



Supplement of

Reconstructing past hydrology of eastern Canadian boreal catchments using clastic varved sediments and hydro-climatic modelling: 160 years of fluvial inflows

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This supplementary material provides additional visual support and statistical information on varve's parameters series. Quantitative data on the sedimentological response of cores NAS-1 and NAS-2 to post-1972 Naskaupi River hydrological changes are also available.

Total varve thickness (TVT), detrital layer thickness (DLT) and the particle size (P99D₀) series from different sites (BEA-1, NAS-1 and NAS-2) share similarities in their short- and longer-term variability. TVT and DLT series (Fig. S1, S2, Tab. S1, S2) generally show downward trends especially in core BEA-1 and NAS-2. A step in the TVT and DLT is observable in the early 1920s at the three sites. Despite the increase in thickness values of varves deposited post-1971 in core NAS-1, each core has recorded a decrease for the 1972-2016 period.

P99D₀ series of core BEA-1 and NAS-1 (Fig. S3, Tab. S3) show a slight coarsening trend towards the end of the 19th century. From 1900 to 1971, P99D₀ values are generally below average. There is an increase of P99D₀ values in core NAS-1 after 1972, but this increase remains very moderate. An increase of P99D₀ values in core BEA-1 is also observed after 1972 while the Beaver River's catchment is devoid of anthropogenic modifications and most likely unaffected by the Naskaupi River diversion.

Varve's parameters series reveals common decadal-scale variability, especially $P99D_0$ series (Fig. S3). Recently, all series show high river discharges from 1975 to 1985 and 1995 to 2005 and lower river discharges from 1985 to 1995 and 2005 to 2016.

Fig. S4 and S5 of the supplements present all reconstructions tested using different sources of sedimentological data. Despite differences, Q-mean and Q-max reconstructions are consistent with the observed data and generally share common interannual variability. Note that there are small differences between reconstructions using the combined DLT and P99D₀ series (without the NAS-1 1978-2016 period) and the combined series including all data (Fig. S4b, S5b). Excluding or not the 1972-2016 measurements from NAS-1 from the combined series has no major incidence on reconstructions. Indeed, a statistically significant decreasing trend is observed over the last 90 years in both reconstructed Q-mean series using combined DLT series without the

NAS-1 1978-2016 period or the DLT combined series including all data reconstructions (Fig. S4b).

Tab S6, S7, S8, S9, S10, S11 of the supplements provide the results of model calibration using a twofold cross-validation technique over the instrumental period for all Naskaupi River Q-mean, Q-max and Labrador region Q-mean reconstructions. Average coefficient of efficiency (CE) and average reduction of error (RE) were calculated over the verification period to evaluate reconstruction skills. CE and RE value, ranging from + 1.0 to - ∞ . RE > 0, indicates that the reconstruction is better than the calibration period mean. RE and CE \leq 0 being no better than the calibration period. Statistics in boldface show that reconstructions proposed in Fig. 8 and 9 of the paper offer the best calibration and validation results.



Figure S1 Total Varve Thickness (TVT) time series of core (a) BEA-1, (b) NAS-1 and (c) NAS-2, with 5-year moving average (black line). Trend lines are shown for the 1856-1919, 1920-1971 and 1972-2016 periods (thin black lines). The 1972 marker layer is outlined by the thick black dashed line.

Table S1 The mean, variance and trend of TVT series from each site for the 1856-2016, 1856-1919, 1920-1971 and 1972-2016 periods. Trends of mean in Boldface are significant using the mantel and Kendal trend test.

BEA-1								
	1856-2016	1856-1919	1920-1971	1972-2016				
	TVT	TVT	TVT	TVT				
mean (mm)	3.58	3.91	4.01	2.63				
variance	1.49	0.8	1.68	1.01				
trend of mean	decrease	decrease	decrease	decrease				
		NAS-1						
	1856-2016	1856-1919	1920-1971	1972-2016				
	TVT	TVT TVT		TVT				
mean (mm)	4.39	3.80	4.57	5.03				
variance	1.91	0.73	1.39	3.32				
trend of mean	increase	decrease	decrease	decrease				
		NAS-2						
	1856-2016	1856-1919	1920-1971	1972-2016				
	TVT	TVT	TVT	TVT				
mean (mm)	4.16	3.77	5.44	3.23				
variance	2.91	0.78	3.56	2.29				
trend of mean	rend of mean decrease decrease			decrease				



Figure S2. Detrital Layer Thickness (DLT) time series of core (a) BEA-1, (b) NAS-1 and (c) NAS-2, with 5-year moving average (black line). Trend lines are shown for the 1856-1919, 1920-1971 and 1972-2016 periods (thin gray lines). The 1972 marker layer is outlined by the thick black dashed line.

Table S2. The mean, variance and trend of DLT series from each site for the 1856-2016, 1856-1919, 1920-1971 and 1972-2016 periods. Trends of mean in Boldface are significant using the mantel and Kendal trend test.

BEA-1								
	1856-2016	1856-1919	1920-1971	1972-2016				
	DLT	DLT	DLT	DLT				
mean (mm)	1.82	2.14	1.98	1.18				
variance	0.824	0.52	0.97	0.53				
trend of mean	decrease	decrease	decrease	decrease				
NAS-1								
	1856-2016	1856-1919	1920-1971	1972-2016				
	DLT	DLT DLT		DLT				
mean (mm)	2.4	1.79	2.29	3.39				
variance	1.52	0.28	0.67	2.78				
trend of mean	increase	decrease	no trend	decrease				
		NAS-2						
	1856-2016	1856-1919	1920-1971	1972-2016				
	DLT	DLT	DLT	DLT				
mean (mm)	NA	NA	NA	1.59				
variance	NA	NA	NA	0.68				
trend of mean	NA	NA	NA decreas					



Figure S3. P99D₀ time series of cores (a) BEA-1, (b) NAS-1 and (c) NAS-2, with 5-year moving average (black line). Trend lines are shown for the 1856-1919, 1901-1971 and 1972-2016 periods (thin black lines). The 1972 marker layer is outlined by the black dashed line.

Table S3. The mean, variance and trend of $P99D_0$ series from each site for the 1856-2016, 1856-1900, 1901-1971 and 1972-2016 periods. Trend of mean in Boldface are significant using the mantel and Kendal trend test.

BEA-1								
	1856-2016	1856-1900	1901-1971	1972-2016				
	P99D0	P99D0	P99D0					
mean (mm)	33.72	37.01	32.48	33.05				
variance	59.98	74.13	38.06	72.66				
trend of mean	decrease	increase	decrease	increase				
NAS-1								
	1856-2016	1856-1900	1901-1971	1972-2016				
	P99D0	P99Do P99Do		P99D0				
mean (mm)	35.39	33.75	31.66	42.91				
variance	67.63	63.58	31.44	49.22				
trend of mean	increase	increase	increase	no trend				
		NAS-2						
	1856-2016	1856-1900	1901-1971	1972-2016				
	P99D0	P99D0	P99D0	P99D0				
mean (mm)	NA	NA	NA	33.75				
variance	NA	NA	NA	27.21				
trend of mean	NA	NA	NA increase					

Table S4 P-values of correlation coefficients (Pearson r) between the hydrologaical variables with Total Varve Thickness (TVT), Detrital Layer Thickness (DLT) and particle size (P99D₀) on the instrumental period (1978-2011; n=31) for each core. P-values in boldface are significant at p < 0.05.

			Hydrolog	gical variabl	es of statior	n 03PB002	
	Core BEA-1	Q-mean	Q-max	Q-max-Jd	Rise-Time	Nb-days-supQ80	Q-nival
	тvт	0.00235	0.00935	0.31609	0.76341	0.00192	0.02562
	DLT	0.00158	0.03322	0.95891	0.24100	0.01414	0.08081
	P99D ₀	0.00103	0.00108	0.78222	0.37780	0.06799	0.02787
(0	Core NAS-1	Q-mean	Q-max	Q-max-Jd	Rise-Time	Nb-days-supQ80	Q-nival
ters	тvт	0.00287	0.00011	0.09818	0.17339	0.00162	0.00134
ame	DLT	0.00202	0.00004	0.10021	0.14203	0.00262	0.00208
oara	P99D ₀	0.31655	0.00037	0.03683	0.00909	0.16793	0.02700
nent	Core NAS-2	Q-mean	Q-max	Q-max-Jd	Rise-Time	Nb-days-supQ80	Q-nival
∋din	түт	0.00557	0.01045	0.83791	0.19485	0.00143	0.00887
Š	DLT	0.00022	0.00091	0.71064	0.49883	0.00061	0.00039
	P99D ₀	0.03202	0.01603	0.30583	0.16440	0.09550	0.02709
	Combined series	Q-mean	Q-max	Q-max-Jd	Rise-Time	Nb-days-supQ80	Q-nival
	ТVТ	0.00111	0.00065	0.30307	0.27989	0.00048	0.00268
	DLT	0.00003*	0.00009	0.57270	0.71331	0.00024	0.00072
	P99D ₀	0.00048	0.000001	* 0.63259	0.79008	0.01717	0.00129

Table S5 Significant positive correlations between the instrumental Naskaupi River mean annual discharge data (Q-mean) with other hydrometric stations Q-mean series on the instrument period (1978-2011).

	Naskaupi Q-mean				
Hydrometric Stations	Pearson r	P-value			
Ugjoktok Q-mean	0.84	0.00000001			
Minipi Q-mean	0.70	0.00002766			
Little Mecatina Q-mean	0.73	0.00001165			
Eagle Q-mean	0.49	0.00693760			



Figure S4. Naskaupi River Q-mean reconstructed from the DLT series using (a) singlecore data, (b) combined DLT series, and (c) other combinations of core data. Observed Q-mean is also shown for the 1978-2011 period (black line).



Figure S5. Naskaupi River Q-max reconstructed from the $P99D_0$ series using (a) singlecore data, (b) combined $P99D_0$ series, and (c) other combinations of core data. Observed Q-max is also shown for the 1978-2011 period (black line).

Table S6. Statistics of model calibrations using a simple linear regression between the different DLT series and the observed Q-mean data on the total instrumental period (1978-2016).

exp-var	rep-var	rmse	R ²	P-value
BEA-1 DLT	Q-mean	13.11	0.30	0.00158
NAS-1 DLT	Q-mean	13.22	0.28	0.00202
NAS-2 DLT	Q-mean	12.30	0.38	0.00022
combined DLT (without the NAS-1 1972-2016 period)	Q-mean	11.24	0.48	0.00001
combined DLT	Q-mean	11.51	0.46	0.00003
NAS-1/2 DLT	Q-mean	12.11	0.40	0.00014
BEA-1/NAS-1 DLT	Q-mean	12.44	0.37	0.00031

Table S7. Statistics of model calibrations based on a twofold cross-validation technique to validate the predictive ability of the reconstructed Naskaupi River Q-mean series. Coefficient of determination (R^2) and root mean square error (RMSE) are given for calibration periods while reduction of error (RE) and coefficient of efficiency (CE) are given for the verification periods.

exp-var	rep-var	rmse	R ²	P-value	RE	CE	verification periods
	0	15.52	0.16	0.131	0.45	0.42	1978-1993
BEA-1 DL1	Q-mean	9.06	0.58	0.001	0.08	0.04	1994-2011
	O-mean	14.13	0.30	0.028	0.27	0.23	1978-1993
NAS-T DET	Q-mean	12.07	0.25	0.058	0.31	0.28	1994-2011
NAS-2 DLT	0 maan	11.90	0.50	0.002	-0.01	-0.07	1978-1993
	Q-mean	11.81	0.28	0.042	0.42	0.40	1994-2011
combined DLT (without the NAS-1 1972-2016 period)	Q-mean	12.44	0.46	0.004	0.50	0.47	1978-1993
combined DET (without the NAS-1 1972-2010 period)		9.57	0.53	0.002	0.46	0.43	1994-2011
combined DLT	0 maan	12.56	0.45	0.005	0.47	0.44	1978-1993
	Q-mean	10.14	0.47	0.005	0.45	0.43	1994-2011
	0 maan	12.72	0.43	0.006	0.33	0.29	1978-1993
NAS-1/2 DLT	Q-mean	11.23	0.35	0.020	0.43	0.41	1994-2011
	0 mean	13.97	0.32	0.024	0.44	0.41	1978-1993
BEA-1/NAS-1 DLT	Q-mean	10.37	0.45	0.007	0.32	0.29	1994-2011

Table S8 Statistics of model calibrations using a simple linear regression between the different $P99D_0$ series and the observed Q-max data on the total instrumental period (1978-2016).

exp-var	rep-var	rmse	R ²	P-value
BEA-1 P99D0	Q-max	84.93	0.31	0.001082
NAS-1 P99D0	Q-max	81.99	0.36	0.000367
NAS-2 P99D0	Q-max	92.52	0.18	0.016030
combined P99Do (without the NAS-1 1972-2016 period)	Q-max	80.54	0.38	0.000213
combined P99Do	Q-max	67.68	0.56	0.000001
NAS-1/2 P99D0	Q-max	74.55	0.47	0.000021
BEA-1/NAS-1 P99D0	Q-max	70.87	0.52	0.000005

Table S9 Statistics of model calibrations based on a twofold cross-validation technique to validate the predictive ability of the reconstructed Naskaupi River Q-max series. Coefficient of determination (R^2) and root mean square error (RMSE) are given for calibration periods while reduction of error (RE) and coefficient of efficiency (CE) are given for the verification periods.

exp-var	rep-var	rmse	R ²	P-value	RE	CE	verification periods
BEA-1 P99D₀	0	79.81	0.45	0.00462	-0.05	-0.08	1978-1993
	Q-max	83.13	0.25	0.05708	0.30	0.28	1994-2011
	0	81.04	0.43	0.00581	0.23	0.21	1978-1993
NAS-1 P99D0	Q-max	79.24	0.32	0.02807	0.30	0.28	1994-2011
NAS-2 P99D0	0 may	100.52	0.12	0.18280	0.26	0.24	1978-1993
	Q-max	82.25	0.27	0.04861	0.12	0.10	1994-2011
	Q-max	81.30	0.43	0.00609	0.24	0.21	1978-1993
combined P99D6 (without the NAS-1 1972-2016 period)		75.30	0.39	0.01349	0.34	0.33	1994-2011
combined P00De	Q-max	59.37	0.69	0.00006	0.27	0.24	1978-1993
Combined P35D0		68.33	0.49	0.00347	0.55	0.54	1994-2011
NAS 1/2 B00Da	0 may	75.09	0.51	0.00187	0.39	0.36	1978-1993
NAS-1/2 P99D0	Q-max	71.27	0.45	0.00622	0.46	0.45	1994-2011
BEA-1/NAS-1 P99Do	0 max	55.83	0.73	0.00003	0.08	0.05	1978-1993
	Q-max	75.34	0.38	0.01361	0.54	0.53	1994-2011

Table S10. Statistics of model calibrations using a simple linear regression between the different DLT series and the observed Labrador region Q-mean data on the total instrumental period (1969-2016).

exp-var	rep-var	rmse	R ²	P-value
BEA-1 DLT	Labrador Q-mean	0.86	0.17	0.006706
NAS-1 DLT	Labrador Q-mean	0.86	0.19	0.003620
NAS-2 DLT	Labrador Q-mean	0.73	0.42	0.000004
combined DLT (without the NAS-1 1972-2016 period)	Labrador Q-mean	0.73	0.42	0.000003
combined DLT	Labrador Q-mean	0.74	0.40	0.000008
NAS-1/2 DLT	Labrador Q-mean	0.77	0.36	0.000028
BEA-1/NAS-1 DLT	Labrador Q-mean	0.81	0.27	0.000381

Table S11. Statistics of model calibrations based on a twofold cross-validation technique to validate the predictive ability of reconstructed Labrador region Q-mean series. Coefficient of determination (R^2) and root mean square error (RMSE) are given for calibration periods while reduction of error (RE) and coefficient of efficiency (CE) are given for the verification periods.

exp-var	rep-var	rmse	R ²	P-value	RE	CE	verification periods
	Labradar O maan	1.03	0.11	0.1296	0.28	-0.01	1969-1990
BEA-T DET		0.58	0.28	0.0132	0.14	0.00	1991-2011
NAS-1 DLT	Labradar O maan	0.96	0.26	0.0177	-0.04	-0.52	1969-1990
		0.63	0.16	0.0715	0.16	0.01	1991-2011
NAS-2 DLT	Labrador O moon	0.77	0.52	0.0002	0.11	-0.30	1969-1990
	Labrador Q-mean	0.59	0.27	0.0149	0.40	0.29	1991-2011
combined DLT (without the NAS 1 1072 2016 period)	Labrador Q-mean	0.80	0.48	0.0005	0.25	0.10	1969-1990
combined DET (without the NAS-1 1972-2016 period)		0.55	0.36	0.0039	0.39	0.28	1991-2011
combined DLT	Labrador Q-mean	0.78	0.51	0.0003	0.05	-0.40	1969-1990
combined DE1		0.57	0.31	0.0085	0.35	0.23	1991-2011
	Labradar O maan	0.84	0.43	0.0012	0.21	-0.16	1969-1990
NAS-1/2 DLT		0.59	0.26	0.0177	0.33	0.21	1991-2011
	Labrador O moan	0.89	0.36	0.0039	-0.06	-0.55	1969-1990
BEA-1/NAS-1 DL1	Labrador Q-mean	0.60	0.25	0.0205	0.22	0.08	1991-2011