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Assessment of the contribution of residential waste burning to ambient PM_{10} concentrations in Hungary and Romania

András Hoffer et al.

Correspondence to: András Hoffer (hoffer.andras@mk.uni-pannon.hu)

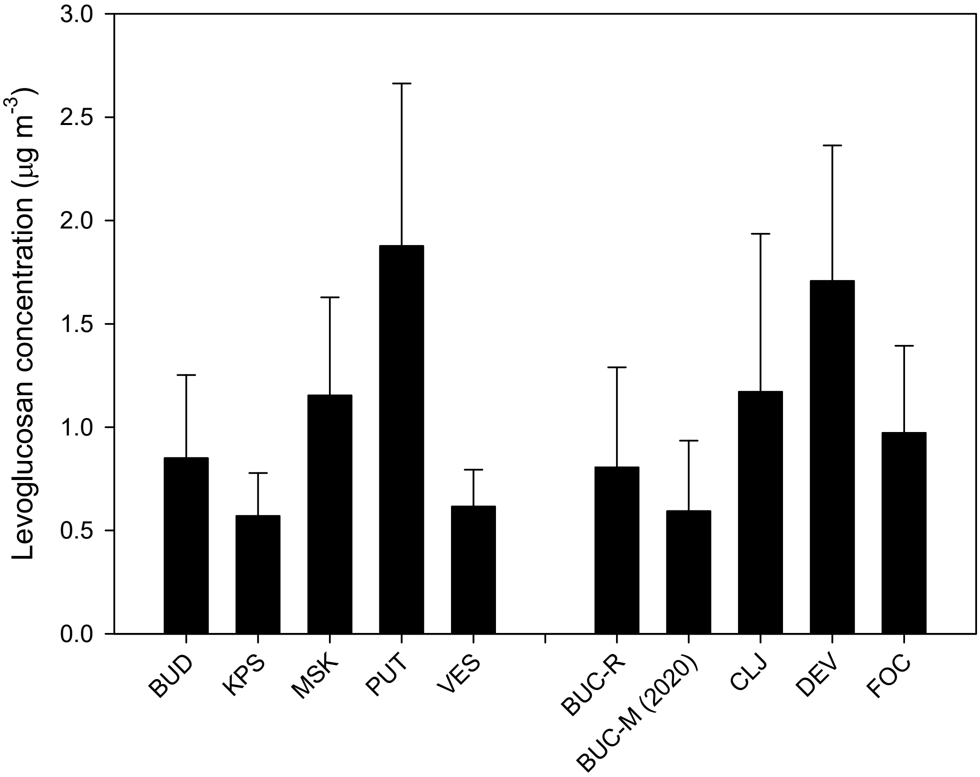

Figure S1 Average concentration of levoglucosan measured at the sampling locations in the heating seasons.

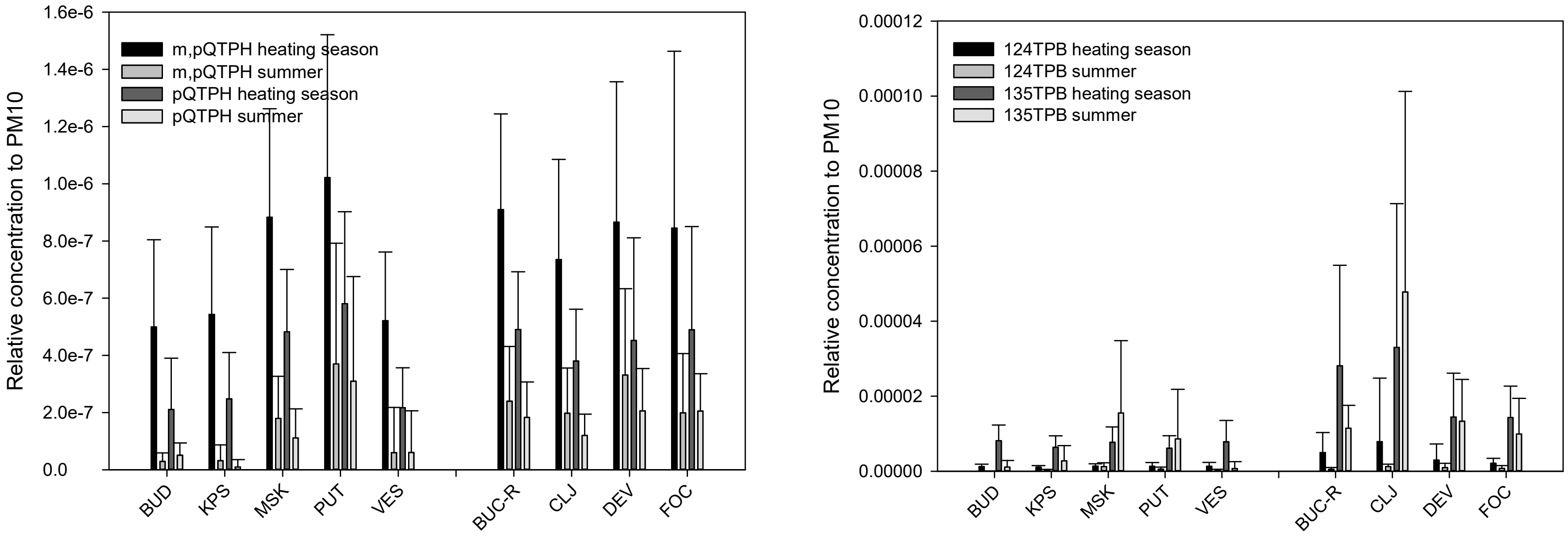

Figure S2 The relative concentration (concentration ratio) of quaterphenyls (left side) and triphenylbenzenes (right side) to PM_{10} in the samples collected in the heating season as well as in the summer samples.

The calculation of emission factors used in the estimations

To obtain the average emission factor which was used in the estimation of the contribution of waste burning, both the PM10 emission factor (on a relative scale) reported by Hoffer et al., 2020, and the emission factors of the tracer compounds (both the absolute EFs (mg kg^{-1}) and the relative EFs (µg g^{-1} $PM10^{-1}$) reported by Hoffer et al., 2021 were used. Since the emission factors of the tracer compounds depend on the type of the burned material, and a given marker compound might also be emitted from the burning of different waste types, we performed a sensitivity analysis by calculating the average emission factors for each tracer compounds for different waste mixtures. (For the relative EFs we have calculated the amount of the emitted PM10 and the amount of the given tracer compound in the emitted PM10 for the different waste mixtures, whereas for the absolute EFs given in Table 4 the amount of the emitted tracer compound was related to the weight of the different waste mixtures). As a starting point, we assumed that on a mass basis, the burned household waste consist of 52.6% furniture panels, 15.8% paper, 15.8% rag and 15.8% plastics (the mass ratios of these waste types in this case is 10:3:3:3, respectively), and calculated the resulting average emission factor for each tracer components. We also assumed that the composition of the plastic waste is 42% PE, 28% PET, 14% PP and PS, 0.7% PVC and ABS according to Bodzay and Bánhegyi, (2016). In the calculations we increased the relative amount of the different waste types and/or groups of the waste mixture by a factor of 10. The weighted averages of the emission factors of the marker compounds were calculated for all possible combinations (altogether 15 combinations). Table S1 and table S2 show the obtained EF values for the different waste mixtures. The results of these calculations are summarized in Table 2 which shows the obtained minimum and maximum relative EF values, as well as the average relative EFs of the 15 possible mixture combinations. Table 4 contains the average absolute EF values. Here, we note that the obtained EF values of the different tracers are characteristic only for those waste types the combustion of which produces the given tracer compound (it is not an average EF for the whole waste mixture), as the effects of the different waste burning emission sources are treated separately. (That is why the estimated EF values of melamine which is emitted solely from the burning of furniture panels does not change as the composition of the burned waste varies).

Table S1. The EF (μg g^{-1} PM_{10}^{-1}) of the marker compounds for the burning of different waste mixtures

	Composition of waste (%)									EF (μg g^{-1} PM_{10}^{-1})											
	LDF	PAP	RAG	ABS	PE	PET	PP	PS	PVC	135-TPB	124-TPB	m-TPH	p-TPH	m,p-QTPH	p-QTPH	2-BEVT	SSS	ASS	SAS	SSA	Melamine
	53	16	16	0.11	6.7	4.4	2.2	2.2	0.11	169	68	632	1823	176	127	70	1173	175	298	154	19000
	92	2.8	2.8	0.019	1.2	0.78	0.39	0.39	0.019	58	20	183	1823	176	127	70	505	197	344	177	19000
	22	65	6.5	0.046	2.8	1.8	0.92	0.92	0.046	139	52	536	1823	96	127	70	820	109	149	81	19000
	22	6.5	65	0.046	2.8	1.8	0.92	0.92	0.046	69	74	618	1106	117	79	15	1173	175	298	154	19000
	22	6.5	6.5	0.46	28	18	9.2	9.2	0.46	343	101	959	2392	250	167	196	2449	140	238	122	19000
	74	22	2.2	0.016	0.93	0.62	0.31	0.31	0.016	60	19	194	1823	96	127	70	491	180	306	158	19000
	74	2.2	22	0.016	0.93	0.62	0.31	0.31	0.016	45	38	312	1106	117	79	15	505	197	344	177	19000
	74	2.2	2.2	0.16	9.3	6.2	3.1	3.1	0.16	213	69	652	2392	250	167	196	1243	191	334	171	19000
	14	41	41	0.029	1.7	1.2	0.58	0.58	0.029	70	66	575	1106	98	79	15	820	109	149	81	19000
	14	41	4.1	0.29	17	12	5.8	5.8	0.29	318	95	914	2392	217	167	196	2090	98	136	73	19000
	14	4.1	41	0.29	17	12	5.8	5.8	0.29	247	96	881	1823	193	127	70	2449	140	238	122	19000
	61	18	18	0.013	0.78	0.52	0.26	0.26	0.013	47	36	311	1106	98	79	15	491	180	306	158	19000
	61	18	1.8	0.13	7.8	5.2	2.6	2.6	0.13	205	66	636	2392	217	167	196	1173	175	298	154	19000
	61	1.8	18	0.13	7.8	5.2	2.6	2.6	0.13	174	70	645	1823	193	127	70	1243	191	334	171	19000
	10	30	30	0.21	13	8.5	4.2	4.2	0.21	235	91	850	1823	176	127	70	2090	98	136	73	19000
Min.	10	1.8	1.8	0.013	0.78	0.52	0.26	0.26	0.013	45	19	183	1106	96	79	15	491	98	136	73	19000
Max.	92	65	65	0.46	28	18	9.2	9.2	0.46	343	101	959	2392	250	167	196	2449	197	344	177	19000
Avg.										159	64	593	1783	165	125	89	1248	157	260	135	19000
Values used										200	100	600	1800	200	100	100	1200	200	300	100	19000

Table S2. The EF (mg kg^{-1}) of the marker compounds for the burning of different waste mixtures

	Composition of waste (%)									EF (mg kg^{-1})											
	LDF	PAP	RAG	ABS	PE	PET	PP	PS	PVC	135-TPB	124-TPB	m-TPH	p-TPH	m,p-QTPH	p-QTPH	2-BEVT	SSS	ASS	SAS	SSA	Melamine
	53	16	16	0.11	6.7	4.4	2.2	2.2	0.11	1.1	0.53	5.0	26	1.6	1.8	0.66	5.7	0.54	0.94	0.47	51
	92	2.8	2.8	0.019	1.2	0.78	0.39	0.39	0.019	0.23	0.10	0.92	26	1.6	1.8	0.66	1.7	0.65	1.2	0.58	51
	22	65	6.5	0.046	2.8	1.8	0.92	0.92	0.046	0.53	0.23	2.4	26	0.35	1.8	0.66	2.5	0.25	0.33	0.18	51
	22	6.5	65	0.046	2.8	1.8	0.92	0.92	0.046	0.51	0.62	5.2	10	1.0	0.75	0.14	5.7	0.54	0.94	0.47	51
	22	6.5	6.5	0.46	28	18	9.2	9.2	0.46	5.4	1.8	17	56	5.0	3.9	2.1	38	0.57	0.98	0.48	51
	74	22	2.2	0.016	0.93	0.62	0.31	0.31	0.016	0.22	0.08	0.9	26	0.35	1.8	0.66	1.5	0.54	0.93	0.47	51
	74	2.2	22	0.016	0.93	0.62	0.31	0.31	0.016	0.21	0.21	1.8	10	1.0	0.75	0.14	1.7	0.65	1.2	0.58	51
	74	2.2	2.2	0.16	9.3	6.2	3.1	3.1	0.16	1.5	0.60	5.9	56	5.0	3.9	2.1	7.0	0.66	1.2	0.59	51
	14	41	41	0.029	1.7	1.2	0.58	0.58	0.029	0.38	0.40	3.5	10	0.57	0.75	0.14	2.5	0.25	0.33	0.18	51
	14	41	4.1	0.29	17	12	5.8	5.8	0.29	3.1	1.1	11	56	2.1	3.9	2.1	15	0.26	0.35	0.18	51
	14	4.1	41	0.29	17	12	5.8	5.8	0.29	3.0	1.4	13	26	2.6	1.8	0.66	38	0.57	0.98	0.48	51
	61	18	18	0.013	0.78	0.52	0.26	0.26	0.013	0.20	0.18	1.6	10	0.57	0.75	0.14	1.5	0.54	0.93	0.47	51
	61	18	1.8	0.13	7.8	5.2	2.6	2.6	0.13	1.3	0.51	5.0	56	2.1	3.9	2.1	5.7	0.54	0.94	0.47	51
	61	1.8	18	0.13	7.8	5.2	2.6	2.6	0.13	1.3	0.61	5.8	26	2.6	1.8	0.66	7.0	0.66	1.2	0.59	51
	10	30	30	0.21	13	8.5	4.2	4.2	0.21	2.2	1.0	9.5	26	1.6	1.8	0.66	15	0.26	0.35	0.18	51
Min.	10	1.8	1.8	0.013	0.78	0.52	0.26	0.26	0.013	0.20	0.082	0.86	10	0.35	0.75	0.14	1.5	0.25	0.33	0.18	51
Max.	92	65	65	0.46	28	18	9.2	9.2	0.46	5.4	1.8	17	56	5.0	3.9	2.1	38	0.66	1.2	0.59	51
Avg.										1.4	0.62	5.90	30	1.9	2.1	0.90	9.9	0.50	0.85	0.43	51

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