Supplement of

Rain-fed streams dilute inorganic nutrients but subsidise organic-matter-associated nutrients in coastal waters of the northeast Pacific Ocean

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Supplementary Information

Extended methods

2.2.3 Targeted stream samplings during rainfall events (ctd.)

Sample times were determined by comparing the height of each bottle above low water level to the water levels recorded with an Odyssey water stage logger installed alongside each rack. The pump sampler (Hach Sigma 900 MAX sampler) was pre-programmed to sample based on stream stage over the rising limb and by time over the falling limb, and was remotely triggered during unexpected rainfall events. Water samples collected using the single-stage or pump samplers were typically retrieved from the installations within 12 to 24 hours (20% of samples were retrieved within 36 hours and 5% of samples were retrieved up to 3 days after collection) and transported to the field station in a cool bag where they were processed as above for TDN, TDP, dFe, and DOC, and starting in 2018, NH$_4^+$, NO$_3^-$, TP, and TN. To test the reliability of the single-stage sampler method, chemistry results of bottles installed at the same height in all watersheds in 2015, as well as single-stage samples collected concurrently with pump samples at watershed 708, were compared (Table S4). Differences between single-stage sampler bottles were 13.5±4.8%, 37.6±14.8%, 9.9±4.8%, and 3.5±1.1% for dFe, TDP, TDN, and DOC respectively. For the same parameters, differences between the single-stage and pump samplers were 37.9±33.0%, 168.5±39.9%, 13.3±10.1%, and 3.6±2.9%, respectively. While differences in TDP concentrations were large, we note that TDP concentrations were often at or below detection (0.058 µmol L$^{-1}$), such that small absolute differences (e.g., 0.100 vs. 0.200 µmol L$^{-1}$) produce large relative ones (100%).
Fig. S1. Station-specific mean monthly measured (± SE) and modeled air temperature on Calvert and Hecate Island between January 2015 and December 2018. Modeled mean monthly air temperatures extracted from the Climate NA spatially downscaled models (climatena.com, Wang et al. 2016) at coordinates corresponding to Hakai weather stations SSN626PWR, SSN1015US, SSN708, SSN819PWR, SSN693PWR, WSN703, and WSN844 (see Table S3).
Fig. S2. Station-specific total monthly measured and modeled rainfall on Calvert and Hecate Island between January 2015 and December 2018. Modeled total monthly rainfall extracted from Climate NA (climatena.com, Wang et al. 2016) at coordinates corresponding to Hakai weather stations SSN626PWR, SSN1015US, SSN708, SSN819PWR, SSN693PWR, WSN703, and WSN844 (see Table S3).
Fig. S3. Monthly mean (n = 7 stations) temperature (a) and precipitation (b) anomalies, relative to the model 1981-2010 normal (ClimateNA; Wang et al., 2016), in relation to the Oceanic Niño Index. Statistics are shown for a Pearson product moment correlation.
**Fig. S4.** Monthly flow-weighted nutrient concentrations by watershed over time. Note that the y-axes scales vary between the different constituents.
**Fig. S4 (ctd).** Monthly flow-weighted nutrient concentrations by watershed over time. Note that the y-axes scales vary between the different constituents.
Fig. S5. Stoichiometric ratios (mol mol\(^{-1}\)) of the freshwater fluxes by watershed over time. Ratios calculated based on the monthly fluxes for each watershed.
**Fig. S6.** Nutrient concentration mixing plots across the freshwater plume (0, 1 and 5 m at six stations) at the outlet of watershed 703 for the 135 mm rainfall event on 19-Sept-2015 (day 2 of 8-day event). Combined nitrate-nitrite (NO$_3^-$+NO$_2^-$; panel a), phosphate (PO$_4^{3-}$; panel b), silicic acid (Si(OH)$_4$; panel c), dissolved organic carbon (DOC; panel d), dissolved organic nitrogen (DON; panel e), and dissolved iron (dFe; panel f) are shown. Freshwater and marine end-members are the mean concentration at watershed 703 for the month of September and the plume sample with the highest salinity, respectively.
Figure S7. Stoichiometric ratios across the freshwater plume (0, 1 and 5 m at six stations) at the outlet of watershed 703 during the rainfall event on 19-Sept-2015. Freshwater and marine end-members are the mean concentration at watershed 703 for the month of September and the plume sample with the highest salinity, respectively.
**Supplementary Information**

**Table S1.** Marine sampling station information.

<table>
<thead>
<tr>
<th>Station</th>
<th>Latitude (°N)</th>
<th>Longitude (°W)</th>
<th>Depth (m)</th>
<th>Record</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meay Channel</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>MEA02</td>
<td>51.6754</td>
<td>128.0876</td>
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<td>MEA03</td>
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<td>128.0873</td>
<td>55</td>
<td>Aug-14 to Nov-14</td>
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<td>MEA04</td>
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<td>128.0693</td>
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<td>Aug-14 to Feb-16</td>
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<td><strong>Kwakshua Channel</strong></td>
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<td>KC7</td>
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<td>Aug-14 to Feb-16</td>
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<td>KC10</td>
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<td>127.9516</td>
<td>345</td>
<td>Aug-14 to Feb-16</td>
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<tr>
<td>KC11</td>
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<td>KC12</td>
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<td>KC14</td>
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<td>127.9961</td>
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<td>Aug-14 to Feb-16</td>
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<td>KC15</td>
<td>51.6569</td>
<td>128.0034</td>
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<td>KC16</td>
<td>51.6563</td>
<td>128.0419</td>
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<td>Aug-14 to Feb-16</td>
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<tr>
<td><strong>Pruth Bay</strong></td>
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<tr>
<td>PRUTH</td>
<td>51.6554</td>
<td>128.0913</td>
<td>70</td>
<td>Aug-14 to Nov-18</td>
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</tbody>
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### Table S2. Analytical methods and laboratories by chemical constituent.

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Constituent name</th>
<th>Period</th>
<th>Data</th>
<th>Instrument/Formula</th>
<th>Analytical Lab</th>
<th>Detection limit (µmol L⁻¹)</th>
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</thead>
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<tr>
<td>TN</td>
<td>Total nitrogen</td>
<td>2014-19</td>
<td>Fresh</td>
<td>Lachat QuickChem QC8500</td>
<td>BASL</td>
<td>0.500</td>
</tr>
<tr>
<td>TDN</td>
<td>Total dissolved nitrogen</td>
<td>2014-19</td>
<td>Fresh</td>
<td>Lachat QuickChem QC8500</td>
<td>BASL</td>
<td>0.500</td>
</tr>
<tr>
<td>NH₄⁺</td>
<td>Ammonium</td>
<td>2014-19</td>
<td>Fresh</td>
<td>Lachat QuickChem QC8500</td>
<td>BASL</td>
<td>0.214</td>
</tr>
<tr>
<td>NO₃⁻+NO₂⁻</td>
<td>Combined nitrate-nitrite</td>
<td>2014-15</td>
<td>Both</td>
<td>Lachat QuickChem QC8500</td>
<td>BASL</td>
<td>0.143</td>
</tr>
<tr>
<td></td>
<td><em>DIN</em></td>
<td>2015-19</td>
<td>Both</td>
<td>Lachat QuickChem QC8500</td>
<td>U.B.C.</td>
<td>0.036</td>
</tr>
<tr>
<td>DON*</td>
<td><em>Dissolved inorganic nitrogen</em></td>
<td>2014-19</td>
<td>Fresh</td>
<td><em>DIN = NH₄⁺ + NO₃⁻ + NO₂⁻</em></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TP</td>
<td>Total phosphorus</td>
<td>2014-19</td>
<td>Fresh</td>
<td>Lachat QuickChem QC8500</td>
<td>BASL</td>
<td>0.045</td>
</tr>
<tr>
<td>TDP</td>
<td>Total dissolved phosphorus</td>
<td>2014-19</td>
<td>Fresh</td>
<td>Lachat QuickChem QC8500</td>
<td>BASL</td>
<td>0.058</td>
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<tr>
<td>PO₄³⁻</td>
<td>Phosphate</td>
<td>2015-19</td>
<td>Both</td>
<td>Lachat QuickChem QC8500</td>
<td>U.B.C.</td>
<td>0.032</td>
</tr>
<tr>
<td>DOC</td>
<td>Dissolved organic carbon</td>
<td>2014-19</td>
<td>Fresh</td>
<td>OI Analytical Aurora</td>
<td>ACSL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1030W TOC analyser (wet oxidation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2014-19</td>
<td>Mar</td>
<td>OI Analytical Aurora</td>
<td>Ján Veizer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1030W TOC analyser (high temperature combustion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>Dissolved iron</td>
<td>2014-19</td>
<td>Fresh</td>
<td>ICP-OES</td>
<td>ACSL</td>
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<tr>
<td>Si(OH)₄</td>
<td>Dissolved silica</td>
<td>2014-19</td>
<td>Both</td>
<td>Lachat QuickChem QC8500</td>
<td>U.B.C.</td>
<td>0.100</td>
</tr>
</tbody>
</table>

* Data availability for monthly surveys of freshwater (Fresh), marine (Mar) or both (Both) for each chemical parameter.

*BASL, Biogeochemical Analytical Service Laboratory in the Department of Biological Sciences at the University of Alberta (Edmonton, AB, Canada). U.B.C., Marine Zooplankton and Micronekton Laboratory in the Department of Earth Oceans and Atmospheric Sciences (Vancouver, B.C., Canada). ACSL, Analytical Chemistry Services Laboratory, Ministry of Environment and Climate Change Strategy (Victoria, BC, Canada). Ján Veizer, Ján Veizer Stable Isotope Facility at the University of Ottawa (Ottawa, ON, Canada). UC Davis, University of California Davis Stable Isotope Facility (Davis, CA, USA).*
### Table S3. Characteristics of the seven study watersheds and freshwater outlet streams.

<table>
<thead>
<tr>
<th>Watershed ID</th>
<th>Area (km²)</th>
<th>Slope (%)</th>
<th>Lakes (% area)²</th>
<th>Wetlands (% area)²</th>
<th>Annual Q (x10⁶ m³; ±SE)³</th>
<th>Temperature (°C ± SE)</th>
<th>pH (± SE)</th>
<th>Weather station ID</th>
<th>Elevation (m.a.s.l.)⁴</th>
<th>Latitude (°N)</th>
<th>Longitude (°W)</th>
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</thead>
<tbody>
<tr>
<td>626</td>
<td>3.2</td>
<td>21.7</td>
<td>4.7</td>
<td>48.0</td>
<td>6.07 ± 0.25</td>
<td>11.10 ± 0.52</td>
<td>5.31 ± 0.14</td>
<td>SSN626PWR</td>
<td>13</td>
<td>51.6408</td>
<td>128.1219</td>
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<tr>
<td>1015</td>
<td>3.3</td>
<td>34.2</td>
<td>9.1</td>
<td>23.8</td>
<td>5.44 ± 0.22</td>
<td>11.74 ± 0.69</td>
<td>5.36 ± 0.10</td>
<td>SSN1015US</td>
<td>17</td>
<td>51.6906</td>
<td>128.0653</td>
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<tr>
<td>819</td>
<td>4.8</td>
<td>30.1</td>
<td>0.3</td>
<td>50.2</td>
<td>8.25 ± 0.45</td>
<td>9.41 ± 0.50</td>
<td>4.42 ± 0.07</td>
<td>SSN819PWR</td>
<td>79</td>
<td>51.6619</td>
<td>128.0419</td>
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<tr>
<td>844</td>
<td>5.7</td>
<td>32.5</td>
<td>0.3</td>
<td>35.2</td>
<td>11.83 ± 0.15</td>
<td>9.43 ± 0.52</td>
<td>4.47 ± 0.07</td>
<td>WSN844</td>
<td>90</td>
<td>51.6614</td>
<td>127.9975</td>
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<tr>
<td>708</td>
<td>7.8</td>
<td>28.5</td>
<td>7.5</td>
<td>46.3</td>
<td>16.11 ± 0.62</td>
<td>11.95 ± 0.62</td>
<td>5.01 ± 0.10</td>
<td>SSN708US</td>
<td>12</td>
<td>51.6486</td>
<td>128.0684</td>
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<tr>
<td>693</td>
<td>9.3</td>
<td>30.2</td>
<td>4.4</td>
<td>42.8</td>
<td>30.46 ± 0.99</td>
<td>12.03 ± 0.65</td>
<td>4.83 ± 0.09</td>
<td>SSN693PWR</td>
<td>51</td>
<td>51.6442</td>
<td>127.9978</td>
</tr>
<tr>
<td>703</td>
<td>12.8</td>
<td>40.3</td>
<td>1.9</td>
<td>24.3</td>
<td>39.36 ± 1.49</td>
<td>9.04 ± 0.54</td>
<td>5.41 ± 0.09</td>
<td>WSN703</td>
<td>42</td>
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<td>128.0228</td>
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<td>Total gauged</td>
<td>46.9</td>
<td>32.7</td>
<td>3.7</td>
<td>37.1</td>
<td>117.53 ± 3.60</td>
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<tr>
<td>Total¹</td>
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<td>-</td>
<td>174.50 ± 5.33</td>
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</table>

¹ Total values obtained by multiplying the total gauged values, when relevant by 1.484.
² Watershed coverage statistic calculation described in Gonzalez Arriola et al. 2015 and Oliver et al. 2017.
³ Standard error (SE) on annual Q: variability around annual discharge estimate across 4 calendar years (2015-2018).
⁴ Elevation: elevation in metres above sea level of stream sampling station.
**Supplementary Information**

**Table S4.** Results of tests comparing rack sample bottles and rack and pump sampler chemistry during rainfall events in 2015.

<table>
<thead>
<tr>
<th>Date/time collected</th>
<th>Watershed</th>
<th>DOC</th>
<th>Fe</th>
<th>Si</th>
<th>TDP</th>
<th>TDN</th>
</tr>
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<tr>
<td><strong>Between rack sampler bottles at same height</strong></td>
<td></td>
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</tr>
<tr>
<td>21-Jul-2015 08:00</td>
<td>703</td>
<td>4.1</td>
<td>6.9</td>
<td>1.1</td>
<td>25</td>
<td>10.8</td>
</tr>
<tr>
<td>29-Aug-2015 11:50</td>
<td>626</td>
<td>1.7</td>
<td>1.4</td>
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</tr>
<tr>
<td>29-Aug-2015 13:50</td>
<td>708</td>
<td>5.2</td>
<td>20.2</td>
<td>0.9</td>
<td>120</td>
<td>10.4</td>
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<tr>
<td>29-Aug-2015 14:30</td>
<td>844</td>
<td>2.3</td>
<td>0.8</td>
<td>1.6</td>
<td>31.6</td>
<td>4.2</td>
</tr>
<tr>
<td>29-Aug-2015 17:11</td>
<td>693</td>
<td>0.1</td>
<td>533.3*</td>
<td>9.3</td>
<td>0</td>
<td>37.3</td>
</tr>
<tr>
<td>30-Aug-2015 04:20</td>
<td>819</td>
<td>2.4</td>
<td>26.7</td>
<td>1.3</td>
<td>9.1</td>
<td>0</td>
</tr>
<tr>
<td>30-Aug-2015 18:30</td>
<td>1015</td>
<td>8.8</td>
<td>24.9</td>
<td>0.9</td>
<td>38.5</td>
<td>3.2</td>
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<tr>
<td><strong>Mean ± SE</strong></td>
<td>All</td>
<td>3.5 ± 1.1</td>
<td>87.7 ± 74.4</td>
<td>2.2 ± 1.2</td>
<td>37.6 ± 14.8</td>
<td>9.9 ± 4.8</td>
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<td><strong>Between rack and pump sampler chemistry results</strong></td>
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<td>10-Oct-2015 18:05</td>
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<td>6.5</td>
<td>70.8</td>
<td>1.6</td>
<td>128.6</td>
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</tr>
<tr>
<td>11-Oct-2015 22:20</td>
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<td>0.7</td>
<td>4.9</td>
<td>0.4</td>
<td>208.3</td>
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</tr>
<tr>
<td><strong>Mean ± SE</strong></td>
<td>All</td>
<td>3.6 ± 2.9</td>
<td>37.9 ± 33.0</td>
<td>1.0 ± 0.6</td>
<td>168.5 ± 39.9</td>
<td>13.3 ± 10.1</td>
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</table>

*Mean calculated without outlier (Watershed 693 on 29-Aug-2015 17:11).*
**Supplementary Information**

Table S5. LOADEST log-linear model statistics by watershed and nutrient species.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Species</th>
<th>Watershed</th>
<th>No. obs.</th>
<th>Model</th>
<th>R²</th>
<th>Bias (%)</th>
<th>PLR ⁠&lt;sub&gt;a&lt;/sub&gt;</th>
<th>E ⁠&lt;sub&gt;b&lt;/sub&gt;</th>
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</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>DOC</td>
<td>1015</td>
<td>106</td>
<td>9</td>
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<td></td>
<td>DOC</td>
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<td>115</td>
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<td>135</td>
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<td>DOC</td>
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<td>99.0</td>
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<td>Nitrogen</td>
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<td>72</td>
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<td>70</td>
<td>7</td>
<td>98.3</td>
<td>4.54</td>
<td>1.04</td>
<td>0.92</td>
</tr>
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<td>0.13</td>
<td>1.00</td>
<td>0.99</td>
</tr>
<tr>
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<td>TN</td>
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<td>75</td>
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*a* Partial Load Ratio (PLR, Stenback et al. 2011) quantifies bias in the estimated loads, where PLR > 1.0: overestimation, and a PLR < 1.0: underestimation.

*b* Nash-Sutcliffe Efficiency Index \((E, \text{Nash and Sutcliffe 1970})\), where \(E = 1.0\): perfect fit, \(E = 0.0\): load estimate = mean, and \(E < 0\): observed mean is a better estimate than the model.

*c* All models were constructed from data collected between 01-Aug-2014 and 31-Mar-2019, with the exception of PO\(_4^3^-\), for which only data after 01-Jan-2015 were included.
Table S6. Characterisation of rain events over the whole period of record near sea level, based on the weather station at the outlet of watershed 626.

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Total no. days* 1614 - 365 - 366 - 365 - 365 -

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<td>≥ 15 days</td>
<td>3</td>
<td>175-346</td>
<td>5</td>
<td>152-508</td>
<td>3</td>
<td>324-567</td>
<td>3</td>
<td>237-490</td>
</tr>
<tr>
<td>Longest event (days)</td>
<td>23</td>
<td>[Dec.]</td>
<td>21</td>
<td>[Mar.]</td>
<td>47</td>
<td>[Mar.]</td>
<td>25</td>
<td>[Jan.]</td>
</tr>
</tbody>
</table>

4+ day event size b
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50 mm</td>
<td>3</td>
<td>8</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>50-100 mm</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>100-200 mm</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>200-400 mm</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>≥ 400 mm</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

* Total number of days within the period of interest. Whole period = 1-Aug-2014 to 31-Dec-2018.

a mm : Total rainfall in mm over the multi-day event.

b Frequency of rainfall events (more than 4 days long) by total rainfall.
Supplementary Information

Table S7. Summary statistics for measured nutrient concentrations (in μmol L\(^{-1}\)) in fresh and marine waters.

<table>
<thead>
<tr>
<th></th>
<th>MARINE (0 – 5 m)</th>
<th>FRESHWATER</th>
<th>Flow-weighted (^{c})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Measured Mean</td>
<td>Measured Median</td>
<td>Range</td>
</tr>
<tr>
<td>DOC</td>
<td>72.64</td>
<td>63.95</td>
<td>7.87 - 965</td>
</tr>
<tr>
<td>TN</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TDN</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DON</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DIN</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NO(_3)+NO(_2)^{a}</td>
<td>8.18</td>
<td>6.92</td>
<td>0.01 - 22.39</td>
</tr>
<tr>
<td>NH(_4^+)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TP</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TDP</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PO(_4^3-)</td>
<td>0.78</td>
<td>0.78</td>
<td>&lt;D.L. - 2.50</td>
</tr>
<tr>
<td>Si(OH)(_4)</td>
<td>18.67</td>
<td>19.55</td>
<td>0.02 - 40.70</td>
</tr>
<tr>
<td>dFe</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^{a}\) For constituent-specific detection limits (D.L.), see Table S2.

\(^{b}\) Because NO\(_3\)+NO\(_2\) fluxes were poorly modelled, flow-weighted concentrations of NO\(_3\)+NO\(_2\) were determined by subtracting the flow-weighted concentration of NH\(_4^+\) from DIN for each month.

\(^{c}\) Measured freshwater concentrations summarise all samples collected in the seven watersheds between May 2014 and November 2018.

\(^{c}\) Flow-weighted concentrations summarise the monthly statistics across all seven watersheds between August 2014 and December 2018.
**Supplementary Information**

**Table S8.** Results of linear mixed effects models comparing marine nutrient concentrations over time. p-values are shown ($\alpha = 0.05$).

<table>
<thead>
<tr>
<th></th>
<th>Year (2015-18)</th>
<th>Month (Jan-Dec)</th>
<th>Year*Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees of freedom</td>
<td>3</td>
<td>11</td>
<td>33</td>
</tr>
<tr>
<td>DOC</td>
<td>0.926</td>
<td>0.960</td>
<td>0.960</td>
</tr>
<tr>
<td>$\text{NO}_3^-$+$\text{NO}_2^-$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>Si(OH)$_4$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>$\text{PO}_4^{3-}$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
</tr>
</tbody>
</table>

**Table S9.** Results of linear mixed effects models comparing flow-weighted freshwater nutrient concentrations over time. p-values are shown ($\alpha = 0.05$).

<table>
<thead>
<tr>
<th></th>
<th>Year (2015-18)</th>
<th>Month (Jan-Dec)</th>
<th>Year*Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees of freedom</td>
<td>3</td>
<td>11</td>
<td>33</td>
</tr>
<tr>
<td>DOC</td>
<td>0.567</td>
<td>$&lt;0.001$</td>
<td>0.355</td>
</tr>
<tr>
<td>TN</td>
<td>0.987</td>
<td>$&lt;0.001$</td>
<td>0.532</td>
</tr>
<tr>
<td>TDN</td>
<td>0.963</td>
<td>$&lt;0.001$</td>
<td>0.995</td>
</tr>
<tr>
<td>DON</td>
<td>0.988</td>
<td>$&lt;0.001$</td>
<td>0.999</td>
</tr>
<tr>
<td>DIN</td>
<td>0.672</td>
<td>0.121</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>$\text{NH}_4^+$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>$\text{NO}_3^-$+$\text{NO}_2^-$</td>
<td>0.238</td>
<td>0.002</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>Si(OH)$_4$</td>
<td>0.885</td>
<td>$&lt;0.001$</td>
<td>0.009</td>
</tr>
<tr>
<td>TP</td>
<td>0.795</td>
<td>0.441</td>
<td>0.999</td>
</tr>
<tr>
<td>TDP</td>
<td><strong>0.025</strong></td>
<td>0.711</td>
<td>0.559</td>
</tr>
<tr>
<td>$\text{PO}_4^{3-}$</td>
<td>0.615</td>
<td>0.994</td>
<td>0.953</td>
</tr>
<tr>
<td>Fe</td>
<td>0.818</td>
<td>$&lt;0.001$</td>
<td>0.999</td>
</tr>
</tbody>
</table>
Table S10. Range of freshwater yields of DOC, TN, DON, NO$_3^-$, Si(OH)$_4^-$, PO$_4^{3-}$, and Fe across the 7 watersheds with reference to literature values shown below.

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Area (km$^2$)</th>
<th>Annual yields (kg km$^{-2}$ y$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DOC</td>
</tr>
<tr>
<td>626</td>
<td>3.2</td>
<td>18,300 - 25,100</td>
</tr>
<tr>
<td>1015</td>
<td>3.3</td>
<td>18,700 - 23,700</td>
</tr>
<tr>
<td>819</td>
<td>4.8</td>
<td>22,700 - 29,300</td>
</tr>
<tr>
<td>844</td>
<td>5.7</td>
<td>25,500 - 27,800</td>
</tr>
<tr>
<td>708</td>
<td>7.8</td>
<td>19,600 - 25,500</td>
</tr>
<tr>
<td>693</td>
<td>9.3</td>
<td>20,500 - 24,000</td>
</tr>
<tr>
<td>703</td>
<td>12.8</td>
<td>24,900 - 30,500</td>
</tr>
<tr>
<td>Kwakshua Channel</td>
<td>69.6</td>
<td>22,200 - 26,900</td>
</tr>
</tbody>
</table>

Reference

Seitzinger et al., 2005†

Dürr et al., 2011

Meybeck, 1982

Sugai and Burrell, 1984

Fellman et al., 2021

† – NEWS global biogeochemical model outputs.
* - range of NO$_3^-$ exports (DIN = NO$_3^-$ + NO$_2^-$ + NH$_4^+$).
‡ Range of dFe yields derived from dFe fluxes in De Baar and De Jong (2001) and Krachler et al. (2005), using global riverine drainage basin area to the oceans from Meybeck (1982).
Table S11. Pearson product moment correlations between dissolved organic carbon (DOC) and other nutrients in freshwater ecosystems.

<table>
<thead>
<tr>
<th></th>
<th>All samples</th>
<th>Watersheds*</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>t</td>
<td>df</td>
<td>p</td>
<td>626</td>
<td>1015</td>
<td>819</td>
<td>844</td>
</tr>
<tr>
<td>TN</td>
<td>0.63</td>
<td>19.09</td>
<td>554</td>
<td>&lt;0.05</td>
<td>0.65</td>
<td>0.47</td>
<td>0.72</td>
<td>0.81</td>
</tr>
<tr>
<td>TDN</td>
<td>0.74</td>
<td>34.39</td>
<td>989</td>
<td>&lt;0.05</td>
<td>0.81</td>
<td>0.43</td>
<td>0.74</td>
<td>0.83</td>
</tr>
<tr>
<td>DON</td>
<td>0.72</td>
<td>17.66</td>
<td>296</td>
<td>&lt;0.05</td>
<td>0.64</td>
<td>0.48</td>
<td>0.83</td>
<td>0.85</td>
</tr>
<tr>
<td>DIN</td>
<td>-0.16</td>
<td>-2.90</td>
<td>322</td>
<td>&lt;0.05</td>
<td>0.02</td>
<td>-0.03</td>
<td>-0.02</td>
<td>0.15</td>
</tr>
<tr>
<td>NO₃⁺+NO₂⁻</td>
<td>-0.27</td>
<td>-5.98</td>
<td>474</td>
<td>&lt;0.05</td>
<td>-0.05</td>
<td>0.05</td>
<td>-0.15</td>
<td>0.04</td>
</tr>
<tr>
<td>NH₄⁺</td>
<td>0.15</td>
<td>3.41</td>
<td>542</td>
<td>&lt;0.05</td>
<td>-0.01</td>
<td>-0.07</td>
<td>0.18</td>
<td>0.23</td>
</tr>
<tr>
<td>TP</td>
<td>0.10</td>
<td>2.40</td>
<td>556</td>
<td>&lt;0.05</td>
<td>0.08</td>
<td>0.06</td>
<td>-0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>TDP</td>
<td>0.11</td>
<td>3.28</td>
<td>939</td>
<td>&lt;0.05</td>
<td>0.08</td>
<td>-0.11</td>
<td>-0.19</td>
<td>-0.01</td>
</tr>
<tr>
<td>PO₄³⁻</td>
<td>0.10</td>
<td>2.33</td>
<td>526</td>
<td>&lt;0.05</td>
<td>-0.08</td>
<td>0.18</td>
<td>-0.11</td>
<td>0.32</td>
</tr>
<tr>
<td>Si(OH)₄</td>
<td>0.07</td>
<td>1.35</td>
<td>391</td>
<td>0.18</td>
<td>0.06</td>
<td>0.18</td>
<td>0.35</td>
<td>0.16</td>
</tr>
<tr>
<td>dFe</td>
<td>0.61</td>
<td>22.07</td>
<td>813</td>
<td>&lt;0.05</td>
<td>0.47</td>
<td>0.46</td>
<td>0.69</td>
<td>0.62</td>
</tr>
</tbody>
</table>

*Statistically significant watershed-specific correlations are bolded, based on a Bonferroni-corrected α of 0.001.

Note that p-values are reported here across all samples, but are not used in the interpretation of the results due to the high sample size (df + 1). r > ± 0.20 are highlighted in purple for positive correlations, and in pink for negative correlations.
Table S12. Loadings of nutrients on to the first two principal component (PC) axes using scaling 2. Note that PC1 was multiplied by -1 for ease of interpretation in Fig 5. Bolded numbers indicate the dominant parameters contributing to each PC.

<table>
<thead>
<tr>
<th></th>
<th>PC1 (50.0%)</th>
<th>PC2 (13.8%)</th>
<th>PC3 (11.7%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOC</td>
<td>-2.09</td>
<td>0.15</td>
<td>-0.23</td>
</tr>
<tr>
<td>TN</td>
<td>-2.25</td>
<td>0.16</td>
<td>0.21</td>
</tr>
<tr>
<td>TDN</td>
<td>-2.30</td>
<td>0.15</td>
<td>0.05</td>
</tr>
<tr>
<td>DON</td>
<td>-2.16</td>
<td>0.41</td>
<td>0.42</td>
</tr>
<tr>
<td>DIN</td>
<td>-0.30</td>
<td>-0.43</td>
<td>-2.12</td>
</tr>
<tr>
<td>NH$_4^+$</td>
<td>-1.11</td>
<td>-1.59</td>
<td>-0.28</td>
</tr>
<tr>
<td>TP</td>
<td>-1.52</td>
<td>-1.03</td>
<td>0.56</td>
</tr>
<tr>
<td>TDP</td>
<td>-0.60</td>
<td>-1.78</td>
<td>0.58</td>
</tr>
<tr>
<td>PO$_4^{3-}$</td>
<td>-0.85</td>
<td>0.93</td>
<td>0.91</td>
</tr>
<tr>
<td>Si(OH)$_4$</td>
<td>-1.58</td>
<td>0.70</td>
<td>-1.03</td>
</tr>
<tr>
<td>dFe</td>
<td>-2.22</td>
<td>0.34</td>
<td>-0.17</td>
</tr>
</tbody>
</table>

References


Supplementary Information


