	20.4
Cu	859	485	Fe	31	20
Mn	233	190	Zn	1.7	1.2
Ba	901	627	K	5.6	11
P	366	352	Mg	1.4	4.5
Rb	34	114	Na	3.3	17
Sr	24	97	Ti	0.88	2.5
Ce	10	26	S	1.9	1.0

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