



*Supplement of*

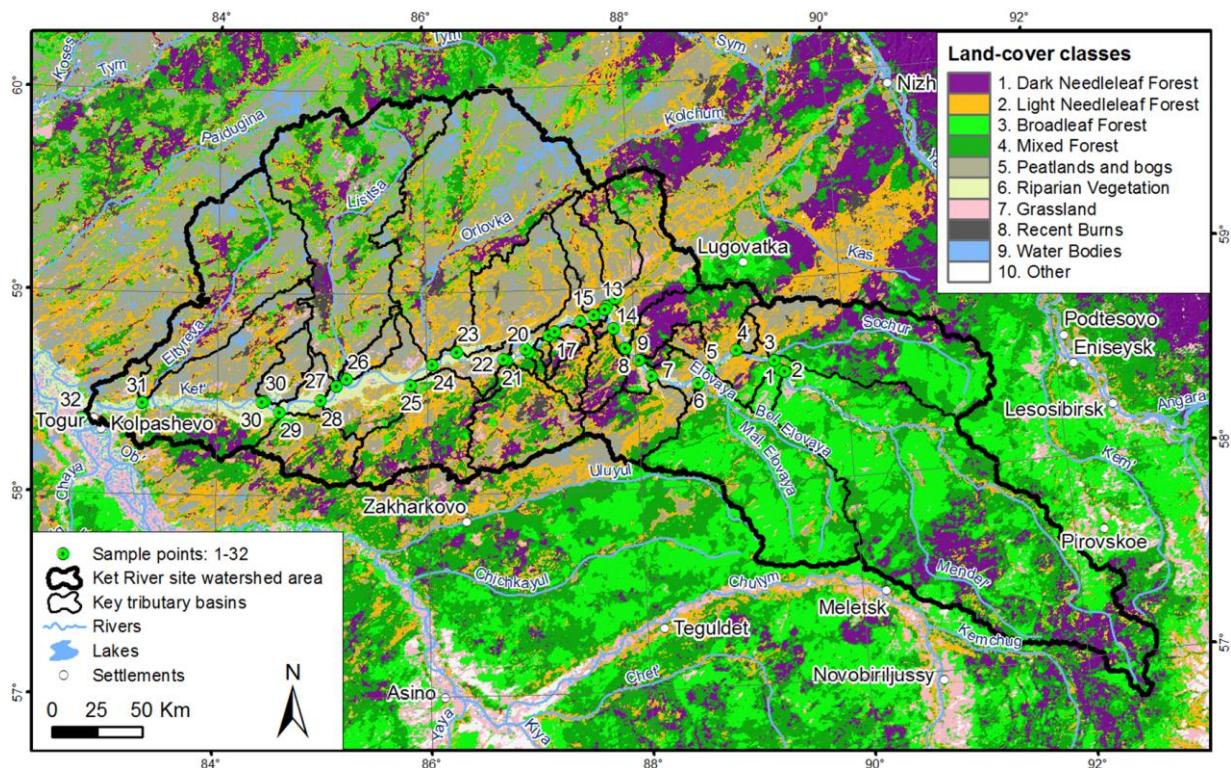
## **Carbon emission and export from the Ket River, western Siberia**

**Artem G. Lim et al.**

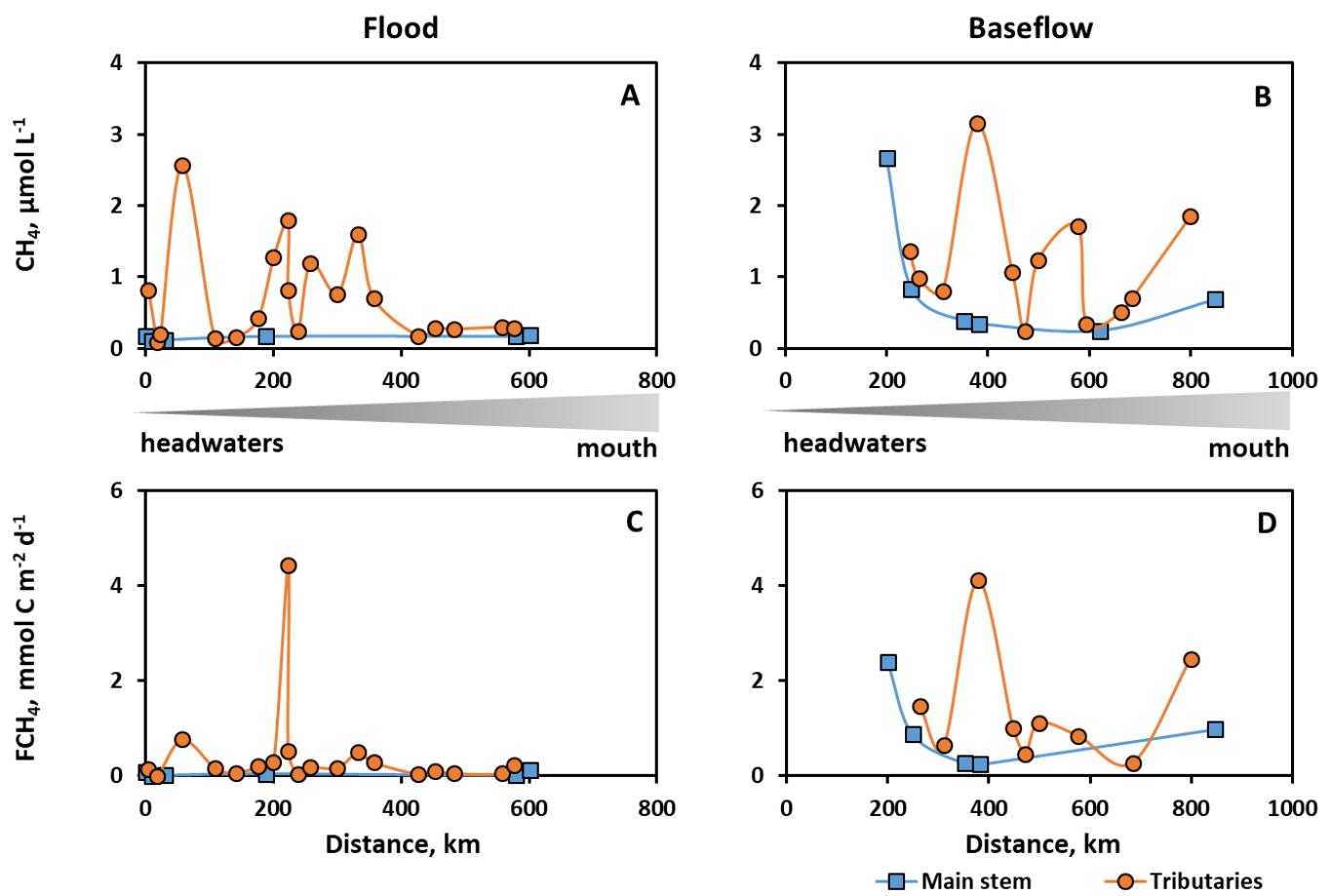
*Correspondence to:* Oleg S. Pokrovsky (oleg.pokrovsky@get.omp.eu)

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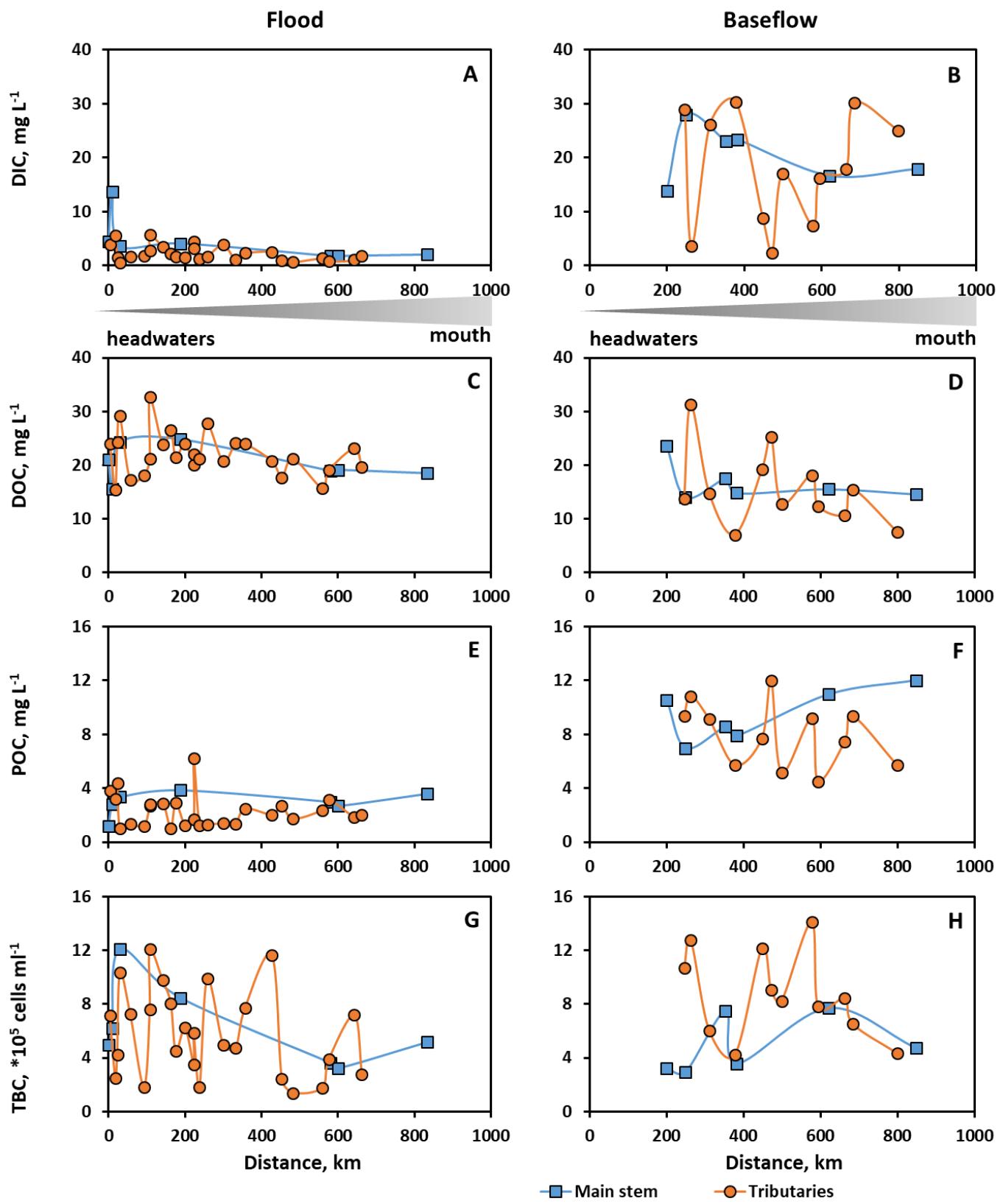
## Supplementary Information



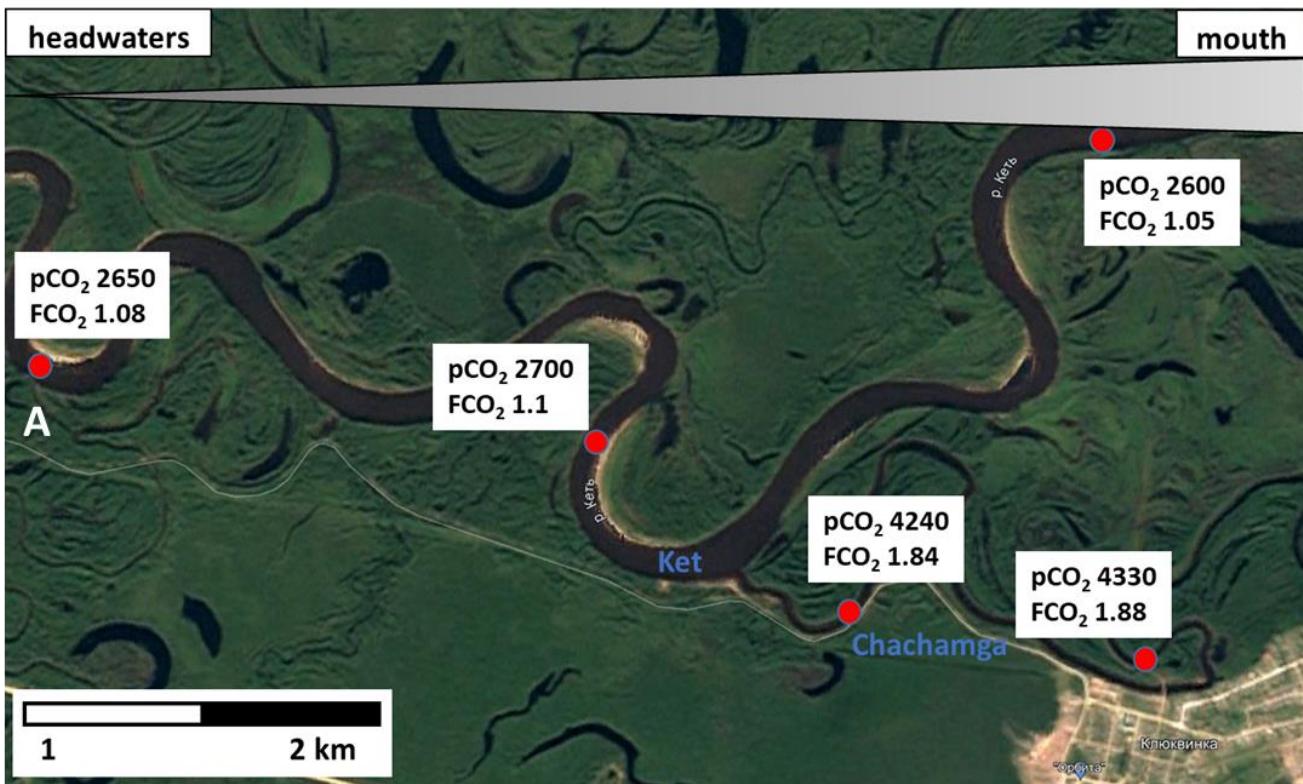
**Fig. S1.** Landscape map of the Ket River basin with sampling points (during spring campaign) as listed in **Table S1** of the Supplement. Map credit: M.A. Korets.



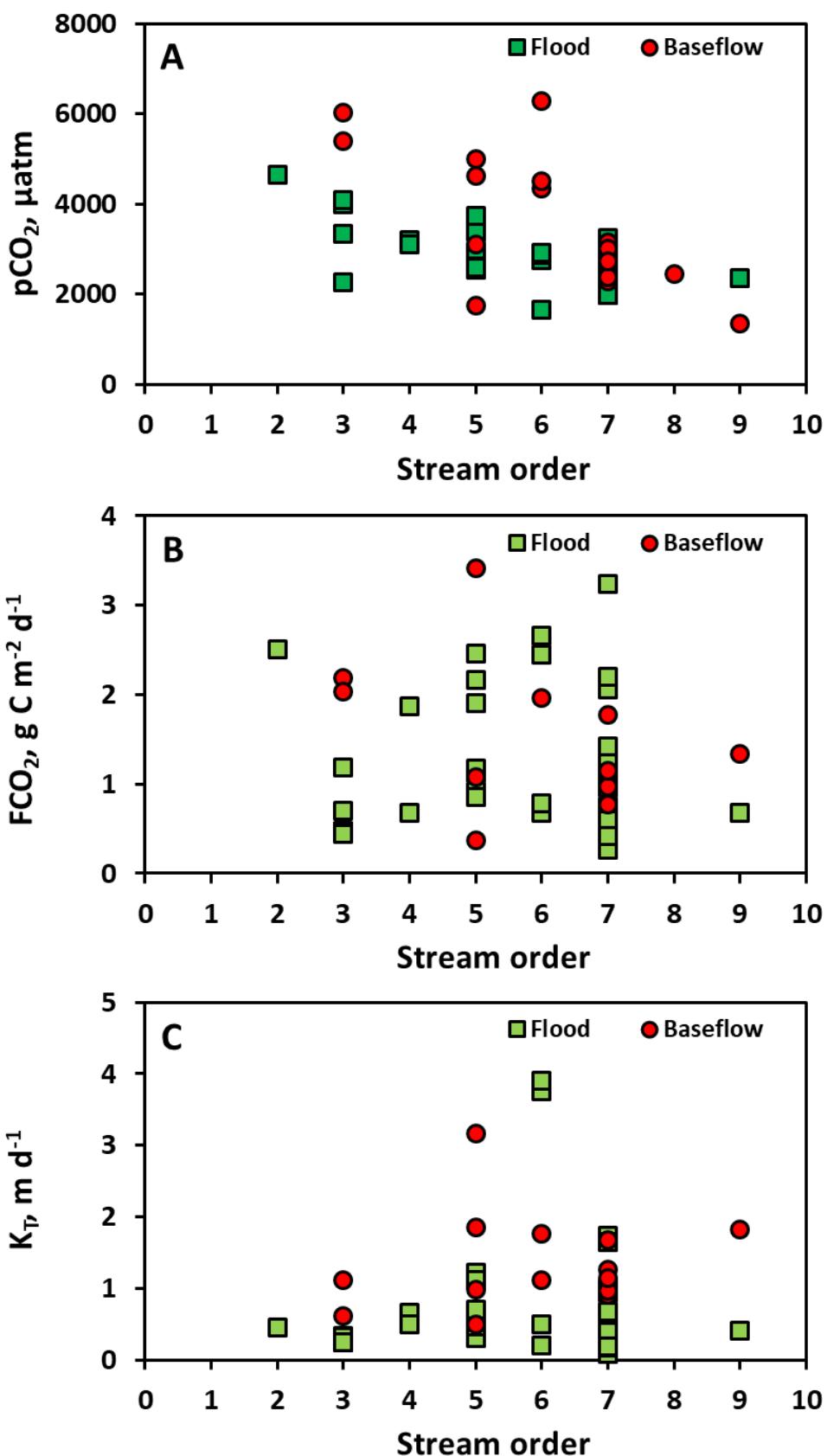
**Figure S2.** The CH<sub>4</sub> concentration profile during spring (**A**) and summer (**B**) and calculated CH<sub>4</sub> fluxes during spring (**C**) and summer (**D**) of the Ket River main stem (blue squares) and tributaries (orange circles) over the 830 km distance, from the headwaters to the mouth. Note that during summer baseflow, the water level did not allow reaching the headwaters of the Ket River.



**Figure S3.** DIC (A, B), DOC (C, D), POC (E, F) and bacterial number (G, H) concentration in the Ket River main stem and tributaries during spring flood (left column) and summer baseflow (right column).



**Fig. S4. A:** Spatial variations of CO<sub>2</sub> concentrations and fluxes in the Ket River main stem and tributaries, including the flood zone (map credit: A.G. Lim). Typical environments of the main stem and tributaries during the spring flood: flooded birch forest (**B**), abundant grassland (**C**), and tree-sheltered main stem (**D**). Photo credit: O. S. Pokrovsky.



**Fig. S5.** Distribution of CO<sub>2</sub> concentration (A), chamber-measured flux (B) and chamber-based gas transfer velocity (C) across stream orders in the Ket River basin during spring flood (green squares) and summer baseflow (red circles).

**Table S1.** List of sampled points at the main stem of the Ket River and its tributaries (see Fig. S1 for locations).

Nº	River name		Strahler order	Latitude, °N	Longitude, °E
1	Ershovka	tributary	5	58.547351	89.386589
2	Ket oxbow	main stem	N.A.	58.538375	89.428338
3	Ket	main stem	7	58.530077	89.417000
4	Ket	main stem	7	58.568891	89.342819
5	Sochur oxbow	tributary	6	58.596760	89.331001
6	Sochur stem	tributary		58.596760	89.331001
7	Ket	main stem	7	58.599885	89.148020
8	Okunevka	tributary	5	58.656150	88.979062
9	Urashnaya	tributary	4	58.569748	88.699403
10	Elovya	tributary	6	58.504258	88.612109
11	Elovya	tributary	6	58.505997	88.594011
12	Olenka	tributary	7	58.553585	88.151616
13	Lopatka	tributary	4	58.633625	88.043036
14	oxbow Ket	tributary	N.A.	58.688389	87.969535
15	Ket	main stem	7	58.735478	87.905680
16	Kasaiga	tributary	5	58.797447	87.812540
17	Derevyannaya	tributary	6	58.940287	87.841998
18	Kedrovaya	tributary	5	58.944982	87.837840
19	Chagiseyka	tributary	5	58.877202	87.628392
20	Kataiga	tributary	3	58.837881	87.494621
21	Laiga	tributary	3	58.773589	87.187814
22	Poludenovka	tributary	2	58.694730	86.990773
23	Utka	tributary	7	58.643559	86.808070
24	Togolika	tributary	7	58.703009	86.302655
25	Orlovka	tributary	5	58.657742	86.022702
26	Chachamga	tributary	3	58.548125	85.857000
27	Segondenka	tributary	3	58.592220	85.265985
28	Lisitsa	tributary	7	58.546690	85.151343
29	floodplain Ket	main stem	N.A.	58.506200	85.147248
30	Ket	main stem	7	58.467672	85.001758
31	Suiga	tributary	6	58.394283	84.697348
32	Alset	tributary	5	58.467412	84.461438
33	Ob river entrance	main stem	9	58.368265	82.727764
34	Ket	main stem	7	58.696513	87.920730
35	Ozernaya	tributary	6	58.904900	87.751220
36	Ket	main stem	7	58.890548	87.733480
37	Chagiseyka	tributary	5	58.865672	87.626177
38	Pirina	tributary	5	58.790455	87.251513
39	Ket	main stem	7	58.710028	86.963530
40	Utka	tributary	7	58.658273	86.774960
41	Ket	main stem	7	58.663337	86.747168
42	Togolika	tributary	7	58.706255	86.294858
43	Orlovka	tributary	5	58.643333	86.063128
44	Chachamga	tributary	3	58.543502	85.857892
45	Segondenka	tributary	3	58.575465	85.247468
46	Lisitsa	tributary	7	58.540877	85.146235
47	Ket	main stem	8	58.470187	84.993445
48	Suiga	tributary	6	58.413310	84.601718
49	Alset	tributary	5	58.463742	84.434788
50	Eltyreva	tributary	6	58.451140	83.296643
51	Ket	main stem	9	58.410130	82.825623

**Table S2.** Measured water temperature, pCO<sub>2</sub>, calculated CO<sub>2</sub> flux, CH<sub>4</sub>, DOC, DIC, POC, and total bacteria (TBC) concentrations and pH in the Ket River and tributaries during two seasons in 2019.

#		River name	Date	pH	SC	T <sub>water</sub>	O <sub>2</sub>	PON	POC	DIC	DOC
			dd/mm		µS cm <sup>-1</sup>	°C	mg L <sup>-1</sup>				
1	trib.	Ershovka	21.05	6.61	61.5	10.5	7.41	0.02	1.16	4.38	21.1
2	m.s.	Ket	21.05	6.74	62	8.8	8.91	0.2	3.79	3.96	24
3	m.s.	Ket	21.05	7.39	123	11.6	11.7	0.14	2.81	13.7	15.5
4	m.s.	Ket	21.05	6.89	60.0	13.5	9.03	0.24	3.34	3.66	24.2
5	trib.	oxbow Sochur	21.05	6.70	65.1	11.4	9.49	0.15	3.2	5.51	15.3
6	trib.	Sochur	21.05	6.26	33.2	7.0	9.01	0.14	4.35	1.48	24.2
7	m.s.	Ket	22.05	5.45	24.2	8.3	9.08	0.05	1.02	0.55	29.2
8	trib.	Okunevka	22.05	6.39	28.8	7.8	8.20	0.04	1.34	1.71	17.2
9	trib.	Urashnaya	22.05	5.76	27.4	10.4	7.39	0.03	1.18	1.81	18.1
10	trib.	Elovya	22.05	6.65	51	9.5	9.12	0.12	2.67	2.81	21.2
11	trib.	Elovya	22.05	6.81	76.8	9.7	9.20	0.11	2.78	5.68	32.7
12	trib.	Olenka	22.05	6.54	51.1	9.4	8.87	0.13	2.87	3.54	23.9
13	trib.	Lopatka	23.05	6.61	33.8	5.9	7.03	0.02	1.03	2.17	26.5
14	trib.	oxbow Ket	23.05	6.23	28.3	6.3	9.52	0.08	2.89	1.71	21.4
15	m.s.	Ket	23.05	6.60	53.6	9.1	9.88	0.19	3.85	4.1	24.8
16	trib.	Kasaiga	23.05	5.72	24.2	8.9	8.12	0.05	1.26	1.52	24
17	trib.	Derevyannaya	23.05	6.38	47.5	7.8	8.55	0.08	1.7	4.45	20.1
18	trib.	Kedrovaya	24.05	6.56	34	6.7	9.67	0.07	6.23	3.25	22
19	trib.	Chagiseyka	24.05	5.82	19	9	6.85	0.01	1.26	1.25	21.2
20	trib.	Kataiga	24.05	6.28	27.6	7.3	9.17	0.05	1.27	1.71	27.7
21	trib.	Laiga	24.05	6.53	51	10.8	6.84	0.01	1.39	3.85	20.7
22	trib.	Poludennovka	24.05	6.14	30.3	9.4	6.73	0.07	1.37	1.15	24.1
23	trib.	Utna	25.05	6.55	40.8	8.5	10.0	0.04	2.48	2.3	24
24	trib.	Togolika	25.05	6.44	39.3	11.9	7.87	0.1	2.04	2.52	20.7
25	trib.	Orlovka	25.05	5.46	15.5	8.8	9.33	0.02	2.71	0.97	17.7
26	trib.	Chachamga	25.05	5.66	24	13.3	6.56	0.02	1.72	0.66	21.2
27	trib.	Segondenka	25.05	6.20	25.9	14.5	6.50	0.06	2.37	1.37	15.7
28	trib.	Lisitsa	27.05	5.66	19.3	6.9	9.78	0.15	3.14	0.78	19
29	m.s.	floodplain Ket	27.05	6.28	32.8	6.3	8.54	0.14	2.98	1.77	18.9
30	m.s.	Ket	27.05	6.01	31.9	10	8.97	0.15	2.69	1.76	19.1
31	trib.	Suiga	27.05	5.94	29.4	10.1	8.48	0.05	1.85	1.02	23.1
32	trib.	Alset	27.05	6.13	31.1	10.8	8.32	0.05	2.03	1.78	19.7
33	m.s.	Ob river entrance	28.05	6.28	30.2	10.2	9.22	0.07	3.59	2.04	18.4
34	trib.	Ket	30.08	6.87	113	14.5	7.57	0.82	9.35	29	13.7
35	m.s.	Ozernaya	30.08	7.50	224	16.3	8.71	0.73	10.6	13.9	23.5
36	m.s.	Ket	30.08	6.80	217	16.8	8.96	0.78	6.95	28	14
37	trib.	Chagiseyka	30.08	6.05	51.7	15.6	7.46	0.88	10.8	3.6	31.3
38	trib.	Pirina	30.08	7.08	202	16.5	8.06	1.11	9.11	26.2	14.7
39	m.s.	Ket	30.08	7.40	184	17.2	8.99	1	8.55	23.1	17.4
40	trib.	Utna	30.08	7.44	234	13	10.2	0.37	5.7	30.3	6.99
41	m.s.	Ket	31.08	7.38	186	16.8	8.62	0.84	7.88	23.4	14.8
42	trib.	Togolika	31.08	6.82	77.5	16	8.23	0.51	7.69	8.74	19.2
43	trib.	Orlovka	31.08	6.09	35.6	15.2	8.69	0.76	12	2.38	25.2
44	trib.	Chachamga	31.08	5.60	135	15.6	7.06	0.39	5.15	17.1	12.8
45	trib.	Segondenka	01.09	6.31	67	14.6	6.50	0.6	9.17	7.33	18.1
46	trib.	Lisitsa	01.09	6.99	130	14.6	8.95	0.26	4.50	16.2	12.3
47	m.s.	Ket	01.09	7.22	135	16.2	8.54	1.09	11	16.7	15.5
48	trib.	Suiga	01.09	6.81	144	14.5	6.53	0.5	7.45	17.8	10.6
49	trib.	Alset	01.09	7.31	136	16.5	9.38	1.02	9.34	30.1	15.4
50	trib.	Eltyreva	02.09	7.15	196	12.6	7.66	0.42	5.71	25.0	7.53
51	m.s.	Ket	02.09	7.44	142	15.7	8.85	1.31	12	17.9	14.6

**Table S2, continued.**

#	TBC	SUVA <sub>254</sub>	pCO <sub>2</sub>		K <sub>T</sub>	chamber-measured FCO <sub>2</sub>	CH <sub>4</sub>	
			meas.	calc.			μmol L <sup>-1</sup>	mmol m <sup>-2</sup> d <sup>-1</sup>
	*10 <sup>5</sup> cells ml <sup>-1</sup>	L mg C m <sup>-1</sup>						
1	4.94	4.06	2930	2267	1.22	1.91	0.17	0.08
2	7.17	3.93	2450	3113	0.25	0.75	0.82	0.13
3	6.21	3.82	2180	2600	0.08	0.56	0.10	0.002
4	12.1	4.1	2470	1826	0.17	0.26	0.12	0.01
5	2.49	3.9	2810	3523	0.20	0.68	0.09	0.002
6	4.22	4.34	2260	1373	nd	nd	0.20	nd
7	10.3	4.41	2590	750	0.56	1.25	nd	nd
8	7.27	5.18	3380	1446	0.47	0.91	2.57	0.77
9	1.83	4.29	3200	2433	0.66	1.87	nd	nd
10	7.57	4.28	2750	1849	3.75	2.66	0.14	0.17
11	12.1	4.19	2860	2989	nd	nd	nd	nd
12	9.77	4.15	3240	2659	1.00	1.42	0.16	0.06
13	8.03	4.18	3100	1385	0.50	0.68	nd	nd
14	4.49	4.54	2660	1591	0.94	1.07	0.43	0.20
15	8.46	4.04	2390	2845	0.59	0.59	0.17	0.04
16	6.24	4.42	2620	1975	0.35	0.85	1.27	0.29
17	3.52	4.5	2920	3804	3.91	2.45	1.79	4.44
18	5.85	4.72	2610	2244	1.11	2.46	0.82	0.52
19	1.83	4.54	3730	1571	0.31	1.13	0.24	0.03
20	9.89	4.55	2260	1577	0.25	0.48	1.2	0.19
21	4.95	3.87	4000	3028	0.33	1.18	0.76	0.17
22	4.73	4.3	4640	1247	0.46	2.51	1.6	0.49
23	7.73	4.58	2280	1670	0.67	0.96	0.7	0.28
24	11.6	3.92	3040	2249	0.4	2.06	0.18	0.03
25	2.41	4.69	2540	1336	0.7	2.17	0.28	0.1
26	1.39	4.15	4100	994	0.32	0.7	0.27	0.05
27	1.76	4.52	3330	1626	0.25	0.44	0.3	0.05
28	3.92	4.98	1990	970	1.74	2.20	0.29	0.22
29	3.62	4.45	2170	1580	0.19	0.42	0.17	0.01
30	3.22	4.39	1990	2097	1.65	3.24	0.19	0.13
31	7.18	4.36	1660	1264	0.49	0.78	nd	nd
32	2.75	4.12	2600	2011	0.47	1.17	nd	nd
33	5.16	4.37	2360	2023	0.41	0.68	nd	nd
34	10.7	4.93	2440	4031	nd	nd	1.37	nd
35	3.22	3.87	4350	4710	1.11	1.96	2.66	2.4
36	2.94	3.85	2330	4580	1.26	0.97	0.84	0.87
37	12.8	5.06	4620	4874	1.86	7.37	0.99	1.47
38	6.03	4.62	5010	6442	0.98	1.08	0.81	0.65
39	7.51	3.81	2280	4686	0.91	0.78	0.38	0.26
40	4.24	3.44	3150	5323	1.68	1.15	3.16	4.12
41	3.56	4.22	2370	4913	0.97	0.77	0.35	0.24
42	12.2	5.3	3010	5117	1.14	1.78	1.07	1
43	9.03	5.04	3115	3115	3.16	3.42	0.24	0.46
44	8.24	5.84	5390	7326	1.11	2.19	1.24	1.12
45	14.1	4.93	6030	7922	0.61	2.04	1.71	0.84
46	7.82	5.34	2740	6954	nd	nd	0.35	nd
47	7.71	4.93	2450	4784	nd	nd	0.25	nd
48	8.42	5.53	6300	6256	nd	nd	0.51	nd
49	6.52	4.85	1750	7272	0.49	0.37	0.70	0.27
50	4.35	3.95	4500	7763	1.77	4.3	1.85	2.46
51	4.72	4.88	1360	3269	1.83	1.34	0.69	0.98

Abbreviations : # - sampling point as shown in **Fig. 1**; trib. – tributaries; m.s. – main stem; SC – Specific conductivity; Temp. water – temperature water; Dis. O<sub>2</sub> – dissolved oxygen; meas. – measured; calc. – calculated..

**Table S3.** Results of PCA treatment of the entire dataset including physico-chemical parameters of the water column and land cover. Significant values are highlighted.

	<b>Factor 1</b>	<b>Factor 2</b>
MAAT	0.004	-0.385
MAP	-0.437	0.599
S <sub>watershed</sub>	0.219	-0.014
Dark Needleleaf forest	<b>0.991</b>	-0.019
Light Needleleaf forest	<b>0.954</b>	0.114
Broadleaf forest	<b>0.963</b>	-0.104
Mixed forest	<b>0.982</b>	-0.072
Peatlands and bogs	<b>0.883</b>	0.193
Riparian Vegetation	<b>0.937</b>	0.082
Grassland	<b>0.987</b>	0.032
Recent burns	<b>0.901</b>	0.160
Water bodies	<b>0.790</b>	0.219
Total biomass	0.166	-0.544
T <sub>water</sub>	0.004	-0.385
F <sub>CH4</sub>	-0.098	0.528
CH <sub>4</sub>	-0.247	0.338
pCO <sub>2</sub>	-0.463	0.425
FCO <sub>2</sub>	-0.137	0.555
K <sub>T</sub>	0.299	0.626
PON	0.445	0.574
POC	0.365	0.682
TBC	-0.207	0.200
pH	0.387	0.175
O <sub>2</sub>	0.362	-0.224
S.C.	0.328	0.408
SUVA	-0.116	0.603
Cl	0.294	0.117
SO <sub>4</sub>	0.014	-0.703
DIC	0.304	0.456
DOC	-0.266	-0.474
Si	0.053	0.741
P <sub>tot</sub>	-0.072	0.506
<b>Expl.Var</b>	<b>19.2</b>	<b>6.65</b>
<b>Prp.Totl</b>	<b>0.412</b>	<b>0.142</b>

**Table S4. A** Mann-Whitney U Test comparison concentration in different season (flood vs. baseflow) in tributaries and main channel. Significant differences are in red.

	tributaries			main steam		
	U	Z	p-value	U	Z	p-value
pH	66	-2.50	0.01	0	-2.19	0.03
Dissolved O <sub>2</sub>	122	0.56	0.58	3	1.42	0.16
Specific cond.	12	-4.36	<0.001	0	-2.19	0.03
DIC	13	-4.33	<0.001	0	-2.19	0.03
DOC	70	2.35	0.02	0	2.19	0.03
SUVA <sub>254</sub>	55	-2.87	<0.001	7	0.39	0.70
PON	0	-4.78	<0.001	0	-2.19	0.03
POC	4	-4.64	<0.001	0	-2.19	0.03
TBC	64	-2.55	0.01	8	0.13	0.90
K <sub>T</sub>	30	-2.92	<0.001	3	-0.88	0.38
FCO <sub>2</sub>	69	-1.65	0.10	4	-0.53	0.60
pCO <sub>2</sub>	65	-2.52	0.01	9	0.00	1.00
FCH <sub>4</sub>	19	-3.38	<0.001	0	-1.62	0.11
CH <sub>4</sub>	60	-2.01	0.04	4	-0.50	0.62

**Table S4 B.** Mann-Whitney U Test comparison of parameter concentration between tributaries and main channel during different seasons.

	flood			baseflow		
	U	Z	p-value	U	Z	p-value
pH	29	-0.44	0.66	13	2.15	0.03
Dissolved O <sub>2</sub>	22	-0.96	0.34	18	1.64	0.10
Specific cond.	24	-0.80	0.42	17	1.73	0.08
DIC	26	-0.64	0.52	22	1.26	0.21
DOC	30	0.36	0.72	35	-0.05	0.96
SUVA <sub>254</sub>	27	0.56	0.57	14	-2.01	0.04
PON	10	-1.93	0.05	12	2.20	0.03
POC	9	-2.01	0.04	24	1.08	0.28
TBC	34	0.00	1.00	10	-2.39	0.02
K <sub>T</sub>	30	0.09	0.93	18	0.08	0.94
FCO <sub>2</sub>	30	0.21	0.83	6	-1.91	0.06
pCO <sub>2</sub>	10	1.97	0.05	5	-2.86	<0.001
FCH <sub>4</sub>	16	0.19	0.85	8	-1.63	0.10
CH <sub>4</sub>	16	0.19	0.85	20	-1.45	0.15