

**Wildfires as a source of PAHs in surface waters in background regions  
(Lake Baikal, Russia)**

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**Supplementary data:**

Tables S1: Toxicity equivalency factors (TEF), risk quotient for negligible concentrations ( $RQ_{Nss}$ ) and risk quotient for the maximum permissible concentrations ( $RQ_{MPCs}$ ) of the individual and total PAHs in water;

Table S2: Concentration range (mean/median) for the detected PAHs in the upper water layer of the pelagic zone of Lake Baikal (the monitoring from 2015 to 2020);

Table S3: Concentration range for the detected PAHs in the aerosol above the water surface; Table S4: PAH ratios in Baikal aerosol during wildfires in adjacent areas;

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Table S6: Estimation of the influx of PAHs to Lake Baikal with the Baikal tributaries;

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Table S8: The benzo[a]pyrene equivalent concentrations of PAHs in the upper water layer of the pelagic zone of Lake Baikal;

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Table S10. Concentration  $\Sigma$ PAHs in the water column of Lake Baikal (400 m), ng/L.

**Table S1.** Toxicity equivalency factors (TEF), risk quotient for negligible concentrations (NCs) and risk quotient for maximum permissible concentrations (MPCs) for the individual and total PAHs in water [49-51]

PAHs	TEF	NCs, ng/L	MPCs, ng/L
Naphthalene	0.001	12	1200
Acenaphthalene	0.001	0.7	70
Acenaphthene	0.001	0.7	70
Flourene	0.001	0.7	70
Phenanthrene	0.001	3	300
Fluoranthene	0.001	3	300
Pyrene	0.001	0.7	70
Chrysene	0.01	3.4	340
Σ <sub>8</sub> PAHs	-	24.2	2420

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**Table S2.** Concentration range (mean/median) for detected PAHs in the upper water layer of the pelagic zone of Lake Baikal (the monitoring from 2015 to 2020)

Season	Basin	$\Sigma$ PAHs, ng/L	$\Sigma$ naphthalenes, ng/L	$\Sigma$ naphthalenes from $\Sigma$ PAHs, %,	Fluorene, ng/L	Phenanthrene, ng/L	Fluoranthene, ng/L	Pyrene, ng/L
2015, June	Southern	41-69 (59/62)	27-43	48-65	1.3-1.8	9.6-16	2.7-5.3	1.1-3.2
	Northern	35-60 (52/53)	19-40	55-74	0.8-1.2	4.7-8.5	1.9-2.7	1.3-2.3
2016, June	Southern	36-77 (53/50)	21-58	44-80	0.7-7.2	3.7-5.1	1.9-7.7	0.7-2.2
	Northern	16-20 (19/19)	10-14	59-68	0.8-13	2.6-3.4	1.2-1.8	0.6-0.8
2016, September	Southern	23-610 (210/150)	13-19	3.0-65	0.9-120	3.9-67	1.0-340	0.6-190
		23-39 <sup>1</sup>	16	40-65	0.9-5.9	3.3-4.4	1.0-4.5	0.6-1.7
	Northern	480-610 <sup>2</sup>	16-18	3.0-3.3	94	31-67	170-340	100-190
		85-140 (64/49)	15-24	34-72	1.4-14	3.2-28	1.2-34	0.5-22
2018, June	Southern	58-98 (82/85)	30-86	35-87	2.7-25	4.0-19	2.2-11	0.7-4.3
	Northern	60-110 (81/75)	45-100	74-91	1.4-3.4	2.8-5.7	1.0-2.6	0.5-1.4
2019, June	Southern	64-82 (71/68)	37-60	37-60	3.0-14	18-26	1.9-11	0.8-5.9
		130-290 (230/260)	68-170	51-62	5.3-12	45-92	6.2-17	3.4-8.8
	Northern	130-160 <sup>1</sup>	68-79	51-52	5.3-5.6	45-52	6.2-9.0	3.4-5.4
		210-290 <sup>2</sup>	110-170	50-62	9.5-12	66-91	9.2-17	5.4-8.8
2019, September	Southern	37-65 (48/45)	17-30	35-50	4.1-10	4.2-16	0.4-1.0	2.1-4.4
	Northern	20-57 (41/40)	16-37	46-64	3.7-4.9	4.6-6.2	1.0-1.3	0.4-0.6
2020, June	Southern	13-16 (21/20)	11-24	54-81	0.9-2.2	1.8-4.4	0.6-2.5	0.3-0.9
	Northern	9.0-16 (13/11)	6.8-13	72-80	0.4-0.6	0.9-1.5	0.6-0.7	0.1-0.3
2020, September	Southern	13-20 (17/17)	4.1-6.1	28-47	1.6-3.9	1.9-4.6	1.1-1.8	0.2-0.7
	Northern	10-19 (14/14)	5.8-8.9	41-60	0.9-3.0	1.4-3.5	0.6-0.8	0.3-0.4

Note: <sup>1</sup> minimum values; <sup>2</sup> maximum values

**Table S3.** Concentration range for detected PAHs in aerosol above the water surface, pg/m<sup>3</sup>

PAHs	Sampling season					
	July-August, 2016		July-August, 2019		July-August, 2020	
	Basin		Basin		Basin	
	Southern, n=23	Northern, n=7	Southern, n=11	Northern, n=9	Southern, n=7	Northern, n=7
Naphthalene	110-38900	410-890	8 – 36	6-25	4.9-24	4.9-19
Acenaphthylene,	<2-2060	6-16	< 2	< 2-7.4	<2 – 5.9	< 2-2.4
Acenaphthene	10-10950	2-7	10 -122	3.1-11	<2 – 11	< 2 – 4.7
Fluorene	20-13950	4-8	7 – 67	8.2-39	<2 – 24	< 2 – 9.5
Phenanthrene	40-36420	110-270	34– 147	17-210	17-86	12-34
Anthracene	<2-13	<2-9	<2 – 31	< 2 – 7.2	<2 – 7.7	< 2 – 2.6
Fluoranthene	20-7570	50-110	22 – 480	12 – 1200	29-80	7.5– 66
Pyrene	10-10280	130-1220	14 – 280	12-780	18-53	5.5 – 26
Retene	–	–	34-10	59-330	6.4-46	5.2 –19
Benz[a]anthracene	< 2-1570	< 2-13	6-89	3.5-31	2.6 – 7.1	< 2 – 7.9
Chrysene	10-3120	7-6910	9-150	8.1-230	10- 34	3.0 – 26
Benz[b]fluoranthene	≤ 2-14110	< 2	22-440	< 2 – 420	23-110	6.0 - 62
Benz[k]fluoranthene	≤ 2-5090	< 2	10-220	2.6-120	9.2- 63	2.7 – 23
Benz[e]pyrene	-	–	8-190	2.6-230	14 – 63	4.5 – 37
Benz[a]pyrene	≤ 2-6180	≤ 2	11-182	< 2 –52	7.3- 19	< 2 – 15
Perylene	-	–	<2-24	< 2 – 4.9	<2- 2.1	< 2 – 2.9
Indeno[1,2,3-c,d]pyrene	≤ 2	≤ 2	5-150	2.1-160	30 – 73	7.2 – 52
Benz[g,h,i]perylene	≤ 2	≤ 2	4-255	< 2 – 130	18 - 64	6.1– 49
Dibenz[a,h]anthracene	≤ 2	≤ 2	≤ 2	≤ 2 – 49	2.1-7.9	< 2-7.2
Σ <sub>19</sub> PAHs	220-133000	840-8900	220-3160	170-3900	230-580	94 – 440

**Table S4.** PAH ratios in Baikal aerosol during wildfires in adjacent areas

Ratios	Baikal aerosol	Source
Anthracene/(Anthracene+Phenanthrene)	0.07 - 0.18	> 0.10 <sup>1</sup>
Fluoranthene/(Fluoranthene+Pyrene)	0.25 - 0.82	> 0.50 <sup>1</sup>
Benzo[a]anthracene/(Benzo[a]anthracene+Chrysene)	0.14 - 0.49	0.43-0.46 <sup>1</sup>
Indeno[1,2,3-c,d]pyrene/(Indeno[1,2,3-c,d]pyrene+ Benzo[g,h,i]perylene)	0.45 - 0.56	0.55-0.64 <sup>1</sup>
Benzo[e]pyrene/(Benzo[e]pyrene+Benzo[a]pyrene)	0.71 - 0.72	> 0.50 <sup>2</sup>

Note: <sup>1</sup> wood combustion processes and wood soot [82];

<sup>2</sup> – atmospheric transport [37, 83].

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**Table S5.** ΣPAH concentrations in waters of the tributaries of Lake Baikal, ng/L

Tributaries	PAHs										Σ PAHs
	I	II	III	IV	V	VI	VII	VIII	IX	X	
Southern basin, September 2016											
Utulik	23	6.8	6.2	0.58	0.79	0.96	3.1	1.3	0.82	0.16	44
Solzan	17	5.2	4.3	0.39	0.54	0.56	2.1	0.75	0.42	0.18	31
Khara-Murin	19	8.3	5.2	0.34	0.53	0.46	2.1	0.75	0.54	0.22	38
Snezhnya	29	7.8	6.8	0.66	1.3	1.2	9.2	2.4	2.1	0.17	60
Pereyomnaya	16	3.8	3.2	0.56	0.95	1.2	3.1	1.6	0.88	0.21	32
Southern basin, June 2017											
Utulik	6.8	5.0	3.8	0.60	0.34	0.51	2.4	0.92	0.57	0.30	21
Solzan	12	8.1	7.1	0.64	0.44	0.75	2.7	0.86	0.50		34
Khara-Murin	10	7.1	5.7	0.62	0.56	0.93	3.2	1.2	0.63	0.45	31
Snezhnya	8.1	4.5	3.9	0.72	0.93	1.1	3.3	1.5	0.57	0.47	25
Pereyomnaya	10	5.2	4.5	0.76	1.1	1.0	7.4	1.2	5.2	2.9	39
Southern basin, September 2017											
Utulik	12	3.8	3.2	0.46	0.82	1.2	3.9	1.4	0.82	0.94	28
Solzan	11	2.5	2.3	0.36	0.74	1.4	4.3	2.5	1.6	2.8	30
Khara-Murin	14	3.3	2.4	1.0	1.1	1.7	5.8	3.2	1.9	2.8	37
Snezhnya	8.4	2.7	1.4	0.81	0.76	1.2	4.4	1.4	0.85	1.2	24
Pereyomnaya	8.7	3.0	1.7	0.77	0.96	1.6	6.1	2.6	1.3	2.0	29
Southern basin, May 2019											
Utulik	78	12	7.9	0.2	0.6	1.0	2.9	0.94	0.45	0.29	100
Solzan	81	14	8.9	0.4	0.9	1.1	3.2	1.3	0.52	0.54	110
Khara-Murin	72	12	8.0	0.2	0.6	0.8	2.7	1.0	0.42	0.29	98
Snezhnya	72	12	7.8	0.3	0.9	1.0	2.6	1.1	0.43	0.21	99
pereyomnaya	73	12	8.2	0.2	0.6	0.9	2.5	1.0	0.37	0.21	99
Southern basin, September 2019											
Utulik	3.4	2.6-	1.5-	1.7	5.5	5.1	5.1	1.8	0.76	0.15	24
Solzan	4.3	2.5	2.3	1.4	4.3	4.0	4.3	1.7	0.74	0.17	26
Khara-Murin	3.3	2.7	1.7	0.86	2.7	2.6	3.5	1.2	0.46	0.14	19
Snezhnya	4.9	3.2	2.4	1.5	4.8	4.1	4.7	1.5	0.58	0.14	28
Pereyomnaya	3.1	2.4	2.1	1.1	3.7	3.1	3.8	1.5	0.68	0.20	20
Northern, September 2019											
Relay	10	8.6	6.8	1.8	3.1	3.1	4.0	1.0	0.41	0.11	39
Kichera	18	30	19	2.5	6.4	5.6	6.1	2.0	0.66	0.26	89
Upper Angara	12	17	12	1.9	5.4	4.5	4.6	1.4	0.63	0.15	60
Tompuda	60	42	23	1.3	3.1	3.0	3.7	0.78	0.40	0.11	140
Southern basin, May 2021											
Utulik	16	5.0	5.0	1.4	2.7	5.3	1.8	3.1	1.7	0.52	42
Solzan	14	5.2	4.4	0.41	1.0	1.2	0.30	1.2	0.60	0.27	29
Murino	14	4.0	3.6	0.59	1.4	4.4	1.7	3.6	1.7	0.47	36
Snezhnaya	13	4.9	4.3	1.4	3.9	6.8	3.3	5.3	2.7	0.67	46

Pereyomnaya	16	5.3	3.7	0.62	2.3	2.6	4.1	1.9	0.76	0.53	38
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Note: PAHs: I – naphthalene, II – 2-methylnaphthalene, III - 1-methylnaphthalene, IV – acenaphthylene, V - acenaphthene, VI - fluorene, VII - phenanthrene, VIII – fluoranthene, IX – pyrene, and X – chrysene.

**Table S6.** Estimation of the influx of PAHs to Lake Baikal with the Baikal tributaries

Tributaries	Area of watershed basin, km <sup>2</sup>	Length of river, km	Sampling period					
			May 2019			September 2019		
			$\Sigma_{10}\text{PAHs, ng/L}$	volume of water runoff*, km <sup>3</sup>	$\Sigma_{10}\text{PAH influx, kg}$	$\Sigma_{10}\text{PAHs, ng/L}$	volume of water runoff*, km <sup>3</sup>	$\Sigma_{10}\text{PAH influx, kg}$
Utulik River	960	86	105	0.026	2.7	24	0.044	1.1
Solzan River	150	34	113	0.012	1.4	22	0.013	0.28
Khara-Murin River	1130	86	98	0.082	8.0	28	0.095	2.7
Snezhnaya River	3000	173	99	0.18	18	18	0.203	3.6
Pereyomnaya River	460	42	99	0.066	6.5	21	0.034	0.71
Kichera River	2430	126	-	-	-	134	0.102	14
Tompuda River	1800	108	-	-	-	150	0.102	15

Note: \* - Data from the Russian Hydrometeorological Service (Roshydromet).



**Table S7.** The concentration range for detected PCB indicator congeners in aerosol above the water surface, pg/m<sup>3</sup>

PCB, No	July-August, 2019	July-August, 2020
	n=10	n=23
28	< 0.02 – 0.31	0.05 – 0.34
52	0.02 – 0.15	0.04 – 0.33
101	0.06 – 0.28	< 0.02 – 0.38
118	0.04 – 0.24	< 0.02 – 0.41
153	0.02 – 0.12	< 0.02 – 0.15
138	0.03 – 0.15	< 0.02 – 0.34
180	< 0.02 – 0.04	< 0.02 – 0.06
Σ7PCB	0.28 – 1.3	0.09 – 1.9
mean/median	0.76/0.74	0.98/0.80

**Table S8.** The benzo[a]pyrene equivalent concentrations of PAHs in the upper water layer of the pelagic zone of Lake Baikal

PAHs	Southern basin, September 2016			Northern, September, June 2019			pelagic zone of Lake Baikal, the 2020 season		
	Range	Mean	Median	Range	Mean	Median	Range	Mean	Median
Naphthalene	0.007-0.010	0.009	0.009	0.036-0.098	0.068	0.067	0.003-0.011	0.006	0.006
Acenaphthalene	0.012-0.048	0.033	0.035	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Acenaphthene	0.001-0.075	0.027	0.004	0.002-0.004	0.003	0.003	< 0.001-0.003	0.001	0.001
Flourene	0.027-0.082	0.059	0.063	0.005-0.012	0.009	0.011	< 0.001-0.004	0.001	0.001
Phenanthrene	0.004-0.043	0.015	0.008	0.045-0.092	0.073	0.076	< 0.001-0.004	0.002	0.002
Fluoranthene	0.011-0.226	0.066	0.033	0.006-0.017	0.011	0.010	< 0.001-0.002	0.001	0.001
Pyrene	0.007-0.125	0.037	0.014	0.003-0.009	0.006	0.005	< 0.001-0.001	< 0.001	< 0.001
Chrysene	0.001-0.002	0.001	0.001	< 0.001-0.004	0.001	0.001	< 0.001-0.004	0.001	0.001
ΣTEQ	0.045-0.500	0.220	0.140	0.099-0.220	0.170	0.200	0.006-0.023	0.014	0.014

**Table S9.** Risk quotient for negligible concentrations (RQ<sub>NSs</sub>) and maximum permissible concentrations (RQ<sub>MPCs</sub>) for the individual and total PAHs in the water of Lake Baikal

PAHs	Southern basin, September 2016				Northern basin, June 2019				Pelagic water of Lake Baikal, the 2020 season			
	RQ <sub>NCs</sub>		RQ <sub>MPCs</sub>		RQ <sub>NCs</sub>		RQ <sub>MPCs</sub>		RQ <sub>NCs</sub>		RQ <sub>MPCs</sub>	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Naphthalene	0.61-0.76	0.71	0.006-0.008	0.007	3.0-8.2	5.6	0.03-0.08	0.06	0.28-0.73	0.45	0.003-0.007	0.004
Acenaphthalene	5.7-69	32	0.06-0.69	0.32	0.6-1.2	0.9	0.01-0.02	0.01	0.15-1.1	0.54	0.001-0.011	0.005
Acenaphthene	0.9-6.3	6.3	0.01-1.1	0.16	3.0-5.7	4.5	0.04-0.09	0.06	0.25-3.8	1.5	0.002-0.038	0.015
Flourene	7.9-120	73	0.08-1.2	0.73	7.6-17	13	0.11-0.25	0.19	0.56-5.6	2.3	0.006-0.056	0.023
Phenanthrene	1.4-14	4.8	0.01-0.08	0.05	15-31	24	0.05-0.10	0.08	0.31-1.5	0.73	0.003-0.015	0.01
Fluoranthene	3.6-75	22	0.02-0.75	0.22	2.1-5.6	3.8	0.01-0.02	0.01	0.19-0.73	0.34	0.002-0.008	0.003
Pyrene	10-180	53	0.10-1.8	0.53	4.8-13	9.1	0.07-0.18	0.13	0.21-0.89	0.48	0.002-0.009	0.005
Chrysene	0.03-0.05	0.04	0.0003-0.0005	0.0004	0.03-0.05	0.04	0.0003-0.0005	0.0003	0.015-0.084	0.038	0.0001-0.0008	0.0004
Σ8PAHs	1.8-19	8.7	0.02-0.19	0.09	4.1-9.0	7.1	0.41-0.09	0.07	0.24-0.85	0.51	0.002-0.0008	0.005

**Table S10.** Concentration ΣPAHs in the water column of the lake Baikal (400 m), ng/L

Season	Basin, stations,	
	Southern, Nos 6	Northern, Nos16
2015, June	41	-
2016, June	51	13
2016, September	22	17
2017, September	14	14
2018, June	48	49
2019, June	25	27
2019, September	50	35
2020, June	17	12
2020, September	16	15
Mean/Median	32/25	22/17