SUPPLEMENTARY INFORMATION:

Physico-geographical parameters of rivers, results of statistical treatment, latitudinal pattern of nutrient concentrations for rivers of different size, and impact of permafrost on nutrient concentration in rivers.

Table S1. The physico-geographical characteristics of the catchments as determined by digitalizing available soil, vegetation, lithology and geocryology maps.

No on map	N	E	Description	Sarea, km²	runoff mm.yr	bogs, %	forest, %	lakes, %	PF, %	Type of permafrost
24	65˚06'48.8"	77˚47'58.8"	Tydylyakha	7.5	185	49.4	37.4	12.7	49	Discontinuous
2	56˚43'15.0"	83˚55'35.1"	Chybyr'	8.1	44.8	19.9	28.4	1.01	0	Absent
11	61˚50'28.6"	70˚50'28.2"	Vachinguriyagun	9.5	192	78.7	9.4	11.9	0	Isolated
13	62˚37'08.4"	74˚10'15.9"	Petriyagun	9.7	192	57.2	6.7	36.1	5	Isolated
21	64˚32'07.9"	76˚54'21.3"	Seryareyakha	15.2	186	61.2	19.4	19.4	60	Sporadic
19	64˚09'06.4"	75˚22'18.1"	Apoku-Yakha	18.8	186	75.5	12.8	11.7	38	Sporadic
14	62˚33'39.8"	74˚00'29.5"	Pintyr'yagun	33.5	192	61	0	39	8	Isolated
16	63˚36'48.2"	74˚35'28.6"	Khatytayakha	34.6	194	75.3	13.2	10.8	38	Sporadic
20	64˚17'31.9"	75˚44'33.4"	Etu-Yakha	71.6	186	23.4	71.5	1.96	23	Sporadic
31	67°09'24,81"	78°57'31,76"	Sambotoyakha	75.0	N.D.	26.3	0.45	2.3	71	Continuous
25	65˚23'34.1"	77˚45'46.7"	Ponie-yakha	78.9	185	66	17.7	16.3	70	Discontinuous
10	61˚29'11.1"	74˚09'42.9"	Vach-Yagun	98.9	192	77.9	17.2	1.7	0	Isolated
17	63˚47'04.5"	75˚37'06.8"	Lymbyd'yakha	115	194	59.3	6.1	34.6	30	Sporadic
6	58˚40'46.5"	84˚27'56.6"	Vyalovka	117	127	37	48.4	0.19	0	Absent
30	66°59'25,84"	79°22'30,02"	Malaya Kheyaha	137	N.D.	23.4	43.4	1.4	75	Continuous
15	63˚22'01.6"	74˚31'53.2"	Kamgayakha	175	194	23.7	76.2	0.1	12	Sporadic
3	57˚36'43.3"	83˚37'02.1"	Malyi Tatosh	302	63.4	7.89	66.9	0.09	0	Absent
28	65˚59'14.7"	78˚32'25.2"	Malaya Khadyr-Yakha	513	278	14.8	84.9	0.3	85	Discontinuous
32	67°10'54,8"	78°51'04,5"	Nuny-Yakha	656	312	24.3	37	3.05	72	Continuous
29	66˚17'10.8"	79˚15'06.1"	Ngarka Khadyta-Yakha	1970	277	22	76	2	50	Continuous
5	58˚26'06.9"	82˚05'43.6"	Shudelka	3460	211	68.2	31.8	0.0	0	Absent
26	65˚41'51.1"	78˚01'05.0"	Yamsovey	4030	309	53.7	38.7	7.5	54	Discontinuous
22	64˚40'14.0"	77˚05'27.2"	Purpe	5110	309	48	34	15	48	Sporadic
18	63°49'54.2"	75°22'47.1"	Pyakupur	9881	324	45	40	12	34	Sporadic
12	62°07'50.0"	73°44'05.6"	Tromyegan	10770	263	51.9	35.6	12.6	10	Isolated
23	64˚55'55.1"	77˚56'08.2 "	Aivasedapur	26100	309	40.1	45.5	14.4	20	Sporadic
9	58˚04'20.8"	82˚49'19.7"	Chaya	27622	291	46.9	42.5	10.6	5	Absent
4	61˚26'13.6"	74˚47'39.7"	Agan	27600	291	46.9	42.5	10.6	5	Isolated
8	60°55'41.0"	76°53'49.3"	Vakh	75090	298	35	61	4	5	Absent
27	65˚57'05.5"	78˚18'59.1"	Pur	112000	298	56.9	34.4	8.7	34	Discontinuous
33	67˚22'13.28"	79˚00'25.9"	Taz	150000	330	38	59	3	59	Continuous
1	59°03'45.5"	80°52'08.9"	Ob'	520000	N.D.	9	N.D.	N.D.	0	Absent
7	60˚40'28.8"	77˚31'29.4"	Ob'	773200	216	10	N.D.	N.D.	0	Absent

PF is for permafrost, % of watershed coverage. Full dataset of measured parameters is available at the Research gate (DOI:10.13140/RG.2.2.36650.93121); https://www.researchgate.net/publication/325334684.

Table S2. Correlation matrix of watershed physico-geographical parameters and particulate nutrient concentration. All rivers, June and August and September. Marked (bold and red) Pearson correlations R > 0.28 are significant at $p < 0.09$. Lat and Permaf. are for Latitude (° N) and permafrost coverage of the watershed, %. The runoff is in mm y^{-1} and bogs, forest and lakes represent the % coverage in the watershed

		Lat	S, km²	runoff	Bogs	Forest	Lakes	Permaf
Spring 2016								
permafrost-free (N=8)	RSM, mg/l	**0.87**	**0.91**	0.67	0.12	0.62	**0.79**	-
	N, %	-0.61	-0.38	-0.44	-0.33	-0.60	-0.12	-
	C, %	-0.65	-0.47	-0.46	-0.34	-0.59	-0.23	-
	% C_{RSM} of total C	0.44	0.49	0.53	-0.38	0.36	0.58	-
	P	-0.19	-0.37	-0.18	-0.28	0.51	-0.49	-
	% P_{RSM} of P total	**0.95**	**0.88**	**0.87**	0.03	0.62	**0.80**	-
permafrost-bearing (N=24)	RSM, mg/l	**0.55**	-0.004	0.11	-0.39	0.19	-0.24	**0.52**
	N, %	**-0.55**	-0.16	**-0.53**	**0.66**	**-0.69**	**0.72**	**-0.50**
	C, %	**-0.55**	-0.21	**-0.56**	**0.66**	**-0.72**	**0.78**	**-0.48**
	% C_{RSM} of total C	-0.29	-0.16	-0.38	**0.47**	**-0.61**	**0.75**	-0.25
	P	-0.28	0.05	-0.13	0.33	-0.24	-0.10	-0.36
	% P_{RSM} of P total	-0.24	-0.15	**-0.44**	0.34	**-0.51**	**0.40**	-0.27
Summer 2016								
permafrost-free (N=8)	RSM, mg/l	**0.76**	0.42	0.67	0.38	0.18	0.34	-
	N, %	-0.55	-0.27	-0.43	-0.53	-0.39	-0.01	-
	C, %	**-0.81**	-0.66	**-0.76**	-0.54	-0.41	-0.43	-
	% C_{RSM} of total C	**0.92**	0.63	**0.87**	0.05	0.57	0.56	-
	P	-0.54	**-0.81**	-0.57	-0.44	0.21	**-0.82**	-
	% P_{RSM} of P total	0.53	0.01	0.52	0.20	0.41	-0.15	-
permafrost-bearing (N=24)	RSM, mg/l	**-0.43**	**-0.38**	**-0.40**	**0.55**	-0.30	-0.05	-0.28
	N, %	-0.35	0.06	-0.10	**0.60**	**-0.67**	**0.50**	**-0.41**
	C, %	**-0.53**	-0.24	**-0.61**	**0.63**	**-0.78**	**0.76**	**-0.52**
	% C_{RSM} of total C	**-0.53**	**-0.45**	**-0.58**	**0.38**	-0.26	0.20	**-0.50**
	P	0.29	0.24	0.34	-0.24	0.32	**-0.46**	0.05
	% P_{RSM} of P total	-0.27	-0.28	-0.16	0.35	-0.21	-0.17	-0.22
Autumn 2016								
permafrost-free (N=8)	RSM, mg/l	0.29	0.52	0.45	0.41	-0.01	0.40	-
	N, %	-0.13	0.20	-0.09	-0.39	-0.31	0.45	-
	C, %	-0.51	-0.20	-0.43	-0.44	-0.47	0.08	-
	% C_{RSM} of total C	0.74	**0.88**	**0.78**	0.12	0.37	**0.83**	-
	P	-0.45	-0.74	-0.46	0.01	-0.12	**-0.88**	-
	% P_{RSM} of P total	0.29	0.52	0.45	0.41	-0.01	0.40	-
permafrost-bearing (N=24)	RSM, mg/l	**0.51**	-0.12	0.09	-0.17	0.19	-0.34	**0.61**
	N, %	**-0.55**	0.17	-0.23	**0.70**	**-0.64**	**0.60**	**-0.61**
	C, %	**-0.69**	-0.18	**-0.50**	**0.60**	**-0.66**	**0.78**	**-0.67**
	% C_{RSM} of total C	-0.16	-0.13	-0.21	0.12	-0.02	0.17	-0.12
	P	0.17	0.05	0.28	**-0.36**	**0.60**	-0.36	0.26
	% P_{RSM} of P total	**-0.42**	-0.23	**-0.43**	**0.37**	-0.29	0.32	-0.28

All seasons								
permafrost-free (N=24)	RSM, mg/l	0.41	0.35	0.37	0.14	0.36	0.27	-
	N, %	**-0.47**	-0.25	-0.39	**-0.53**	-0.42	-0.03	-
	C, %	**-0.61**	-0.42	**-0.51**	**-0.52**	**-0.55**	-0.19	-
	% C_{RSM} of total C	**0.62**	**0.58**	**0.64**	-0.01	**0.50**	**0.54**	-
	P	-0.25	**-0.50**	-0.20	0.24	-0.26	**-0.56**	-
	% P_{RSM} of P total	**0.48**	0.32	**0.56**	0.33	0.31	0.20	-
permafrost-bearing (N=70)	RSM, mg/l	0.18	-0.18	-0.09	0.03	0.01	-0.20	**0.26**
	N, %	**-0.44**	0.01	**-0.27**	**0.60**	**-0.62**	**0.55**	**-0.47**
	C, %	**-0.57**	**-0.21**	**-0.54**	**0.60**	**-0.69**	**0.74**	**-0.54**
	% C_{RSM} of total C	**-0.29**	**-0.23**	**-0.36**	**0.29**	**-0.25**	**0.32**	**-0.26**
	P	0.12	0.11	0.19	-0.15	**0.28**	**-0.32**	0.03
	% P_{RSM} of P total	**-0.28**	**-0.21**	**-0.32**	**0.33**	**-0.31**	0.15	**-0.24**

Correlation matrix of watershed physico-geographical parameters and particulate nutrient concentration. All rivers, all seasons, $p < 0.05$

		Latitude	S, km²	runoff	Bogs	Forest	Lakes	Permaf
permafrost-free (N=24)	RSM. mg/l	0.41	0.35	0.37	0.14	0.36	0.27	-
	N. %	-0.47	-0.25	-0.39	**-0.53**	-0.42	-0.03	-
	C. %	**-0.61**	-0.42	-0.51	**-0.52**	**-0.55**	-0.19	-
	% C_{RSM} of total C	**0.62**	**0.58**	**0.64**	-0.01	0.50	**0.54**	-
	P	-0.25	-0.50	-0.20	0.24	-0.26	**-0.56**	-
	% P_{RSM} of P total	0.48	0.32	**0.56**	0.33	0.31	0.20	-
permafrost-bearing (N=70)	RSM. mg/l	0.18	-0.18	-0.09	0.03	0.01	-0.20	**0.26**
	N. %	**-0.44**	0.01	**-0.27**	**0.60**	**-0.62**	**0.55**	**-0.47**
	C. %	**-0.57**	-0.21	**-0.54**	**0.60**	**-0.69**	**0.74**	**-0.54**
	% C_{RSM} of total C	**-0.29**	-0.23	**-0.36**	**0.29**	**-0.25**	**0.32**	**-0.26**
	P	0.12	0.11	0.19	-0.15	**0.28**	**-0.32**	0.03
	% P_{RSM} of P total	**-0.28**	-0.21	**-0.32**	**0.33**	**-0.31**	0.15	**-0.24**

Table S3. Compilation of statistical parameters for the differences in RSM, C, N and P concentration (N=32) among watersheds of different size (<100, 100-1000, 1000-50000, >50000 km²)

Table S3-A: Non-parametric H-criterion Kruskal Wallis for un-paired data, at $p < 0.05$

Season	Variable	H	p-level
Spring	**RSM**	-	-
	C	10.98	**0.0118**
	N	10.55	**0.0145**
	P	-	-
Summer	**RSM**	-	-
	C	15,74	**0.0013**
	N	-	-
	P	-	-
Autumn	**RSM**	-	-
	C	11,02	**0,0116**
	N	10,72	**0,0133**
	P	-	-

Table S3-B: Impact of the watershed area ($S_{watershed}$) on RSM and nutrient concentration. Mann-Whitney U test, statistically significant (at $p < 0.05$) differences are in bold red. (N=32)

Water shed, km²	Variable	Spring			Summer			Autumn		
		U	Z	p-level	U	Z	p-level	U	Z	p-level
<100/100-1000	RSM, mg/l	20.0	-1.415	0.1571	28.0	0.906	0.365	37.00	0.091	0.928
	C, %	11.0	**2.294**	**0.0218**	10.0	**2.537**	**0.011**	12.00	**2.355**	**0.019**
	N, %	10.0	**2.391**	**0.0168**	16.0	**1.992**	**0.046**	9.00	**2.626**	**0.009**
	P,%	25.0	-0.635	0.525	23.0	-1.359	0.174	32.00	-0.543	0.587
100-1000/1000-50000	RSM, mg/l	26.0	0.174	0.862	21.0	-1.059	0.290	22.50	-0.900	0.368
	C, %	23.0	-0.521	0.603	27.0	0.423	0.672	25.00	-0.635	0.525
	N, %	22.0	-0.637	0.524	24.0	-0.741	0.459	17.00	-1.481	0.138
	P,%	26.0	0.174	0.862	31.0	0.0000	1.000	29.00	-0.212	0.832
1000-50000/>50000	RSM, mg/l	8.00	-1.683	0.092	21.0	0.133	0.894	22.50	-0.900	0.368
	C, %	10.0	1.391	0.164	13.0	1.200	0.230	25.00	-0.635	0.525
	N, %	13.00	0.952	0.341	20.00	0.267	0.790	17.00	-1.482	0.138
	P,%	13.00	0.952	0.341	11.00	1.4667	0.1425	29.00	-0.212	0.832

Table S3-C. Non-parametric H-criterion Kruskal Wallis for un-paired data, at $p < 0.05$. Difference between parameters depending on type of permafrost (Absent, Isolated, Sporadic, Discontinuous, Continuous)

Season	Variable	H	p-level
Spring	**RSM**	-	-
	C	12.07	**0.017**
	N	10.59	**0.031**
	P	-	-
Summer	**RSM**	15.81	**0.0033**
	C	14.77	**0.0052**
	N	11.33	**0.0230**
	P	-	-
Autumn	**RSM**	18.28	**0.0004**
	C	10.68	**0.014**
	N	7.86	**0.049**
	P	-	-

Table S3-D. Mann-Whitney U test of the difference in nutrient concentration between two adjacent permafrost zones. Statistically significant (at $p < 0.05$) differences are in bold red. (N=32)

	Variable	Spring			Summer			Autumn		
		U	Z	p-level	U	Z	p-level	U	Z	p-level
Permafrost/ Absent	RSM, mg/l	61.0	-1.266	0.205	63.5	1.414	0.157	22.0	**-3.22**	**0.001**
	C, %	82.0	-0.281	0.778	33.0	**-2.74**	**0.006**	48.0	**-2.09**	**0.037**
	N, %	81.0	-0.328	0.743	34.0	**-2.70**	**0.007**	68.0	-1.22	0.223
	P,%	70.0	0.683	0.495	71.0	1.088	0.277	61.0	1.52	0.128
Absent/ Isolated	RSM, mg/l	19.0	-0.073	0.942	14.5	1.162	0.245	14.0	-1.226	0.220
	C, %	11.0	-1.244	0.213	4.0	**-2.52**	**0.012**	3.0	**-2.647**	**0.008**
	N, %	11.0	-1.244	0.213	2.0	**-2.77**	**0.006**	5.0	**-2.388**	**0.017**
	P,%	20.0	0.452	0.651	13.0	1.356	0.175	11.0	1.614	0.107
Sporadic/ Discontinious	RSM, mg/l	13.0	0.0	1.0	2.0	**2.39**	**0.017**	16.0	-1.221	0.222
	C, %	5.0	1.479	0.139	7.0	1.620	0.105	28.0	0.053	0.958
	N, %	6.0	1.294	0.196	10.0	1.157	0.247	23.0	-0.478	0.633
	P,%	6.5	1.697	0.090	18.0	-0.077	0.939	18.0	-1.009	0.313
Discontinuous/ Continious	RSM, mg/l	6.0	-0.298	0.766	4.0	1.347	0.178	6.0	0.857	0.391
	C, %	5.0	0.596	0.551	9.0	-0.122	0.903	3.0	1.592	0.111
	N, %	5.0	0.596	0.551	10.0	0.122	0.903	4.0	1.347	0.178
	P,%	9.0	-0.122	0.903	4.0	-1.347	0.178	3.0	1.592	0.111

Table S3-E. Mann-Whitney U test for the impact of bog coverage of the watershed on RSM and nutrient concentration, for < 10% and > 10% of lake coverage. Statistically significant (at p < 0.05) differences are in bold red. (N=30)

Variable	Spring			Summer			Autumn		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
RSM, mg/l	90.0	0.0	1.0	100.5	-0.863	0.388	103.5	-0.748	0.454
C, %	44.0	**-2.22**	**0.026**	30.0	**-3.568**	**0.0004**	24.0	**-3.799**	**0.0001**
N, %	44.0	**-2.22**	**0.026**	32.0	**-3.492**	**0.0005**	43.0	**-3.070**	**0.0021**
P,%	76.0	-0.386	0.700	63.0	**2.302**	**0.0213**	104.0	0.729	0.4660

Table S3-F. Mann-Whitney U test for the impact of bog coverage of the watershed on RSM and nutrient concentration, for < 50% and > 50% of bog coverage. Statistically significant (at p < 0.05) differences are in bold red (N=30)

Variable	Spring			Summer			Autumn		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
RSM, mg/l	83.0	0.904	0.366	93.5	-1.132	0.258	119.0	-0.153	0.878
C, %	58.0	**-1.980**	**0.048**	63.0	**-2.30**	**0.021**	71.0	**-1.995**	**0.046**
N, %	62.0	-1.808	0.0707	70.0	**-2.03**	**0.042**	68.0	**-2.110**	**0.035**
P,%	77.0	-0.967	0.334	94.0	1.11	0.266	97.0	0.998	0.318

Table S3-G. Mann-Whitney U test for the impact of bog coverage of the watershed on RSM and nutrient concentration, for < 30% and > 30% of forest coverage. Statistically significant (at p < 0.05) differences are in bold red. (N=30)

Variable	Spring			Summer			Autumn		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
RSM, mg/l	76.0	-0.443	0.658	87.0	0.550	0.582	68.0	-1.386	0.166
C, %	31.0	**2.656**	**0.0079**	11.0	**3.893**	**0.0001**	29.0	**3.102**	**0.0019**
N, %	33.0	**2.558**	**0.0105**	38.0	**2.705**	**0.007**	31.0	**3.014**	**0.0026**
P,%	80.0	0.0258	0.9795	57.0	-1.869	0.062	46.0	**-2.354**	**0.0186**

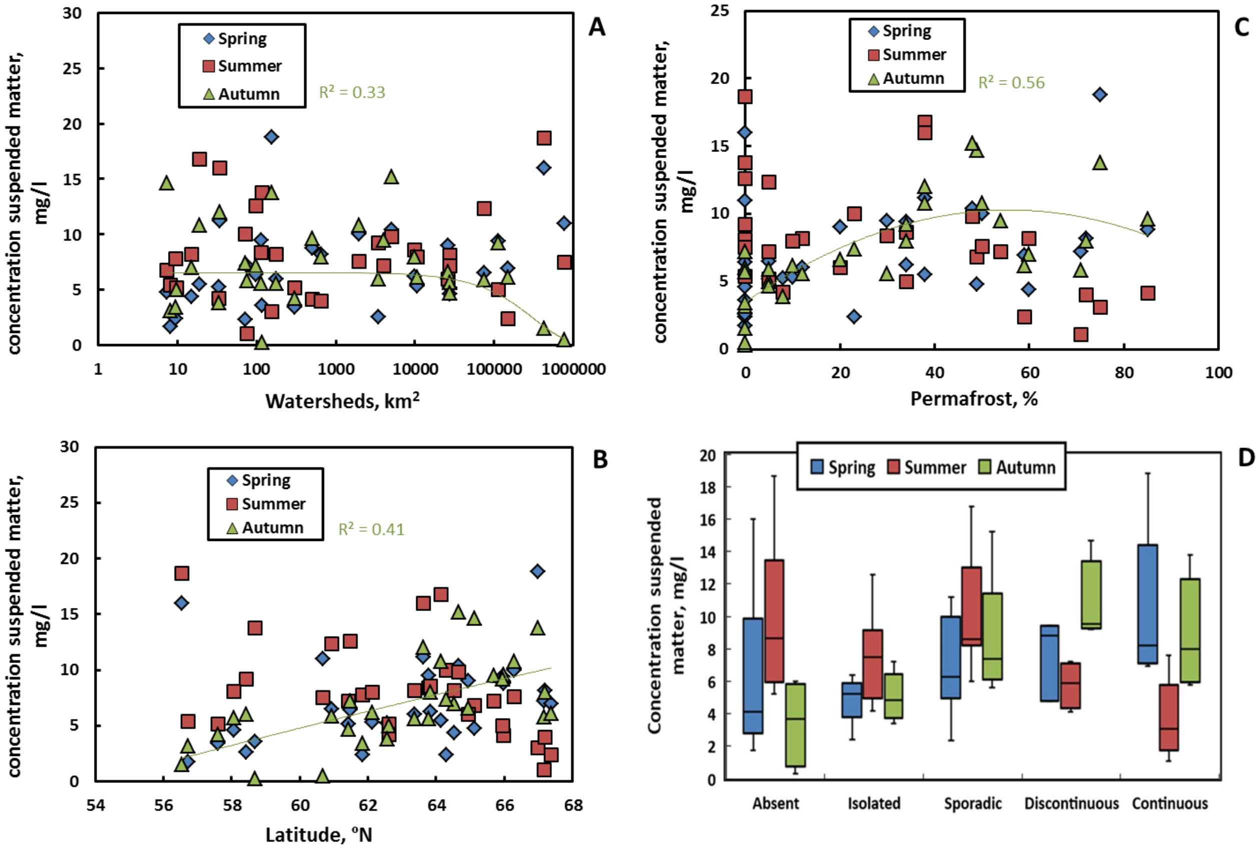

Fig. S1. Effect of watershed size (**A**), latitude (**B**), permafrost coverage (**C**) and box-plot of permafrost type (**D**) on RSM concentration in WSL rivers. The solid lines represent power law (A) and 2^{nd} degree polynomial (B, C) fitting of the data with regression coefficients shown for each season in corresponding panels.

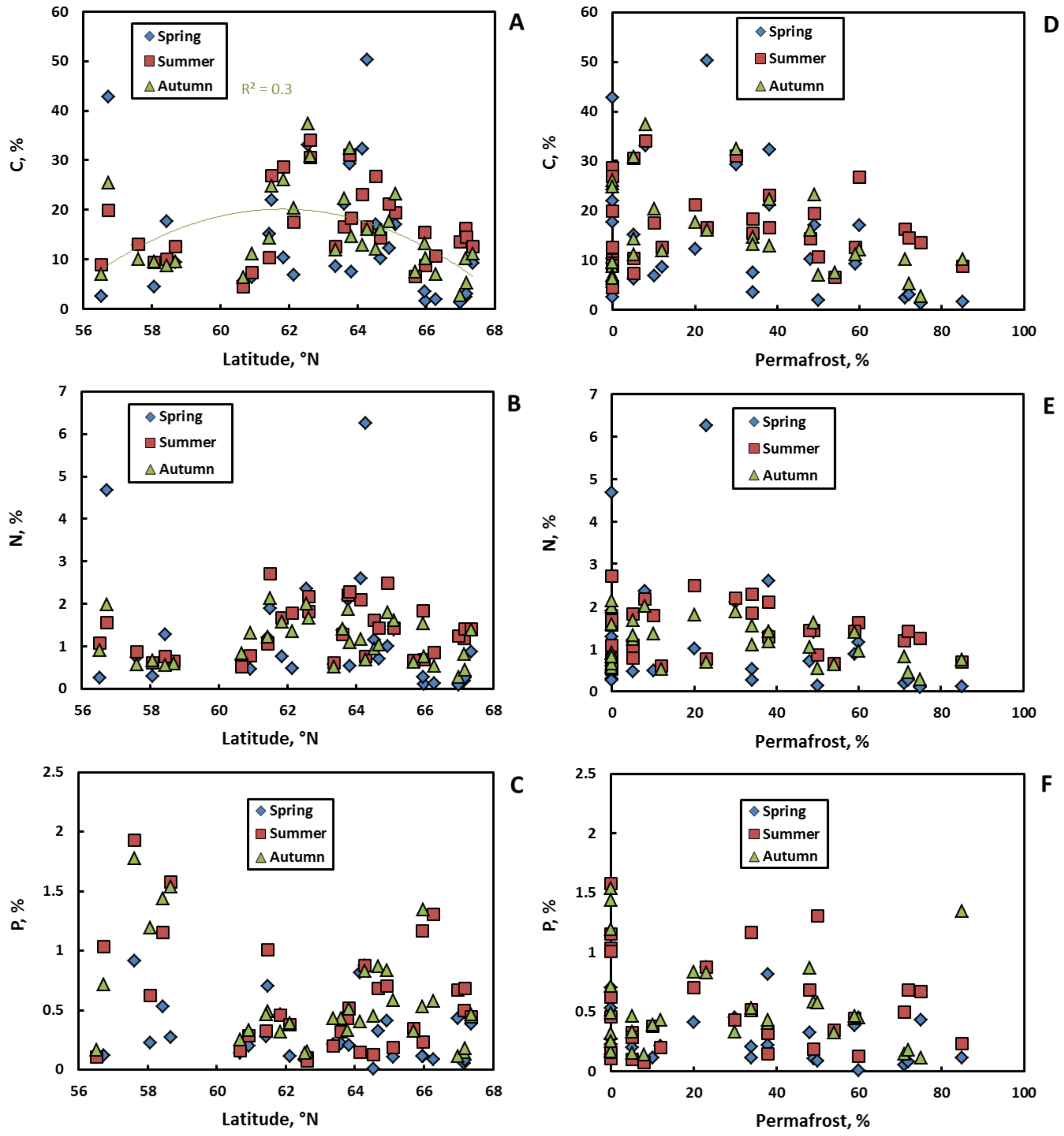

Fig. S2. Latitudinal dependences of C (**A**), N (**B**) and P (**C**) concentration in RSM. Note a local maximum in C concentrations is at 62-64°N, of the isolated to sporadic permafrost zone, where the maximal thawing of permafrost occurs (A). The concentration of N demonstrate significant ($p = 0.05$) local minim at north of 66°N, detectable only in spring. C (**D**), N (**E**) and P (**F**) concentration in RMS of WSL rivers as a function of permafrost coverage of the watershed. No significant ($p < 0.05$) link between the % of permafrost coverage and nutrient concentration was revealed. The solid lines represent 2^{nd} degree polynomial fitting of the data with regression coefficients shown for each season in corresponding panels. Only the curves with $R^2 > 0.3$ are depicted.

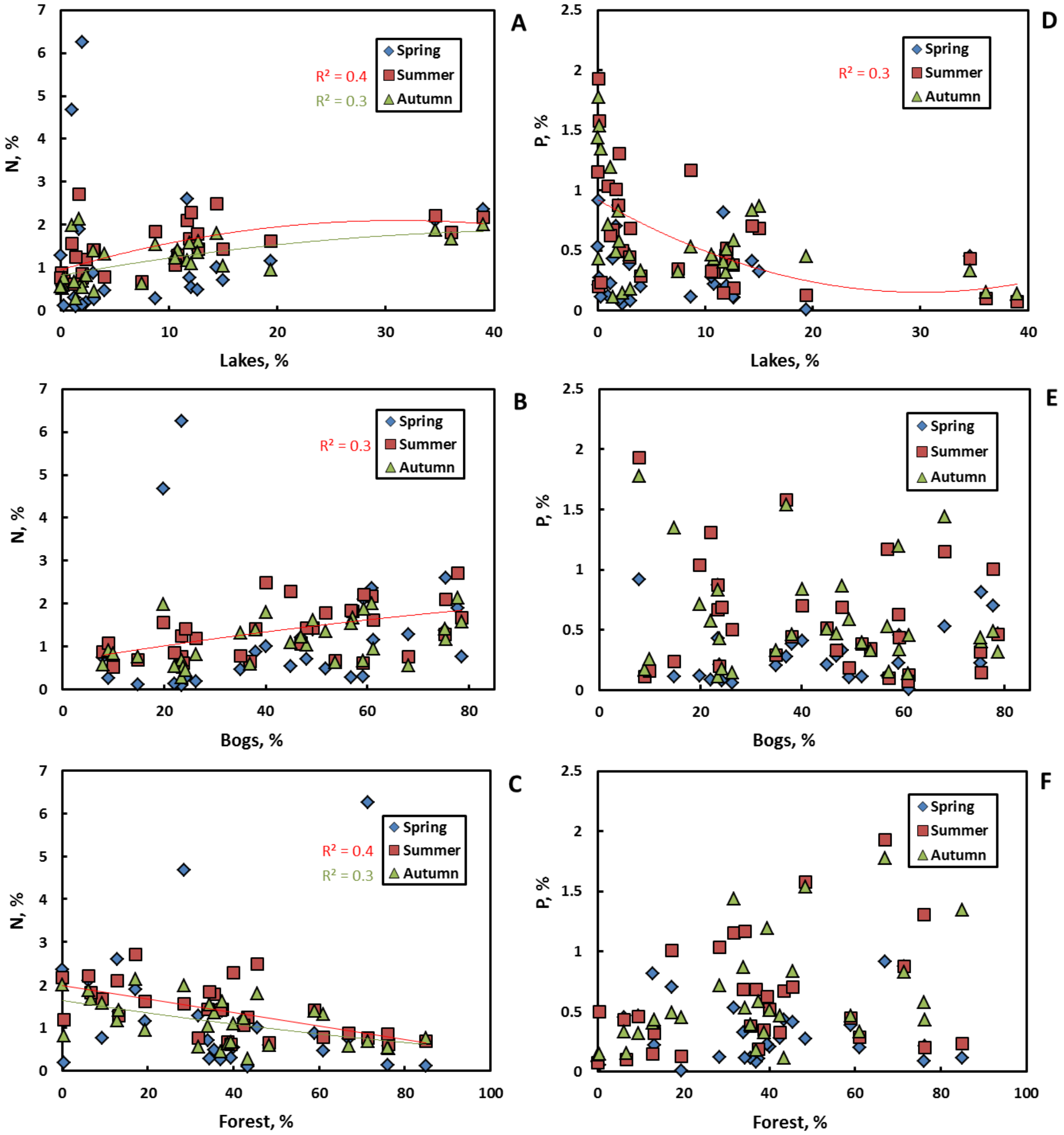

Fig. S3. N (A-C) and P (D-F) concentration in RSM (in ppm) of WSL rivers as a function of lakes (A, D), bogs (B, E) and forest (C, F) coverage of the watershed during different seasons. The solid lines represent 2nd degree polynomial fitting of the data with regression coefficients shown for each season in corresponding panels. Only the curves with $R^2 \geq 0.3$ are depicted.

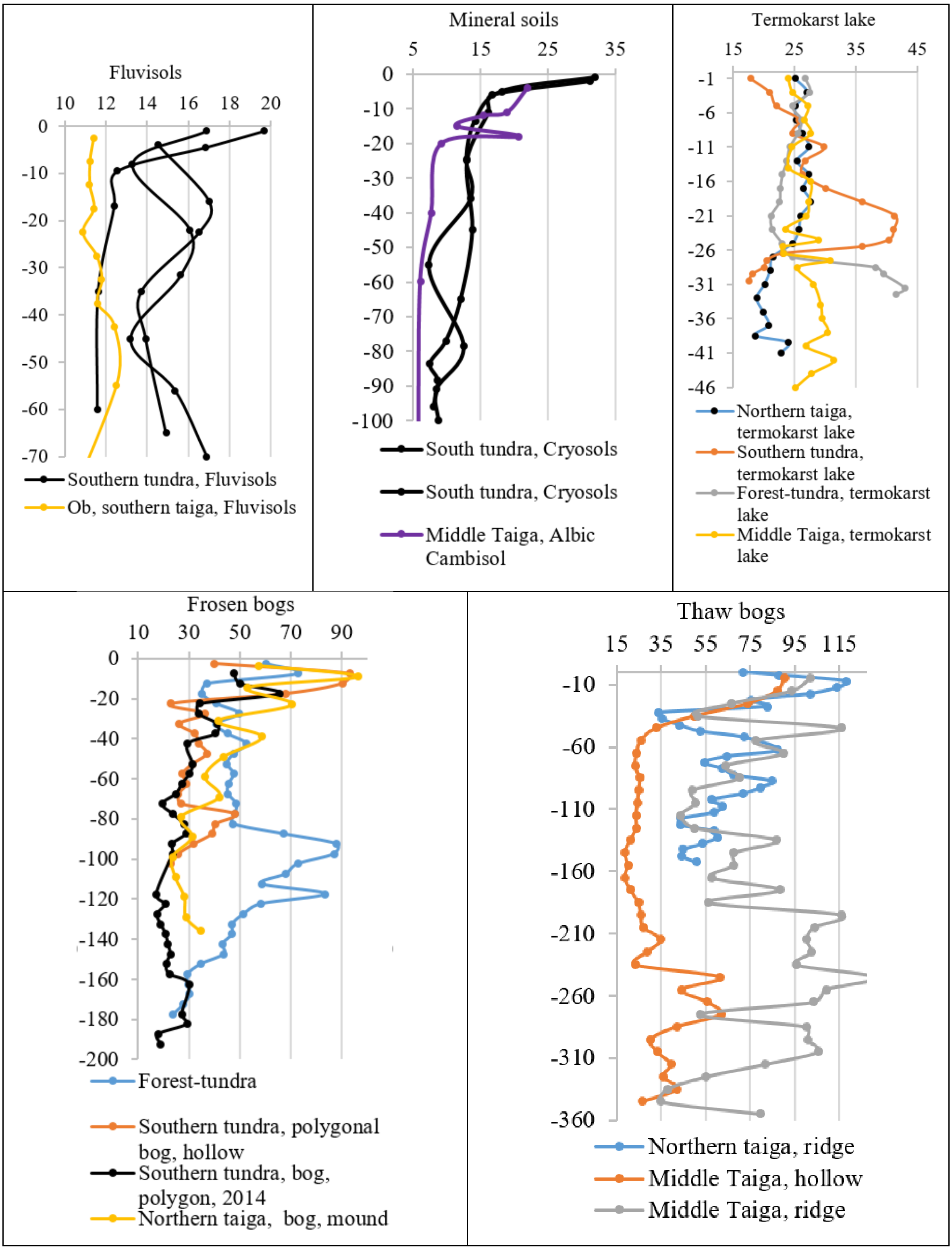

Fig. S4. C:N in peat profile across the latitudinal transect of WSL, corresponding to four main regions (permafrost-free region of Ob, southern taiga; isolated/sporadic permafrost at Kogalym; discontinuous permafrost at Khanymey and continuous permafros at Tazovsky). Authors' unpublished data.

Table S4. Mean C:N values in presented profiles.

Site	Mean ± SD
Cryosols in Tazovsky, south tundra, mineral soils	14.0±7.0
Cryic Histosols, polygonal southern tundra in Tazovsky, (CкTz15)	24.3±5.7
Cryic Histosols, polygonal southern tundra in Tazovsky (CкTz14-2)	28.4±10.7
Cryic Histosols, depression over permafrost, southern tundra (CкTz14-3)	39.5±20.1
Soil of recently drained lakes, south tundra, Tazovsky, 2016	22.4±3.0
Sediments of thermokarst lake in Tazovsky, continuous permafrost	27.3±8.1
Fluvisols in Taz River flood zone, south tundra, continuous permafrost	14.9±2.2
Cryic Histosols, frozen mound in Pangody, forest-tundra (CкP15)	50.0±16.3
Thermokarst lake sediment Pangody, August 2015	27.7±7.3
Cryic Histosols, frozen mound in northern taiga Khanymey (X17-9)	43.6±19.6
Cryic Histosols, frozen mound in northern taiga Khanymey (X14-4)	57.1±16.8
Albic Alisol, light color soil, Khanymey, northern taiga Khanymey	13.0±6.4
Thermokarst lake sediment Khanymey, August 2015	24.0±3.0
Histosols, bog, ridge, northern taiga, Kogalym , sporadic perm. (Kg16-1)	65.4±21.1
Thermokarst lake sediment Kogalym, August 2015	26.8±2.5
Histosols, bog, depression, middle taiga (Stepanova et al., 2015)	36.3±18.8
Histosols, bog, ridge, middle taiga (Stepanova et al., 2015)	79.4±25.5
Fluvisols in floodzone of the Ob River, southern taiga, Kaibasovo, 2017	11.0±1.4