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Topography significantly influencing low flows in snow-dominated water-sheds

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Table of Contents

Tables

Figures

1. Description of the study watersheds

In this study, 28 watersheds located in the Southern Interior of British Columbia, Canada were selected. The watershed name, area, and station number are listed in Table S1. The temporal variations of the average annual precipitation and potential evapotranspiration among the study watersheds are shown in Figs. S1 to S4. The temporal variations of the summer precipitation and potential evapotranspiration among study regions are shown in Figure S5.

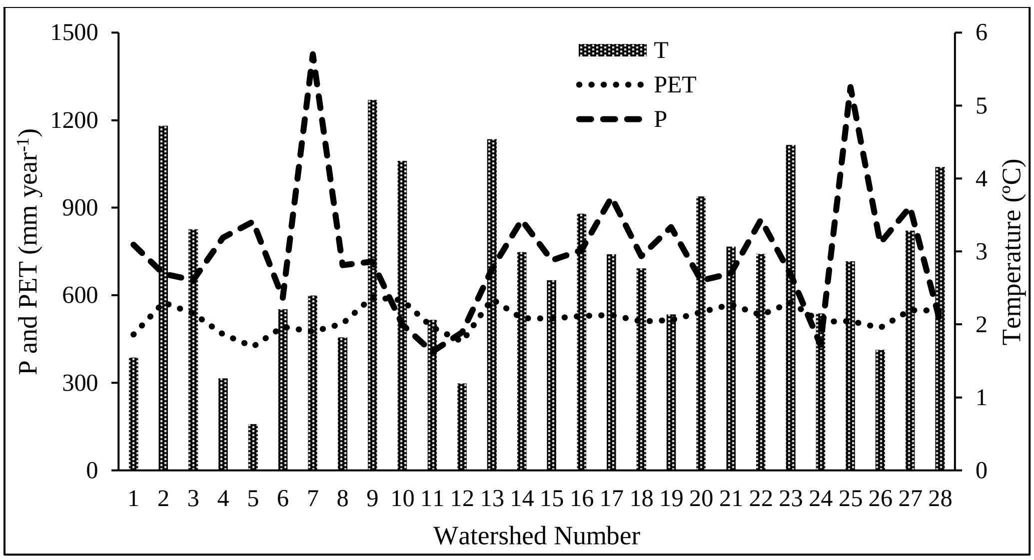

Figure S1 Mean annual precipitation (P), potential evapotranspiration (PET), and temperature (T) in the selected 28 watersheds from 1989 to 1996.

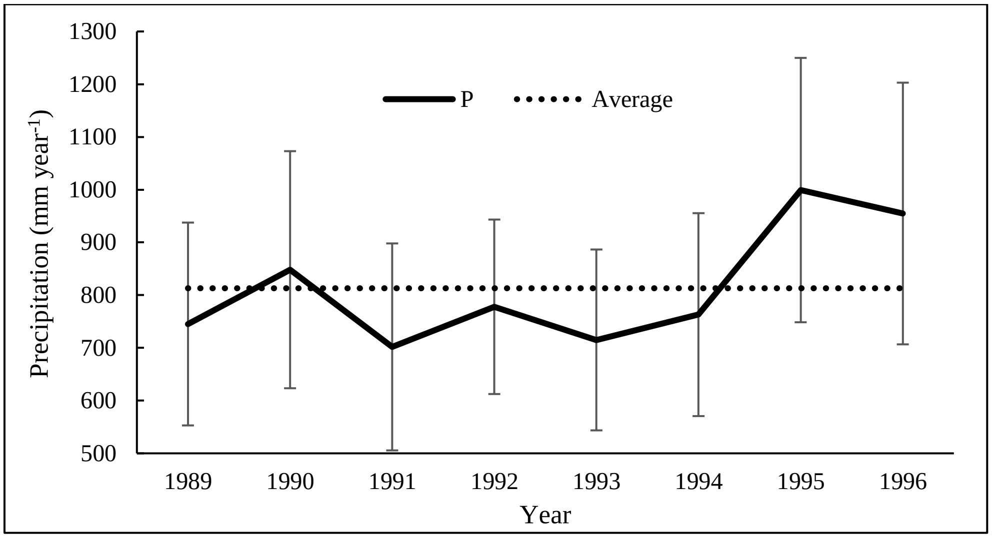

Figure S2 Temporal variations of annual precipitation (P) from 1989 to 1996 in the study watersheds. Bars represent one standard deviation. The dotted line represents the average P for the study period.

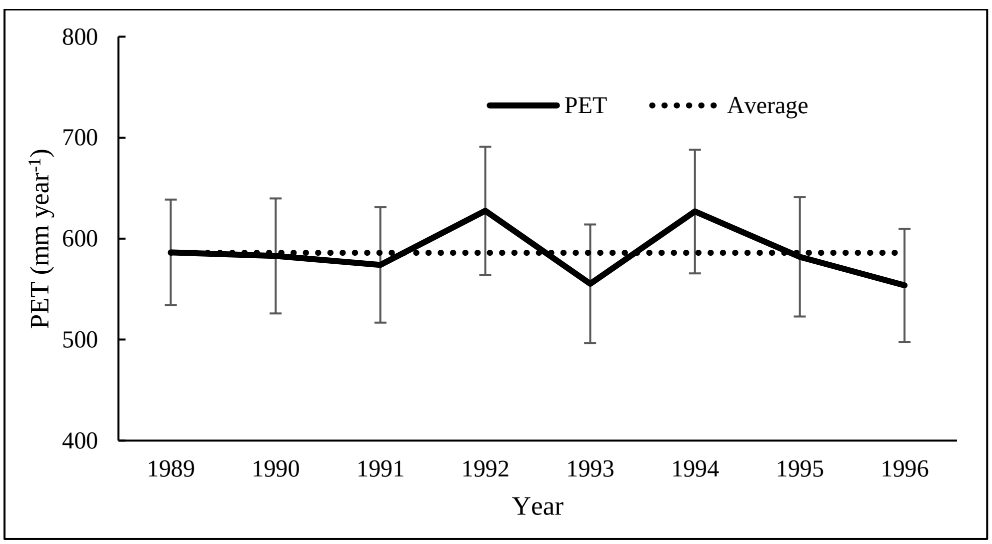

Figure S3 Temporal variations of the annual potential evapotranspiration (PET) from 1989 to 1996 in the study watersheds. Bars represent one standard deviation. The dotted line represents the average PET for the study period.

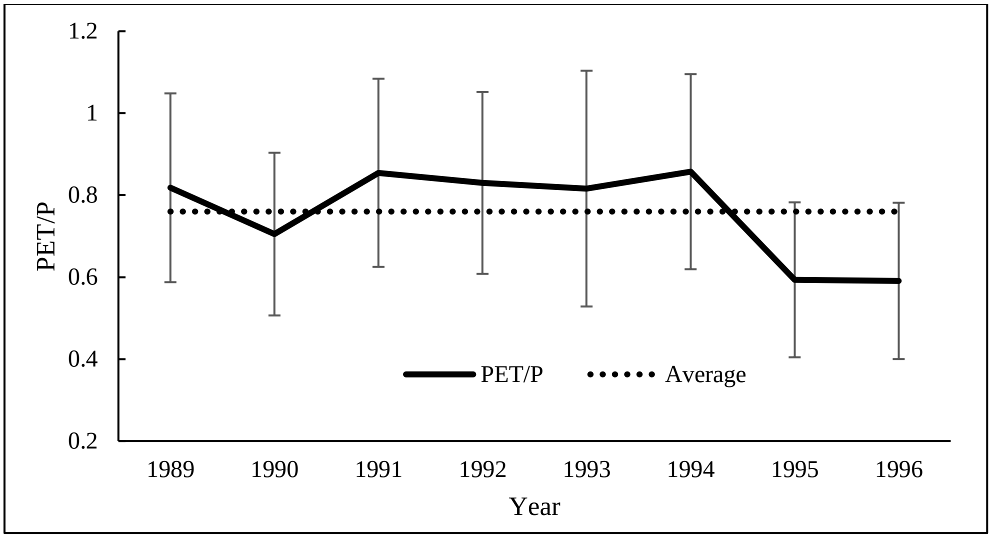

Figure S4 Temporal variations of the annual dryness index (PET/P) from 1989 to1996 in the study watersheds. Bars represent one standard deviation among study watersheds. The dotted line represents the average PET/P across the study period for all watersheds.

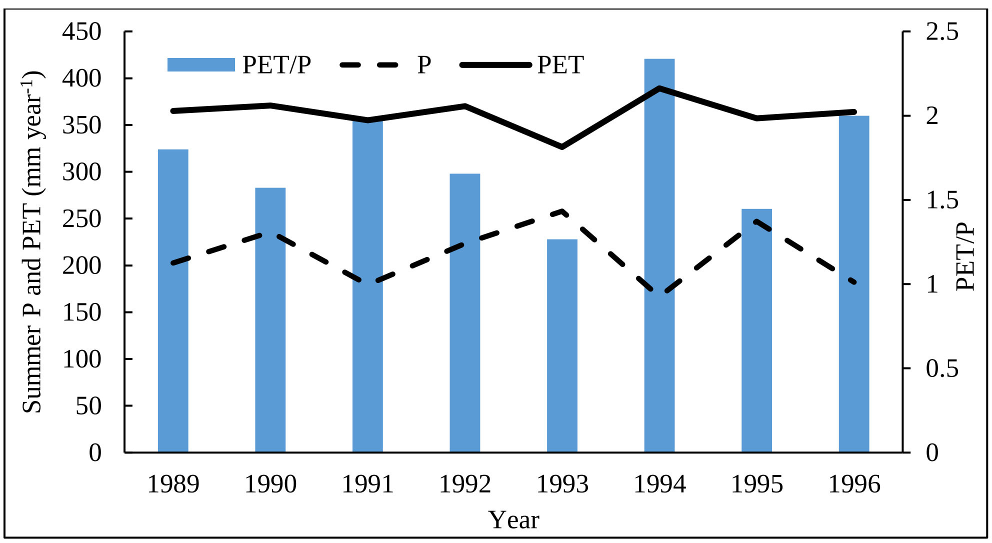

Figure S5 Temporal variations of the average summer (June-September) precipitation (P), potential evapotranspiration (PET), and dryness index (PET/P) in the study watersheds from 1989 to 1996.

Table S1 Watershed number, hydrometric station number, watershed name, and area.

Watershed No.	Station Number	Watershed Name	Area (km^2)
1	08LG016	Pennask Creek Near Quilchena	85.8
2	08LE077	Corning Creek Near Squilax	23.4
3	08NM134	Camp Creek At Mouth Near Thirsk	35.5
4	08NM240	Two Forty Creek Near Penticton	5.1
5	08NM242	Dennis Creek Near 1780 Metre Contour	2.6
6	08NL050	Hedley Creek Near The Mouth	388.8
7	08NL071	Tulameen River Below Vuich Creek	253.4
8	08NM171	Vaseux Creek Above Solco Creek	118.4
9	08LE108	East Canoe Creek Above Dam	21.3
10	08LB012	Paul Creek At The Outlet Of Pinantan Lake	68.9
11	08LF081	Ambusten Creek Near The Mouth	34.0
12	08LF084	Anderson Creek Above Diversions	37.3
13	08LC040	Vance Creek Below Deafies Creek	71.8
14	08LG008	Spius Creek Near Canford	767.8
15	08LE075	Salmon River Above Salmon Lake	148.8
16	08NM174	Whiteman Creek Above Bouleau Creek	109.6
17	08NE110	Inonoaklin Creek Above Valley Creek	322.5
18	08LG064	Beak Creek At The Mouth	83.9
19	08NN015	West Kettle River Near Mcculloch	301.2
20	08NM173	Greata Creek Near The Mouth	43.5
21	08NN019	Trapping Creek Near The Mouth	144.7
22	08NL036	Whipsaw Creek Below Lamont Creek	186.7
23	08NM142	Coldstream Creek Above Municipal Intake	61.1
24	08LG066	Chataway Creek Near The Mouth	36.5
25	08LG048	Coldwater River Near Brookmere	321.8
26	08NM241	Two Forty-One Creek Near Penticton	4.9
27	08NL024	Tulameen River At Princeton	1780.0
28	08NL045	Keremeos Below Wills Intake	181.0

2. Leaf area index (LAI)

Leaf area index (*LAI*) is defined as one-half of the total green leaf area per unit of horizontal ground surface area (Xiao et al., 2014). The Global Land Surface Satellite (GLASS) *LAI* was chosen for this study due to its high temporal (8-day) and spatial (0.05 degree, about 5 km) resolutions from July 1981 to December 2012 (Xiao et al., 2014). The

GLASS *LAI* was derived from the Moderate-Resolution Imaging Spectroradiometer (MODIS) and Advanced High Resolution Radiometer (AVHRR) time-series reflectance data through general regression neural networks. From 1981 to 1999, the *LAI* values were generated from the AVHRR reflectance with the spatial resolution of 0.05 degree. From 2000 to 2012, the *LAI* values were derived from MODIS land surface reflectance (MOD09A1) with the spatial resolution of 1 km. The GLASS *LAI* has been validated by extensive field *LAI* (Xiao et al., 2014).

In this study, the growing season (May to October) *LAI* from 1989 to 1996 was derived for each watershed. Two reviews on the relationship between forest cover changes and water yield clearly indicated that forest cover change is a dominant factor for hydrological variation (Li et al., 2017; Zhang et al., 2017). To minimize the effects of the possible difference in forest cover among the study watersheds on flow variables, the linear regression model was carried out between the LAI and annual mean flow for each watershed. The LAI is treated as an independent variable and annual mean flow is considered as a dependent variable. The null hypothesis is that there are no effects of LAI variations on annual mean flow. The P values of all regression models were higher than 0.05, indicating that the null hypothesis was accepted. Therefore, we assume the vegetation variations did not affect the flow variables in the period of 1989 to 1996 in the selected 28 watersheds.

3. Summaries of Kendall's tau correlations between flow variables and topographic indices

Table S2 Coefficients of the Kendall's tau correlation test between the annual mean flow (Q_{mean}) and topographic indices (TIs) from 1989 to 1996. The coefficients in green color and in an italic style indicate statistical significance at p<0.05. The bold TIs with "*" are the sub-set of TIs identified by factor analysis (FA) for further analysis. TI acronyms are defined in Table 1.

Q_{mean}	1989	1990	1991	1992	1993	1994	1995	1996
Area	0.243	0.233	***0.302***	0.233	0.132	0.164	***0.302***	0.233
DDG*	0.177	0.143	0.155	0.155	0.070	0.104	0.166	0.087
DDGD	0.009	-0.078	-0.084	-0.041	0.066	-0.003	-0.022	-0.066
DEM	0.106	0.053	0.090	0.127	0.016	0.048	0.058	-0.011
FLD	***0.307***	0.254	0.259	***0.307***	0.196	0.206	0.259	0.190
LAI	0.042	-0.032	-0.026	-0.021	0.026	0.111	0.026	0.063
LS*	0.164	0.122	0.116	0.122	0.042	0.085	0.148	0.069
Openness*	0.105	0.048	0.093	0.071	0.020	0.059	0.099	0.037
Perimeter*	0.185	0.185	***0.265***	0.196	0.138	0.159	0.243	0.238
Relief*	0.148	0.116	0.111	0.116	0.069	0.069	0.132	0.053
Roundness	0.016	0.048	-0.053	-0.059	0.037	-0.043	0.000	-0.059
SCA*	-0.095	-0.085	-0.026	-0.053	-0.196	-0.185	-0.058	-0.138
Slope*	0.186	0.159	0.137	0.159	0.088	0.104	0.164	0.077
Stream density	-0.245	-0.229	-0.176	-0.176	-0.160	-0.176	-0.235	-0.197
Stream length	0.201	0.201	0.259	***0.265***	0.185	0.196	0.217	0.201
Surface area*	0.180	0.159	0.164	0.159	0.090	0.101	0.185	0.116
TCI*	0.069	0.069	0.085	0.101	0.000	0.032	0.096	-0.005
Total	-0.021	-0.021	0.810	-0.064	-0.120	-0.106	0.049	-0.064
TPI	0.130	0.098	0.135	0.130	-0.008	0.045	0.125	0.056
TRI*	0.185	0.153	0.148	0.153	0.074	0.085	0.169	0.079
TWI	-0.119	-0.065	-0.027	-0.038	-0.129	-0.146	-0.032	-0.140
UCA*	-0.090	-0.101	-0.021	-0.048	-0.222	-0.201	-0.053	-0.153
Wetland %	0.084	0.109	0.116	0.064	0.122	0.032	0.141	0.122

Table S3 Coefficients of the Kendall's tau correlation test between $Q_{10\%}$ and topographic indices (TIs) from 1989 to 1996. The coefficients in green color and italic style indicate statistical significance $p<0.05$. The bold TIs with sign of "*" are the sub-set of TIs identified by factor analysis (FA) for further analysis. TI acronyms are defined in Table 1.

$Q_{10\%}$	1989	1990	1991	1992	1993	1994	1995	1996
Area	0.175	0.146	0.199	0.170	0.101	0.138	***0.273***	0.199
DDG*	0.160	0.138	0.129	0.155	0.020	0.081	0.180	0.090
DDGD	-0.078	-0.116	-0.138	-0.135	0.103	-0.034	-0.028	-0.094
DEM	0.132	0.045	0.056	0.202	-0.005	0.074	0.082	0.029
FDL	0.122	0.109	0.146	0.127	0.122	0.138	0.188	0.135
LAI	0.058	-0.098	-0.008	0.000	0.026	0.085	0.024	0.072
LS*	0.159	0.114	0.082	0.127	-0.011	0.069	0.151	0.066
Openness*	0.088	0.051	0.074	0.091	-0.020	0.048	0.113	0.045
Perimeter*	0.243	0.183	0.225	0.207	0.127	0.185	***0.310***	0.236
Relief*	0.153	0.119	0.098	0.133	0.016	0.074	0.156	0.050
Roundness	-0.118	-0.013	-0.035	-0.161	-0.016	-0.107	-0.062	-0.094
SCA*	-0.037	-0.045	-0.050	0.021	-0.206	-0.138	-0.024	-0.125
Slope*	0.181	0.151	0.113	0.165	0.038	0.104	0.173	0.074
Stream density	-0.165	-0.163	-0.142	-0.107	-0.075	-0.101	-0.174	-0.158
Stream length	0.175	0.156	0.177	0.191	0.143	0.190	0.230	0.177
Surface area*	0.185	0.167	0.140	0.164	0.048	0.106	0.209	0.114
TCI*	0.074	0.067	0.061	0.107	-0.043	0.027	0.088	-0.008
Total	-0.070	-0.035	0.007	-0.064	-0.106	-0.106	0.064	-0.021
TPI	0.104	0.074	0.112	0.104	-0.050	0.029	0.128	0.064
TRI*	0.180	0.146	0.114	0.159	0.021	0.090	0.183	0.077
TWI	-0.124	-0.067	-0.078	-0.076	-0.189	-0.135	-0.046	-0.165
UCA*	-0.053	-0.072	-0.056	0.005	-0.233	-0.153	-0.029	-0.140
Wetland %	0.071	0.097	0.113	0.013	0.135	0.039	0.187	0.129

Table S4 Coefficients of the Kendall's tau correlation test between $Q_{25\%}$ and topographic indices (TIs) from 1989 to 1996. The coefficients in green color and italic style indicate statistical significance at $p<0.05$. The bold TIs with "*" are the sub-set of TIs identified by factor analysis (FA) for further analysis. TI acronyms are defined in Table 1.

$Q_{25\%}$	1989	1990	1991	1992	1993	1994	1995	1996
Area	***0.294***	0.255	***0.347***	0.234	0.167	***0.340***	***0.372***	***0.435***
DDG*	0.228	0.229	0.248	0.136	-0.048	0.175	***0.280***	0.239
DDGD	-0.059	-0.088	-0.119	-0.088	0.091	0.022	0.066	0.100
DEM	0.151	0.213	0.220	0.165	-0.072	0.218	0.223	0.212
FLD	0.199	0.149	0.209	0.160	0.236	0.255	***0.271***	***0.345***
LAI	0.040	0.106	0.040	-0.027	-0.082	0.149	0.080	0.042
LS*	0.209	0.229	0.215	0.117	-0.088	0.143	0.223	0.196
Openness*	0.164	0.190	0.204	0.074	-0.088	0.179	0.225	0.213
Perimeter*	***0.342***	***0.319***	***0.416***	***0.293***	0.173	***0.387***	***0.426***	***0.408***
Relief*	0.215	0.202	0.209	0.122	-0.056	0.133	0.239	0.180
Roundness	-0.158	-0.196	-0.222	-0.183	0.021	-0.260	-0.220	-0.206
SCA*	-0.008	0.016	0.072	0.053	-0.231	0.005	0.059	-0.058
Slope*	0.236	0.226	0.222	0.149	-0.039	0.165	0.259	0.220
Stream density	-0.077	-0.091	-0.061	-0.059	-0.062	-0.027	-0.027	-0.043
Stream length	***0.283***	0.261	***0.305***	***0.266***	0.252	***0.355***	***0.319***	***0.350***
Surface area*	0.241	0.223	***0.262***	0.165	-0.013	0.196	***0.293***	0.244
TCI*	0.083	0.128	0.173	0.091	-0.099	0.128	0.182	0.112
Total	-0.021	-0.007	0.134	-0.021	-0.148	-0.092	0.064	0.092
TPI	0.149	0.174	0.234	0.099	-0.107	0.141	0.232	0.173
TRI*	0.230	0.218	0.236	0.149	-0.040	0.159	***0.266***	0.207
TWI	-0.148	-0.122	-0.003	-0.054	-0.160	-0.124	-0.070	-0.092
UCA*	-0.003	0.011	0.077	0.048	-0.247	0.000	0.053	-0.048
Wetland %	0.135	0.061	0.132	0.094	0.174	0.064	0.162	0.210

Table S5 Coefficients of the Kendall's tau correlation test between $Q_{50\%}$ and topographic indices (TIs) from 1989 to 1996. The coefficients in green color and italic style indicate statistical significance at $p<0.05$. The bold TIs with "*" are the sub-set of TIs identified by factor analysis (FA) for further analysis. TI acronyms are defined in Table 1.

$Q_{50\%}$	1989	1990	1991	1992	1993	1994	1995	1996
Area	***0.304***	***0.293***	***0.281***	***0.324***	***0.516***	***0.369***	***0.305***	***0.329***
DDG*	0.235	***0.291***	***0.307***	0.225	0.277	0.225	0.216	0.239
DDGD	0.076	-0.069	-0.126	-0.152	0.200	0.054	0.092	-0.092
DEM	0.203	0.261	***0.340***	0.217	0.172	0.260	0.091	0.169
FLD	***0.272***	0.202	0.185	0.201	***0.419***	***0.260***	0.262	0.185
LAI	0.053	0.059	0.035	-0.024	-0.048	0.070	-0.064	0.094
LS*	0.197	***0.293***	***0.319***	0.212	0.188	0.184	0.187	0.228
Openness *	0.194	0.253	***0.275***	0.172	0.230	0.206	0.120	0.217
Perimeter*	***0.352***	***0.330***	***0.308***	***0.383***	***0.473***	***0.412***	***0.326***	***0.361***
Relief*	0.203	***0.277***	***0.292***	0.195	0.199	0.157	0.176	0.212
Roundness	-0.178	-0.194	-0.203	-0.192	-0.158	***-0.279***	-0.097	-0.149
SCA*	0.021	0.096	0.163	0.142	0.011	0.081	-0.043	0.024
Slope*	0.218	0.265	***0.289***	0.205	0.223	0.177	0.188	0.230
Stream density	-0.129	-0.123	-0.057	-0.070	0.114	0.098	-0.156	-0.067
Stream length	0.261	0.197	0.201	***0.281***	***0.441***	***0.336***	0.214	0.238
Surface area*	0.245	***0.277***	***0.287***	0.249	0.253	0.201	0.219	***0.265***
TCI*	0.145	0.198	0.242	0.191	0.184	0.188	0.113	0.159
Total	0.021	0.120	0.162	0.092	0.205	0.106	0.134	0.120
TPI	0.163	0.243	***0.280***	0.231	0.219	0.237	0.142	0.242
TRI*	0.229	***0.282***	***0.287***	0.222	0.231	0.168	0.193	0.228
TWI	-0.016	0.027	0.019	0.052	0.049	-0.050	0.046	-0.060
UCA*	0.027	0.122	0.190	0.142	0.027	0.103	-0.043	0.035
Wetland %	0.185	0.145	0.062	0.137	***0.353***	0.132	0.253	0.117

Table S6 Coefficients of the Kendall's tau correlation test between $Q_{75\%}$ and topographic indices (TIs) from 1989 to 1996. The coefficients in green color and italic style indicate statistical significance at $p<0.05$. The bold TIs with "*" are the sub-set of TIs identified by factor analysis (FA) for further analysis. TI acronyms are defined in Table 1.

$Q_{75\%}$	1989	1990	1991	1992	1993	1994	1995	1996
Area	0.241	***0.288***	***0.358***	***0.319***	***0.363***	***0.412***	***0.506***	***0.290***
DDG*	0.247	0.266	***0.297***	0.238	0.180	0.193	***0.354***	0.197
DDGD	0.048	-0.057	-0.118	-0.121	0.006	0.032	0.144	-0.051
DEM	***0.295***	0.207	0.250	***0.254***	0.202	0.190	***0.349***	0.166
FLD	0.187	0.218	0.218	0.211	0.234	***0.369***	***0.398***	0.204
LAI	0.165	0.008	0.067	-0.092	-0.013	0.060	0.089	0.070
LS*	0.257	***0.267***	***0.315***	0.216	0.153	0.179	***0.317***	0.182
Openness*	0.229	0.213	***0.288***	0.173	0.144	0.174	***0.336***	0.169
Perimeter*	***0.290***	***0.315***	***0.347***	***0.330***	***0.390***	***0.385***	***0.506***	***0.295***
Relief*	0.219	0.240	***0.304***	0.189	0.116	0.157	***0.295***	0.156
Roundness	-0.246	-0.161	-0.128	-0.137	-0.139	-0.159	-0.235	-0.141
SCA*	0.041	0.100	0.159	0.130	0.003	0.033	0.122	-0.032
Slope*	0.241	0.234	0.282	0.224	0.151	0.174	***0.311***	0.189
Stream density	-0.161	-0.171	-0.100	-0.025	0.008	-0.044	0.019	-0.119
Stream length	0.160	0.180	0.229	0.232	***0.283***	***0.374***	***0.403***	0.220
Surface area*	0.214	***0.272***	***0.304***	0.243	0.170	0.201	***0.328***	0.220
TCI*	0.193	0.192	0.252	0.223	0.154	0.164	***0.318***	0.124
Total	0.092	0.134	0.219	0.191	0.162	0.049	0.219	0.035
TPI	0.234	0.249	***0.303***	***0.274***	0.211	0.210	***0.323***	0.207
TRI*	0.236	0.256	***0.299***	0.227	0.153	0.184	***0.311***	0.182
TWI	0.047	0.080	0.047	0.088	0.027	0.003	0.077	-0.112
UCA*	0.068	0.127	0.186	0.135	0.019	0.060	0.133	-0.016
Wetland %	0.099	0.160	0.147	0.135	0.193	0.161	0.201	0.111

Table S7 Coefficients of the Kendall's tau correlation test between $Q_{90\%}$ and topographic indices (TIs) from 1989 to 1996. The coefficients in green color and italic style indicate statistical significance at p<0.05. The bold TIs with "*" are the sub-set of TIs identified by factor analysis (FA) to for further analysis. TI acronyms are defined in Table 1.

$Q_{90\%}$	1989	1990	1991	1992	1993	1994	1995	1996
Area	0.214	***0.297***	***0.353***	***0.391***	***0.311***	***0.297***	***0.396***	0.181
DDG*	***0.277***	***0.264***	0.249	***0.332***	0.198	0.111	***0.295***	0.184
DDGD	-0.042	-0.102	-0.127	-0.097	-0.045	0.058	0.078	-0.163
DEM	***0.296***	0.189	***0.277***	***0.402***	0.257	0.187	0.220	0.100
FLD	0.126	0.227	0.245	0.233	0.203	0.264	***0.302***	0.154
LAI	0.225	-0.022	0.073	-0.041	0.024	0.016	0.159	-0.003
LS*	***0.307***	***0.276***	0.272	***0.326***	0.181	0.077	***0.264***	0.197
Openness *	***0.281***	0.222	0.276	***0.322***	0.165	0.120	***0.294***	0.144
Perimeter*	***0.247***	***0.292***	***0.326***	***0.391***	***0.317***	0.203	***0.352***	0.084
Relief*	***0.263***	***0.249***	0.256	***0.309***	0.165	0.060	***0.253***	0.154
Roundness	-0.194	-0.055	-0.125	-0.185	-0.112	-0.061	-0.131	0.035
SCA*	0.093	0.119	0.186	0.260	0.106	0.000	0.049	-0.057
Slope*	***0.281***	0.230	0.234	***0.318***	0.191	0.066	***0.265***	0.157
Stream density	-0.160	-0.076	-0.084	0.050	-0.068	0.025	-0.058	-0.234
Stream length	0.137	0.222	0.245	0.276	0.208	0.214	0.291	0.089
Surface area*	0.263	***0.249***	0.267	***0.337***	0.214	0.071	***0.275***	0.186
TCI*	0.254	0.190	0.268	***0.366***	0.242	0.122	0.243	0.155
Total	0.092	0.148	0.177	0.247	0.191	0.177	0.177	0.035
TPI	***0.295***	***0.252***	***0.308***	***0.396***	0.266	0.132	***0.284***	0.190
TRI*	***0.274***	0.238	0.256	***0.320***	0.198	0.055	***0.258***	0.170
TWI	0.034	0.058	0.121	0.204	0.124	0.045	0.042	-0.036
UCA*	0.121	0.146	0.213	***0.282***	0.111	0.016	0.066	-0.051
Wetland %	-0.013	0.122	0.088	0.116	0.161	0.197	0.217	0.000

Table S8 Coefficients of the Kendall's tau correlation test between Q_{min} and topographic indices (TIs) from 1989 to 1996. The coefficients in green color and italic style indicate statistical significance at 0.05. The bold TIs with "*" are the sub-set of TIs identified by factor analysis (FA) for further analysis. TI acronyms are defined in Table 1.

Q_{min}	1989	1990	1991	1992	1993	1994	1995	1996
Area	***0.763***	***0.804***	***0.774***	***0.789***	***0.837***	***0.797***	***0.721***	***0.793***
DDG*	***0.459***	***0.402***	***0.397***	***0.437***	***0.445***	***0.371***	***0.399***	***0.462***
DDGD	0.179	0.162	0.134	0.135	0.170	0.190	0.250	0.160
DEM	***0.443***	***0.464***	***0.409***	***0.504***	***0.394***	***0.355***	***0.336***	***0.449***
FLD	***0.612***	***0.623***	***0.597***	***0.627***	***0.627***	***0.602***	***0.580***	***0.605***
LAI	0.146	0.069	0.044	0.050	0.078	0.063	0.201	0.111
LS*	***0.382***	***0.349***	***0.332***	***0.358***	***0.338***	***0.269***	***0.308***	***0.366***
Openness*	***0.435***	***0.411***	***0.384***	***0.434***	***0.430***	***0.383***	***0.399***	***0.465***
Perimeter*	***0.707***	***0.684***	***0.702***	***0.699***	***0.710***	***0.711***	***0.659***	***0.660***
Relief*	***0.354***	***0.332***	***0.315***	***0.358***	***0.349***	***0.275***	***0.308***	***0.349***
Roundness	***-0.403***	***-0.297***	***-0.341***	***-0.351***	***-0.320***	***-0.296***	***-0.346***	***-0.336***
SCA*	0.202	0.244	0.249	0.274	0.189	0.183	0.127	0.227
Slope*	***0.378***	***0.356***	***0.327***	***0.391***	***0.379***	***0.300***	***0.322***	***0.382***
Stream density	0.068	0.127	0.095	0.180	0.120	***0.176***	***0.128***	0.126
Stream length	***0.578***	***0.618***	***0.575***	***0.643***	***0.643***	***0.625***	***0.540***	***0.593***
Surface area*	***0.393***	***0.365***	***0.365***	***0.408***	***0.410***	***0.327***	***0.348***	***0.410***
TCI*	***0.361***	***0.351***	***0.353***	***0.408***	***0.360***	***0.291***	***0.333***	***0.393***
Total	0.276	0.290	***0.318***	0.261	0.276	***0.318***	0.304	0.261
TPI	***0.411***	***0.375***	***0.414***	***0.424***	***0.395***	***0.331***	***0.378***	***0.440***
TRI*	***0.370***	***0.354***	***0.348***	***0.386***	***0.383***	***0.298***	***0.325***	***0.383***
TWI	0.114	0.118	0.147	0.157	0.096	0.091	0.060	0.130
UCA*	0.230	0.272	***0.271***	***0.297***	0.211	0.206	0.150	0.250
Wetland %	0.242	0.217	0.255	0.201	0.256	0.331	0.350	0.172

4. An example of the daily flows in the Tulameen River in 1992

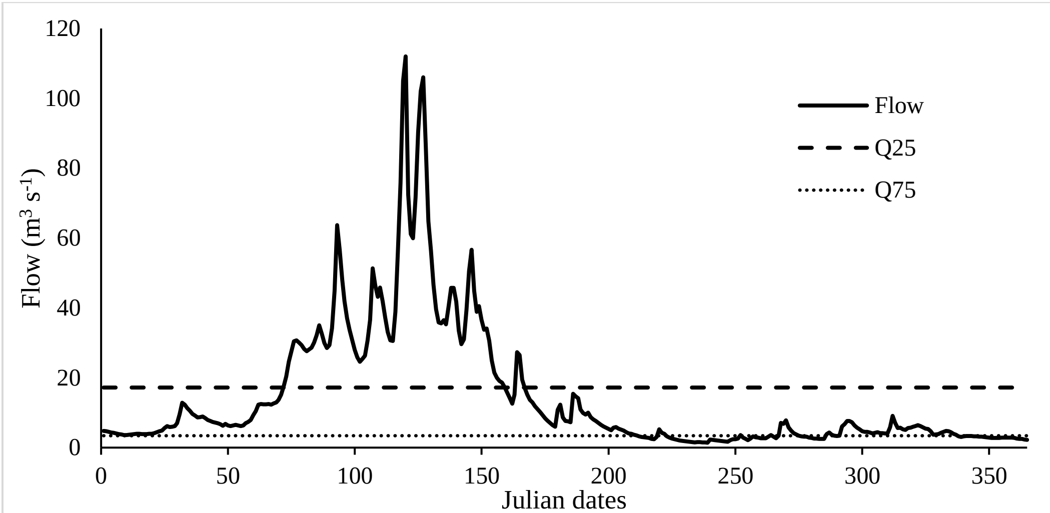

Figure S6 Daily streamflow, $Q_{25\%}$, and $Q_{75\%}$ of the Tulameen River in 1992.

5. Linear regression models between flow variables and the sub-set of TIs from FA

The null hypothesis of the linear regression models in this study is that the TIs have no effect on the flow variables, namely, the coefficients of the linear regression models are equal to zero. As shown in the model summaries in the following sections, the P values of all regression models are <0.01, indicating the null hypothesis was rejected for the models. In addition, the R^2 values are around 0.5, revealing that the selected TIs can be used to explain flow regime component variations (Table S9).

Table S9 The coefficients of determination (R^2) of regression models between flow variables and sub-set of TIs in the period of 1989 to 1996. P values of all models are <0.01.

R^2	$Q_{75\%}$	$Q_{90\%}$	Q_{min}
1989	0.732	0.553	0.424
1990	0.704	0.493	0.458
1991	0.807	0.696	0.485
1992	0.710	0.628	0.506
1993	0.689	0.784	0.360
1994	0.530	0.242	0.447
1995	0.859	0.645	0.611
1996	0.483	0.422	0.537

5.1. Relative contributions TIs to $Q_{75\%}$, $Q_{90\%}$, and Q_{min}

Table S10 Summary of relative contributions of TIs to $Q_{75\%}$ from 1989 to 1996

$Q_{75\%}$	1989	1990	1991	1992	1993	1994	1995	1996	Average	Count	Contributions
Perimeter	18.7	21.3	22.6	22.6	31.3	39.7	35.3	23.2	26.9	8	214.8
SCA	4.9	-	5.3	-	-	13.4	-	-	7.9	3	23.6
UCA	5.3	-	-	7.3	9.3	-	11.6	22.4	11.2	5	55.9
DDG	10.8	8.4	10.5	-	-	8.0	18.5	-	11.2	5	56.2
LS	10.7	9.0	6.7	-	-	-	-	36.9	15.8	4	63.2
Openness	13.3	20.1	14.3	27.7	23.4	10.7	-	17.4	18.1	7	126.9
Relief	-	-	-	-	-	18.5	-	-	18.5	1	18.5
SA	-	-	28.0	31.4	27.8	-	34.6	-	30.5	4	121.8
Slope	13.4	15.3	8.0	-	-	-	-	-	12.3	3	36.8
TCI	-	-	4.5	11.0	8.2	9.8	-	-	8.4	4	33.4
TRI	23.0	26.0	-	-	-	-	-	-	24.5	2	48.9

Table S11 Summary of relative contributions of TIs to $Q_{90\%}$ from 1989 to 1996

$Q_{90\%}$	1989	1990	1991	1992	1993	1994	1995	1996	Average	Count	Contributions
Perimeter	35.8	-	19.9	28.8	20.7	27.1	-	-	26.5	5	132.3
SCA	-	-	-	-	-	15.0	17.7	-	16.4	2	32.7
UCA	10.5	-	5.2	9.4	7.6	-	-	15.0	9.5	5	47.7
DDG	-	11.6	14.0	-	10.0	-	-	13.7	12.3	4	49.3
LS	35.8	18.5	10.5	-	-	-	-	26.6	22.9	4	91.4
Openness	17.9	19.9	12.4	19.0	19.7	-	16.0	-	17.5	6	104.9
Relief	-	-	-	19.5	-	20.0	11.6	-	17.0	3	51.1
SA	-	33.6	21.6	-	29.5	-	28.3	21.1	26.8	5	134.1
Slope	-	16.4	9.5	-	-	-	-	23.6	16.5	3	49.5
TCI	-	-	6.8	23.2	12.5	15.6	9.6	-	13.5	5	67.7
TRI	-	-	-	-	-	22.4	16.9	-	19.7	2	39.3

Table S12 Summary of relative contributions of TIs to Q_{min} from 1989 to 1996

Q_{min}	1989	1990	1991	1992	1993	1994	1995	1996	Average	Count	Contributions
Perimeter	32.2	31.6	20.9	21.1	36.8	14.8	12.6	15.9	23.2	8	185.9
SCA	-	10.2	-	-	11.0	15.5	23.9	15.5	15.2	5	76.1
UCA	17.7	-	14.2	21.0	-	-	-	-	17.6	3	52.9
DDG	-	-	-	-	-	22.2	-	-	22.2	1	22.2
LS	-	33.3	22.0	14.7	30.0	-	12.5	25.2	23.0	6	137.7
Openness	14.3	-	-	8.9	-	-	-	-	11.6	2	23.2
Relief	-	-	-	-	-	10.5	6.5	-	8.5	2	17
SA	-	-	-	-	-	-	11.9	-	11.9	1	11.9
Slope	-	24.9	21.8	-	22.3	-	-	23.3	23.1	4	92.3
TCI	35.7	-	21.1	23.1	-	19.8	16.0	20.0	22.6	6	135.7
TRI	-	-	-	11.2	-	17.1	16.6	-	15.0	3	44.9

Table S13 Summary of the lumped relative contributions of TI to $Q_{75\%}$, $Q_{90\%}$, and Q_{min}

CI	$Q_{75\%}$	$Q_{90\%}$	Q_{min}	Average
Perimeter	214.8	132.3	185.9	533.0
SCA	23.6	32.7	76.1	132.4
UCA	55.9	47.7	52.9	156.5
DDG	56.2	49.3	22.2	127.7
LS	63.2	91.4	137.7	292.3
Openness	126.9	104.9	23.2	255.0
Relief	18.5	51.1	17.0	86.6
SA	121.8	134.1	11.9	267.8
Slope	36.8	49.5	92.3	178.6
TCI	33.4	67.7	135.7	236.8
TRI	48.9	39.3	44.9	133.1
Average				218.2

5.2. Model summaries of $Q_{75\%}$ and TIs from 1989 to 1996

5.2.1. Year 1989

```
lm(formula = Q75_1989 ~ perimeter + UCA + DDG + LS + OPENNESS + SCA +
    Slope + TRI, data = TI)

Residuals:
      Min        1Q    Median        3Q       Max
-0.125094 -0.025652 -0.003529  0.045415  0.080343

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  4.041e-01  1.475e-01   2.740  0.01302 *
perimeter    1.101e-06  4.018e-07   2.740  0.01301 *
UCA         -1.988e-05  9.138e-06  -2.176  0.04242 *
DDG         -4.992e+00  1.767e+00  -2.825  0.01082 *
LS           1.315e-01  6.055e-02   2.173  0.04267 *
OPENNESS    -3.657e+00  2.091e+00  -1.749  0.09639 .
SCA          5.228e-04  2.514e-04   2.079  0.05139 .
Slope       -1.245e+01  4.910e+00  -2.535  0.02018 *
TRI          5.797e-01  1.935e-01   2.997  0.00742 **
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1
Residual standard error: 0.06504 on 19 degrees of freedom
Multiple R-squared:  0.7321,  Adjusted R-squared:  0.6193
F-statistic:  6.49 on 8 and 19 DF, p-value: 0.0004036
```

5.2.2. Year 1990

```
lm(formula = Q75_1990 ~ perimeter + DDG + LS + OPENNESS + Slope + TRI,
    data = TI)

Residuals:
      Min        1Q    Median        3Q       Max
-0.087371 -0.035556 -0.000945  0.022330  0.120496

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.457e-01  9.824e-02   3.519  0.00204 **
perimeter    4.692e-07  2.439e-07   1.924  0.06803 .
DDG         -2.763e+00  1.265e+00  -2.184  0.04044 *
LS           7.744e-02  3.969e-02   1.951  0.06450 .
OPENNESS    -4.894e+00  1.546e+00  -3.166  0.00466 **
Slope       -1.007e+01  3.278e+00  -3.072  0.00578 **
TRI          5.080e-01  1.345e-01   3.776  0.00111 **
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1

Residual standard error: 0.05045 on 21 degrees of freedom
Multiple R-squared:  0.7041,  Adjusted R-squared:  0.6196
F-statistic: 8.329 on 6 and 21 DF,  p-value: 0.0001072
```

5.2.3. Year 1991

```
Call:
lm(formula = Q75_1991 ~ perimeter + DDG + LS + OPENNESS + SCA + Slope +
    SA + TCI, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max
-0.09115 -0.04278 -0.01246  0.03050  0.13767

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  7.047e-01  2.131e-01   3.307  0.00370 **
perimeter    1.188e-06  4.282e-07   2.773  0.01210 *
DDG         -6.093e+00  1.782e+00  -3.420  0.00287 **
LS           1.205e-01  5.858e-02   2.056  0.05376 .
OPENNESS    -7.381e+00  2.269e+00  -3.253  0.00419 **
SCA         -4.018e-05  1.418e-05  -2.834  0.01061 *
Slope       -7.058e+00  3.623e+00  -1.948  0.06629 .
SA           2.334e-02  6.181e-03   3.776  0.00128 **
TCI          1.953e-01  1.038e-01   1.881  0.07536 .
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1
Residual standard error: 0.06931 on 19 degrees of freedom
Multiple R-squared:  0.8075,  Adjusted R-squared:  0.7264
F-statistic: 9.962 on 8 and 19 DF,  p-value: 2.26e-05
```

5.2.4. Year 1992

```
Call:
lm(formula = Q75_1992 ~ perimeter + UCA + OPENNESS + SA + TCI, data = T
I)

Residuals:
      Min        1Q    Median        3Q       Max
-0.079482 -0.034588  0.003925  0.030499  0.072994

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.058e-01  5.116e-02   2.068 0.050572 .
perimeter    4.544e-07  2.311e-07   1.966 0.062011 .
UCA         -8.772e-07  3.217e-07  -2.727 0.012322 *
OPENNESS    -6.607e+00  1.292e+00  -5.115 3.99e-05 ***
SA           7.792e-03  2.025e-03   3.847 0.000875 ***
TCI          1.672e-01  6.498e-02   2.573 0.017359 *
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1

Residual standard error: 0.04431 on 22 degrees of freedom
Multiple R-squared:  0.7096,  Adjusted R-squared:  0.6436
F-statistic: 10.75 on 5 and 22 DF, p-value: 2.515e-05
```

5.2.5. Year 1993

```
Call:
lm(formula = Q75_1993 ~ perimeter + UCA + OPENNESS + SA + TCI, data = T
I)

Residuals:
      Min        1Q    Median        3Q       Max
-0.097691 -0.026347 -0.000605  0.024604  0.098273

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.345e-01  5.399e-02   2.492 0.020745 *
perimeter    6.683e-07  2.439e-07   2.740 0.011946 *
UCA         -1.031e-06  3.396e-07  -3.037 0.006052 **
OPENNESS    -5.986e+00  1.363e+00  -4.391 0.000232 ***
SA           6.859e-03  2.138e-03   3.208 0.004050 **
TCI          1.532e-01  6.858e-02   2.234 0.035948 *
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1

Residual standard error: 0.04677 on 22 degrees of freedom
Multiple R-squared:  0.6893,  Adjusted R-squared:  0.6187
F-statistic: 9.763 on 5 and 22 DF,  p-value: 5.075e-05
```

5.2.6. Year 1994

```
Call:
lm(formula = Q75_1994 ~ perimeter + DDG + OPENNESS + Relief + SCA + 
    TCI, data = TI)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.058751 -0.015446 -0.004067  0.012854  0.084238 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept)  7.906e-02  3.805e-02   2.078  0.05019 . 
perimeter    6.250e-07  1.728e-07   3.616  0.00162 **
DDG         -1.438e+00  7.646e-01  -1.880  0.07403 . 
OPENNESS    -2.265e+00  1.099e+00  -2.060  0.05197 . 
Relief       5.045e-03  1.916e-03   2.633  0.01554 * 
SCA         -1.953e-05  6.957e-06  -2.807  0.01055 * 
TCI          1.199e-01  5.097e-02   2.353  0.02845 * 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.03495 on 21 degrees of freedom
Multiple R-squared:  0.5304,  Adjusted R-squared:  0.3963 
F-statistic: 3.954 on 6 and 21 DF,  p-value: 0.008411
```

5.2.7. Year 1995

```
Call:
lm(formula = Q75_1995 ~ perimeter + UCA + DDG + SA, data = TI)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.074790 -0.028970 -0.003403  0.022623  0.109934 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept)  2.360e-01  7.565e-02   3.119  0.00482 **
perimeter    8.612e-07  2.400e-07   3.588  0.00156 **
UCA         -8.853e-07  3.083e-07  -2.872  0.00862 **
DDG         -2.817e+00  1.100e+00  -2.562  0.01744 * 
SA           8.847e-03  2.487e-03   3.558  0.00167 **
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.05208 on 23 degrees of freedom
Multiple R-squared:  0.6586,  Adjusted R-squared:  0.5993 
F-statistic: 11.09 on 4 and 23 DF,  p-value: 3.675e-05
```

5.2.8. Year 1996

```
Call:
lm(formula = Q75_1996 ~ perimeter + UCA + LS + OPENNESS, data = TI)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.123702 -0.056598 -0.001668  0.054289  0.126588 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept)  1.088e-01  4.486e-02   2.425  0.02355 * 
perimeter    7.641e-07  3.143e-07   2.431  0.02327 * 
UCA         -1.358e-06  4.397e-07  -3.089  0.00517 **
LS           7.375e-02  2.401e-02   3.072  0.00539 **
OPENNESS    -4.426e+00  2.080e+00  -2.128  0.04427 * 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.07263 on 23 degrees of freedom
Multiple R-squared:  0.4826,  Adjusted R-squared:  0.3926 
F-statistic: 5.363 on 4 and 23 DF,  p-value: 0.003354
```

5.3. Model summaries of $Q_{90\%}$ and TIs from 1989 to 1996

5.3.1. Year 1989

```
Call:
lm(formula = Q90_1989 ~ perimeter + UCA + LS + OPENNESS, data = TI)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.097287 -0.035094  0.003757  0.036347  0.075344 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept)  2.334e-02  3.256e-02   0.717  0.48080   
perimeter    7.077e-07  2.282e-07   3.101  0.00503 **
UCA         -7.783e-07  3.192e-07  -2.438  0.02289 * 
LS           5.677e-02  1.743e-02   3.257  0.00347 **
OPENNESS    -3.591e+00  1.510e+00  -2.378  0.02608 * 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.05272 on 23 degrees of freedom
Multiple R-squared:  0.5526,  Adjusted R-squared:  0.4748 
F-statistic: 7.103 on 4 and 23 DF,  p-value: 0.0007064
```

5.3.2. Year 1990

```
Call:
lm(formula = Q90_1990 ~ Slope + SA + LS + DDG + OPENNESS, data = TI)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.070214 -0.029180  0.003069  0.021427  0.106178 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)   
(Intercept)  0.451565   0.124939   3.614  0.00154 **
Slope       -5.338602   2.205449  -2.421  0.02420 * 
SA           0.010430   0.003276   3.184  0.00430 **
LS           0.089466   0.035313   2.534  0.01893 * 
DDG         -2.338472   1.124451  -2.080  0.04942 * 
OPENNESS    -2.573607   1.365113  -1.885  0.07267 . 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.04502 on 22 degrees of freedom
Multiple R-squared:  0.4932,  Adjusted R-squared:  0.378 
F-statistic: 4.282 on 5 and 22 DF,  p-value: 0.007169
```

5.3.3. Year 1991

```
Call:
lm(formula = Q90_1991 ~ perimeter + UCA + DDG + LS + OPENNESS + Slope + 
    SA + TCI, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.06639 -0.02549 -0.01733  0.02431  0.13212 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept)  5.270e-01  1.619e-01   3.254  0.00418 **
perimeter    7.530e-07  3.291e-07   2.288  0.03379 * 
UCA         -8.812e-07  3.934e-07  -2.240  0.03726 * 
DDG         -4.624e+00  1.359e+00  -3.403  0.00298 **
LS           1.259e-01  4.485e-02   2.806  0.01128 * 
OPENNESS    -3.722e+00  1.722e+00  -2.162  0.04362 * 
Slope       -6.748e+00  2.766e+00  -2.440  0.02468 * 
SA           1.263e-02  4.702e-03   2.685  0.01465 * 
TCI          1.473e-01  7.891e-02   1.867  0.07744 . 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 
Residual standard error: 0.05277 on 19 degrees of freedom
Multiple R-squared:  0.6961,  Adjusted R-squared:  0.5681 
F-statistic:  5.44 on 8 and 19 DF,  p-value: 0.001174
```

5.3.4. Year 1992

```
Call:
lm(formula = Q90_1992 ~ perimeter + UCA + OPENNESS + Relief + TCI, data
 = TI)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.069945 -0.021394  0.005658  0.024677  0.048767 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept) -4.919e-02  3.270e-02  -1.504  0.14674   
perimeter    5.063e-07  1.600e-07   3.164  0.00450 **
UCA         -6.914e-07  2.591e-07  -2.669  0.01403 * 
OPENNESS    -3.909e+00  1.092e+00  -3.578  0.00168 **
Relief       4.094e-03  1.708e-03   2.397  0.02544 * 
TCI          1.675e-01  5.068e-02   3.306  0.00322 **
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.03605 on 22 degrees of freedom
Multiple R-squared:  0.6277,  Adjusted R-squared:  0.5431 
F-statistic:  7.42 on 5 and 22 DF,  p-value: 0.0003281
```

5.3.5. Year 1993

```
Call:
lm(formula = Q90_1993 ~ perimeter + UCA + DDG + OPENNESS + SA + TCI, 
    data = TI)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.046550 -0.017709 -0.002745  0.014261  0.065882 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)  1.507e-01  5.069e-02   2.974 0.007246 ** 
perimeter    4.951e-07  1.662e-07   2.980 0.007145 ** 
UCA         -7.872e-07  2.274e-07  -3.461 0.002337 ** 
DDG         -1.878e+00  7.129e-01  -2.635 0.015490 *  
OPENNESS    -4.433e+00  9.491e-01  -4.671 0.000131 ***
SA           8.072e-03  1.722e-03   4.687 0.000126 ***
TCI          1.743e-01  4.637e-02   3.759 0.001156 ** 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.03132 on 21 degrees of freedom
Multiple R-squared:  0.7844,  Adjusted R-squared:  0.7228 
F-statistic: 12.74 on 6 and 21 DF,  p-value: 4.668e-06
```

5.3.6. Year 1994

```
Call:
lm(formula = Q90_1994 ~ perimeter + Relief + SCA + TCI + TRI,
    data = TI)

Residuals:
      Min        1Q    Median        3Q       Max
-0.064842 -0.019059 -0.000727  0.018120  0.075263

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.933e-02  3.144e-02   2.205   0.0382 *
perimeter    4.030e-07  1.854e-07   2.174   0.0408 *
Relief       9.851e-03  4.722e-03   2.086   0.0488 *
SCA         -1.569e-05  8.023e-06  -1.956   0.0633 .
TCI          1.021e-01  5.377e-02   1.899   0.0707 .
TRI         -1.898e-01  8.418e-02  -2.255   0.0345 *
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1

Residual standard error: 0.03593 on 22 degrees of freedom
Multiple R-squared:  0.2424,  Adjusted R-squared:  0.0702
F-statistic: 1.408 on 5 and 22 DF,  p-value: 0.2603
```

5.3.7. Year 1995

```
Call:
lm(formula = Q90_1995 ~ OPENNESS + Relief + SA + SCA + TCI + TRI, data
= TI)

Residuals:
      Min        1Q    Median        3Q       Max
-0.047669 -0.016491 -0.003647  0.015096  0.054430

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.321e-01  7.796e-02   2.977 0.007183 **
OPENNESS    -2.105e+00  9.884e-01  -2.130 0.045205 *
Relief       7.275e-03  3.823e-03   1.903 0.070871 .
SA           1.354e-02  3.783e-03   3.580 0.001766 **
SCA         -2.468e-05  6.283e-06  -3.928 0.000772 ***
TCI          1.126e-01  4.523e-02   2.490 0.021221 *
TRI         -3.038e-01  1.172e-01  -2.594 0.016953 *
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1

Residual standard error: 0.03007 on 21 degrees of freedom
Multiple R-squared:  0.6451,  Adjusted R-squared:  0.5436
F-statistic: 6.361 on 6 and 21 DF,  p-value: 0.0006221
```

5.3.8. Year 1996

```
Call:
lm(formula = Q90_1996 ~ UCA + DDG + LS + Slope + SA, data = TI)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.122575 -0.020684  0.005426  0.028786  0.106930 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept)  5.828e-01  1.608e-01   3.625  0.00150 **
UCA         -7.387e-07  3.300e-07  -2.239  0.03563 * 
DDG         -3.012e+00  1.399e+00  -2.153  0.04253 * 
LS           1.382e-01  4.693e-02   2.944  0.00751 **
Slope       -8.635e+00  2.874e+00  -3.004  0.00653 **
SA           1.112e-02  4.312e-03   2.579  0.01712 * 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.05775 on 22 degrees of freedom
Multiple R-squared:  0.4217,  Adjusted R-squared:  0.2902 
F-statistic: 3.208 on 5 and 22 DF,  p-value: 0.02521
```

5.4. Model summaries of Q_{min} and TIs from 1989 to 1996

5.4.1. Year 1989

```
Call:
lm(formula = Qmin_1989 ~ perimeter + UCA + OPENNESS + TCI, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.15623 -0.08959 -0.02814  0.02717  0.50786 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept) -3.533e-01  1.407e-01  -2.510  0.01954 * 
perimeter    1.810e-06  6.773e-07   2.672  0.01362 * 
UCA         -3.036e-06  1.117e-06  -2.718  0.01227 * 
OPENNESS    -6.851e+00  3.446e+00  -1.988  0.05882 . 
TCI          6.372e-01  2.169e-01   2.938  0.00738 **
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.1554 on 23 degrees of freedom
Multiple R-squared:  0.4236,  Adjusted R-squared:  0.3233 
F-statistic: 4.225 on 4 and 23 DF,  p-value: 0.0104
```

5.4.2. Year 1990

```
Call:
lm(formula = Qmin_1990 ~ perimeter + LS + SCA + Slope, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.18609 -0.06936 -0.01516  0.05157  0.41308 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept)  3.140e-01  1.653e-01   1.899  0.07017 . 
perimeter    1.452e-06  5.468e-07   2.655  0.01415 * 
LS           2.673e-01  8.981e-02   2.977  0.00675 **
SCA         -4.670e-05  2.172e-05  -2.150  0.04233 * 
Slope       -1.346e+01  5.028e+00  -2.677  0.01345 * 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.1258 on 23 degrees of freedom
Multiple R-squared:  0.4582,  Adjusted R-squared:  0.364 
F-statistic: 4.863 on 4 and 23 DF,  p-value: 0.005446
```

5.4.3. Year 1991

```
Call:
lm(formula = Qmin_1991 ~ perimeter + UCA + LS + Slope + TCI, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.20597 -0.10166 -0.01866  0.06244  0.48597 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)  2.164e-01  2.424e-01   0.893   0.3817  
perimeter    1.863e-06  7.374e-07   2.527   0.0192 *
UCA         -3.230e-06  1.197e-06  -2.699   0.0131 *
LS           2.968e-01  1.238e-01   2.397   0.0254 *
Slope       -1.869e+01  6.680e+00  -2.799   0.0105 *
TCI          4.509e-01  2.260e-01   1.995   0.0585 .
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.1661 on 22 degrees of freedom
Multiple R-squared:  0.4851,  Adjusted R-squared:  0.368 
F-statistic: 4.145 on 5 and 22 DF,  p-value: 0.008363
```

5.4.4. Year 1992

```
Call:
lm(formula = Qmin_1992 ~ perimeter + UCA + LS + TCI + TRI, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.18656 -0.07575  0.00304  0.03680  0.39293 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept) -1.231e-01  1.215e-01  -1.013  0.32210   
perimeter    2.188e-06  6.501e-07   3.365  0.00279 **
UCA         -3.394e-06  9.644e-07  -3.519  0.00193 **
LS           2.014e-01  8.898e-02   2.264  0.03379 * 
TCI          4.257e-01  1.707e-01   2.494  0.02064 * 
TRI         -5.910e-01  2.205e-01  -2.680  0.01367 * 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.1242 on 22 degrees of freedom
Multiple R-squared:  0.5056,	Adjusted R-squared:  0.3932 
F-statistic: 4.499 on 5 and 22 DF,  p-value: 0.005635
```

5.4.5. Year 1993

```
Call:
lm(formula = Qmin_1993 ~ perimeter + LS + SCA + Slope, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.17686 -0.06891 -0.03780  0.04566  0.43013 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)  2.450e-01  1.778e-01   1.378   0.1816  
perimeter    1.368e-06  5.881e-07   2.327   0.0291 *
LS           2.163e-01  9.661e-02   2.239   0.0351 *
SCA         -4.226e-05  2.337e-05  -1.809   0.0836 .
Slope       -1.080e+01  5.409e+00  -1.997   0.0578 .
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1 

Residual standard error: 0.1353 on 23 degrees of freedom
Multiple R-squared:  0.3597,	Adjusted R-squared:  0.2483 
F-statistic:  3.23 on 4 and 23 DF,  p-value: 0.0305
```

5.4.6. Year 1994

```
Call:
lm(formula = Qmin_1994 ~ perimeter + DDG + Relief + SCA + TCI +
    TRI, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max
-0.07093 -0.03417 -0.01463  0.01993  0.20145

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.301e-01  6.604e-02  -1.970   0.0621 .
perimeter    7.422e-07  3.536e-07   2.099   0.0481 *
DDG          2.603e+00  1.469e+00   1.771   0.0910 .
Relief       1.636e-02  8.687e-03   1.883   0.0736 .
SCA         -4.026e-05  1.476e-05  -2.727   0.0126 *
TCI          2.487e-01  1.007e-01   2.470   0.0222 *
TRI         -4.193e-01  1.630e-01  -2.573   0.0177 *
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1

Residual standard error: 0.06606 on 21 degrees of freedom
Multiple R-squared:  0.4473,  Adjusted R-squared:  0.2894
F-statistic: 2.833 on 6 and 21 DF, p-value: 0.03515
```

5.4.7. Year 1995

```
Call:
lm(formula = Qmin_1995 ~ perimeter + LS + Relief + SCA + SA +
    TCI + TRI, data = TI)

Residuals:
      Min        1Q    Median        3Q       Max
-0.117308 -0.043482 -0.001117  0.026868  0.214352

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  4.670e-01  2.462e-01   1.897 0.072384 .
perimeter    9.726e-07  4.495e-07   2.163 0.042790 *
LS           1.554e-01  6.107e-02   2.544 0.019309 *
Relief       1.693e-02  9.801e-03   1.727 0.099575 .
SCA         -7.817e-05  1.756e-05  -4.452 0.000245 ***
SA           2.736e-02  1.202e-02   2.276 0.033967 *
TCI          3.105e-01  1.124e-01   2.763 0.011997 *
TRI         -1.187e+00  3.371e-01  -3.521 0.002148 **
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1

Residual standard error: 0.07245 on 20 degrees of freedom
Multiple R-squared:  0.611,   Adjusted R-squared:  0.4748
F-statistic: 4.487 on 7 and 20 DF, p-value: 0.003801
```

5.4.8. Year 1996

```
Call:
lm(formula = Qmin_1996 ~ perimeter + LS + SCA + Slope + TCI, data = TI)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.17384 -0.05504  0.00553  0.04533  0.35404 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)   
(Intercept)  1.948e-01  1.737e-01   1.122  0.27416   
perimeter    1.292e-06  5.223e-07   2.473  0.02159 * 
LS           2.489e-01  8.836e-02   2.817  0.01004 * 
SCA         -7.144e-05  2.349e-05  -3.041  0.00600 **
Slope       -1.497e+01  4.758e+00  -3.146  0.00469 **
TCI          3.238e-01  1.618e-01   2.001  0.05783 . 
---
Signif. codes:  0 ?**?0.001 ?*?0.01 ??0.05 ??0.1 ??1

Residual standard error: 0.119 on 22 degrees of freedom
Multiple R-squared:  0.5366,  Adjusted R-squared:  0.4313 
F-statistic: 5.095 on 5 and 22 DF,  p-value: 0.002979
```

6. FA test validation

There is a concern that the FA excluded TIs that were significant related to flow regimes, but not included in the MLR models. To address this concern, we have re-run analysis by conducting the MLR models for Q_{min} in 1989, 1990, and 1991 as examples (Table S10). The results showed that the MLR models included several redundant TIs (e.g., wetland coverage, roundness, stream length) if the FA test was not conducted. It should be noted that they were not significantly correlated with low flows indicated by Kendall tau correlation test (Table S8). This further suggests that some redundant and nonsignificant TIs would be introduced if the FA test was not initially conducted. Therefore, our research methodology is sound.

Table S14 Topographic indices included in the multiple regression models of Q_{min} for years of 1989, 1990, and 1991 with or without the FA test.

Year	Model variables with initial FA test	Model variables without initial FA test
1989	Openness, **Perimeter**, TCI, UCA	DDG, DDGD, LS, Openness, **Perimeter**, Relief, Roundness, SA, Stream Length, Slope, TRI, TPI, Wetland
1990	**LS, Perimeter**, Relief, SCA, Slope,	Median Elevation, Roundness, Stream Length, Wetland, TPI, **LS**, Openness, SA, TCI, TRI
1991	**LS, Perimeter**, Slope, TCI, UCA	DDG, DDGD, LS, Openness, **Perimeter**, Relief, Roundness, Stream Length, SCA, SA, TRI, Wetland

References

Li, Q., Wei, X., Zhang, M., Liu, W., Fan, H., Zhou, G. ... & Wang, Y. (2017). Forest cover change and water yield in large forested watersheds: A global synthetic assessment. Ecohydrology.

Xiao, Z., Liang, S., Wang, J., Chen, P., Yin, X., Zhang, L. and Song, J., 2014. Use of general regression neural networks for generating the GLASS leaf area index product from time-series MODIS surface reflectance. *IEEE Transactions on Geoscience and Remote Sensing*, *52*(1), pp.209-223.

Zhang, M., Liu, N., Harper, R., Li, Q., Liu, K., Wei, X. ... & Liu, S. (2017). A global review on hydrological response to forest change across multiple spatial scales: importance of scale, climate, forest type and hydrological regime. *Journal of Hydrology*.