

Supplementary Material

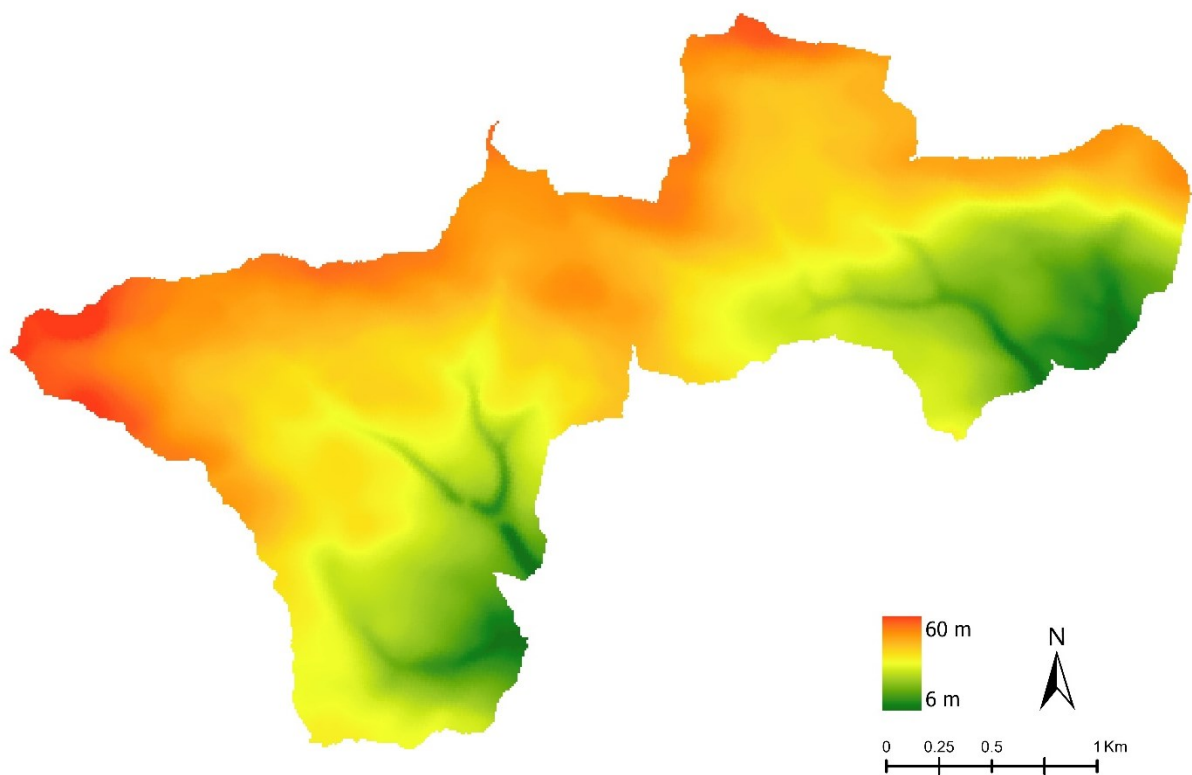


Figure S1. DEM in watershed (metres above mean sea level). Layer provided from the Province of PEI (Province of PEI, 2023), displayed in WGS 1984 UTM Zone 20N projected coordinate system.

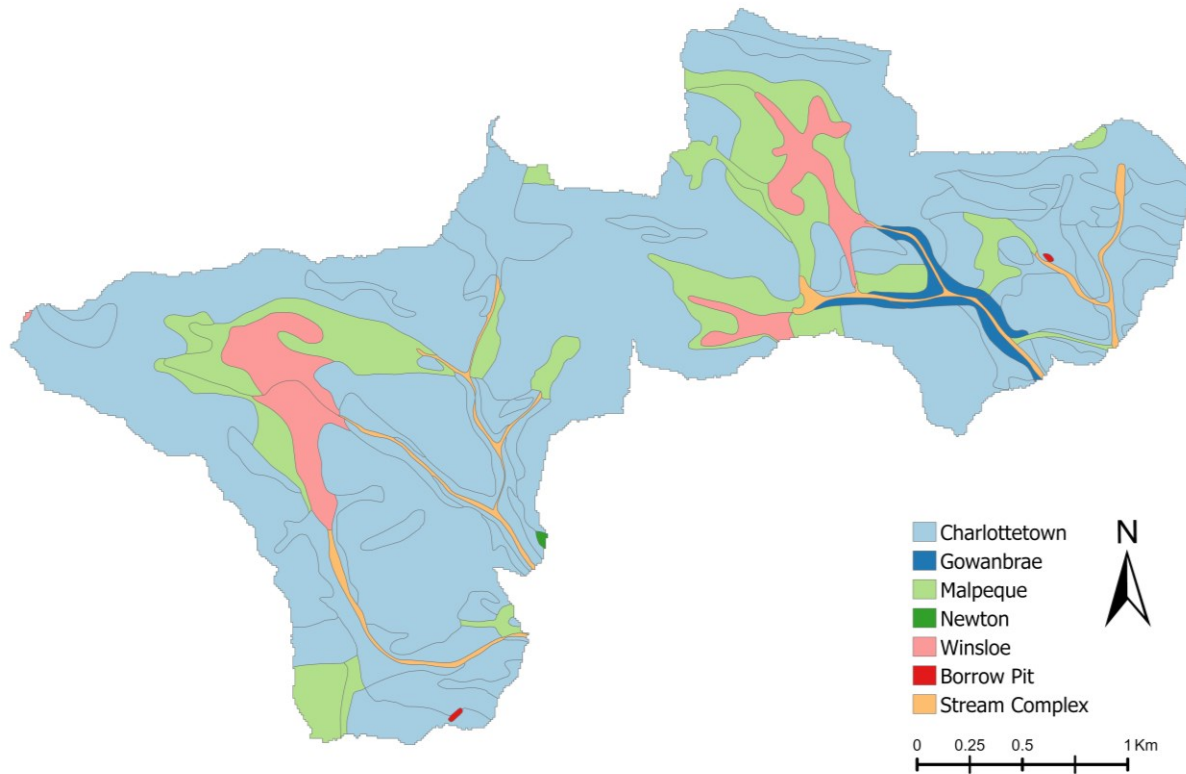


Figure S2. Soil types in watershed. Layer provided from the Province of PEI (Province of PEI, 2023), displayed in WGS 1984 UTM Zone 20N projected coordinate system.

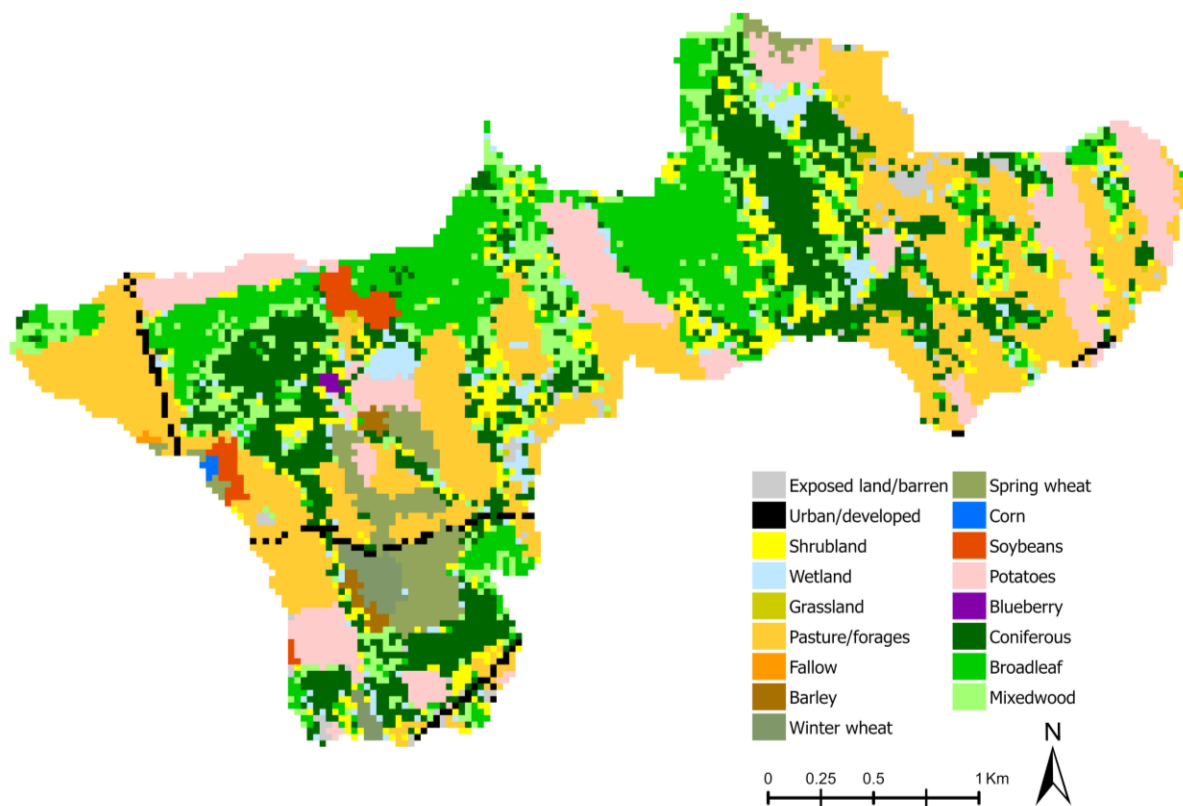


Figure S3. Land uses in watershed. Layer provided from ACI 2019 (Agriculture and Agri-food Canada, 2023), displayed in WGS 1984 UTM Zone 20N projected coordinate system.

Table S1. Agricultural operation inputs for PBC crop rotation.

Year 1			
Potato			
Date:	Operation:	Type:	Application Rate:
15-May	Till	Disk Plow	-
30-May	Fertilize	15-15-15	1000 kg ha ⁻¹ (170 kg N ha ⁻¹)
31-May	Plant	Potato	-
15-Sep	Harvest and Kill	Potato	-
30-Sep	Till	Mouldboard Plow	-
Year 2			
Barley			
Date:	Operation:	Type:	Application Rate:
15-May	Till	Disk Plow	-
16-May	Plant	Barley	-
15-Sep	Harvest and Kill	Barley	-
Year 3			
Red Clover			
Date:	Operation:	Type:	Application Rate:
15-May	Till	Disk Plow	-
16-May	Plant	Red Clover	-
15-Sep	Harvest and Kill	Red Clover	-
30-Sep	Till	Mouldboard Plow	-

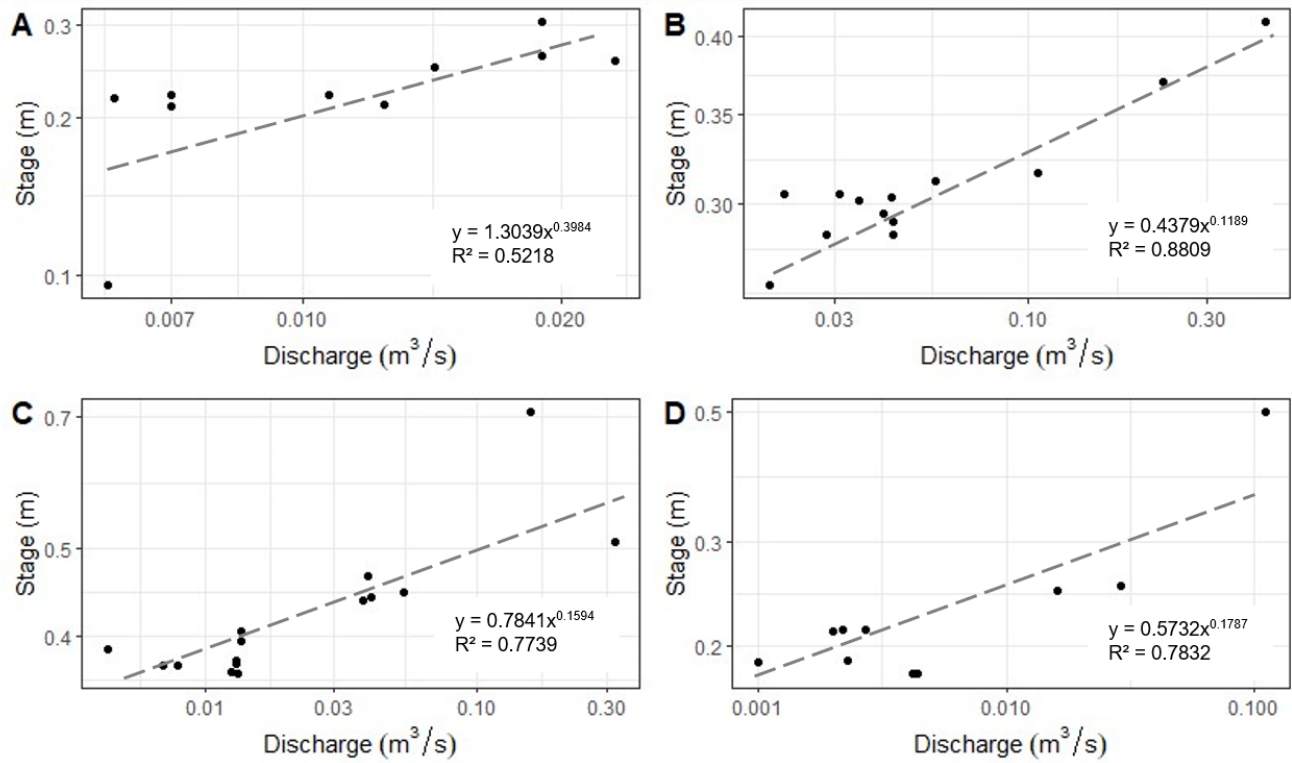


Figure S4. a) Tributary 1 rating curve, b) Tributary 2 rating curve, c) Tributary 3 rating curve, d) Tributary 4 rating curve.

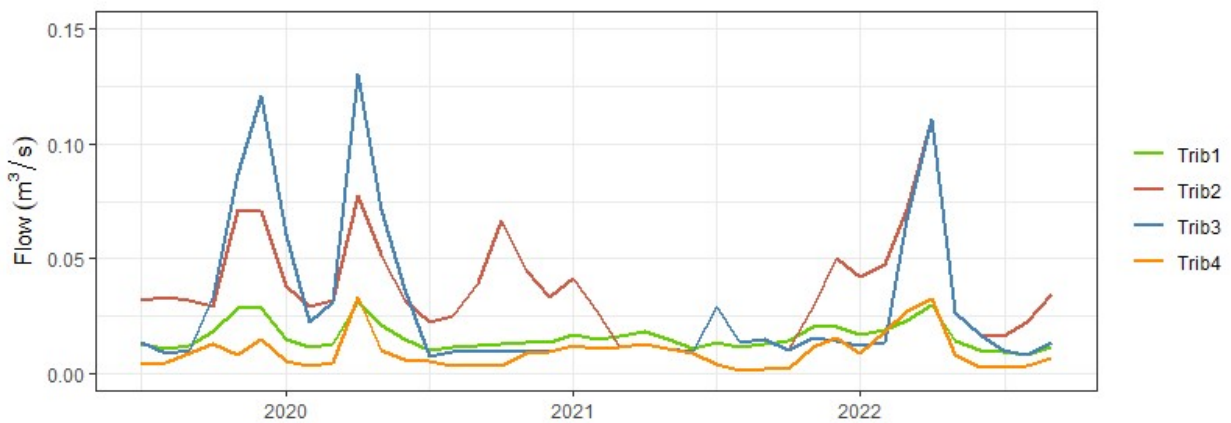


Figure S5. Monthly averaged flows in all four monitored tributaries.

Table S2. SWAT+ Toolbox sensitivity analysis results.

Parameter	Description	Unit	1st Order Sensitivity
perco	Recharge to deep aquifer (the fraction of root zone percolation that reaches the deep aquifer)	Fraction	0.112
awc	Available water capacity of the soil layer	mm H ₂ O /mm	0.083
cn2	SCS curve number	-	0.0695
k	Saturated hydraulic conductivity	mm/hr	0.041
canmx	Maximum canopy storage	mm H ₂ O	0.033
snomelt_min	Melt factor for snow on December 21	mm H ₂ O/°C - day	0.012
esco	Soil evaporation compensation factor	-	0.011
cn3_swf	Pothole evaporation coefficient, Soil water at CN3: 0=fc, 0.99=near saturation	-	0.01
snomelt_tmp	Snowfall temperature	°C	0.0016
snomelt_max	Melt factor for snow on June 21	mm H ₂ O/°C - day	0.0005
surlag	Surface runoff lag coefficient	days	0
revap_min	Threshold depth of water in the shallow aquifer for “revap” or percolation to the deep aquifer to occur	m	0

revap_co	Threshold depth of water in shallow aquifer required to allow revap to occur	-	0
bf_max	Maximum daily baseflow	mm	0
alpha	Baseflow recession constant	1/days	-0.00147
flo_min	Minimum aquifer storage to allow return flow	m	-0.00371
snomelt_lag	Snowpack temperature lag factor	-	-0.00568

Table S3. TSS and nitrate sample concentration (Adapted from Oliver et al., 2024).

Total Suspended Solids (mg/L)				
Sample Date	Tributary 1	Tributary 2	Tributary 3	Tributary 4
2022-07-27	*270.0	22	16	8
2022-08-23	8	10	18	24
2022-10-15	20	12	6	18
2023-02-22	0	2.5	5	0
2023-04-28	4.7	17.8	0	0
2023-05-30	0	0	44	0
2023-07-05	8.2	8	6.2	4.2
2023-08-23	1.5	18.5	3.1	3.1
Nitrate-Nitrogen (mg/L)				

Sample Date	Tributary 1	Tributary 2	Tributary 3	Tributary 4
2021-11-11	4.50	2.10	0.70	-
2021-12-06	-	1.70	-	-
2022-03-03	2.70	2.00	0.70	1.60
2022-04-06	4.5	2.2	3.3	0.9
2022-04-09	4.4	2.4	0.8	3.1
2022-07-27	5.1	2.4	1.8	1.4
2022-08-23	4.8	2	2.5	1
2022-10-15	4.7	2.5	2.5	0.9
2023-02-22	5.4	1.1	0.5	2.1
2023-04-28	6.2	1.8	0.7	2.1
2023-05-30	3.9	1.5	1.1	2.1
2023-07-05	1.6	0.4	0	0.4
2023-08-23	4.1	1.7	1.2	3.1
2023-11-28	2.7	1.7	0.4	2.4

*Note: this value is assumed erroneous because there was no large precipitation event prior to sample collection.

Table S4. Parameters used in sensitivity analysis and calibration. Sensitive parameters selected based on Liang et al., 2020.

Parameter	Definition	Range	Sensitivity (t-stat)	Sensitivity (p value)	Fitted Value
SOL_NO3	Initial NO3 concentration in the soil layer (mg kg ⁻¹)	0-100	3.989	0.000	14.65
HLIFE_NGW	Half-life of nitrate in the shallow aquifer (days)	0-200	12.855	0.000	117.64
SDNCO	Denitrification threshold water content	0-1	29.789	0.000	0.66
CDN	Denitrification exponential rate coefficient	0-3	-33.531	0.000	0.07
CMN	Rate factor for humus mineralization of active organic nitrogen	0.001-0.003	1.222	0.222	0.0029
NPERCO	Nitrogen percolation coefficient	0-1	1.193	0.234	0.77
RCN	Concentration of nitrogen in rainfall (mg L ⁻¹)	0-15	-0.145	0.884	5.67
N_UPDIS	Nitrogen uptake distribution parameter	0-100	0.082	0.935	66.7

Table S5. Climate models chosen from for modeling. Average annual precipitation calculated for period of 151 years.

GCM	SSP	Cumulative precipitation (mm)	Average annual precipitation (mm/yr)
GFDL-ESM4	SSP1-2.6	206729	1369
	SSP2-4.5	208164	1379
	SSP3-7.0	206925	1370
	SSP5-8.5	206217	1366
NorESM2-LM	SSP-1.26	204189	1352
	SSP-2.45	207712	1376
	SSP-3.70	206367	1367
	SSP-5.85	205649	1362
MIROC-ES2L	SSP-1.26	211059	1398
	SSP-2.45	210319	1393
	SSP-3.70	211233	1399
	SSP-5.85	215118	1425
FGOALS-g3	SSP1-2.6	201705	1336
	SSP2-4.5	204532	1355
	SSP3-7.0	208062	1378
	SSP5-8.5	208455	1380

MRI-ESM2-0	SSP-1.26	213387	1413
	SSP-2.45	211321	1399
	SSP-3.70	211645	1402
	SSP-5.85	212014	1404
INM-CM5-0	SSP1-2.6	199803	1323
	SSP2-4.5	200799	1330
	SSP3-7.0	204437	1354
	SSP5-8.5	201280	1333

Table S6. All model run descriptions.

Model run	Description	Input weather data	Input weather data duration	Model output years	Model warmup years
1	Calibration	BH weather station, East Point and St. Peters stations	2016-2022	2019-2022	3
2	Climate change	INM-CM5-0 (SSP 245)	1950-2100	1990-2100	40
3	Climate change	INM-CM5-0 (SSP 585)	1950-2100	1990-2100	40
4	Climate change	FGOALS-g3 (SSP 245)	1950-2100	1990-2100	40
5	Climate change	FGOALS-g3 (SSP 585)	1950-2100	1990-2100	40

6	Climate change	MRI-ESM2-0 (SSP 245)	1950-2100	1990-2100	40
7	Climate change	MRI-ESM2-0 (SSP 585)	1950-2100	1990-2100	40
8	BMP: 60 m buffer strips	MRI-ESM2-0 (SSP 585)	1950-2100	1990-2100	40
9	BMP: Delayed tillage	MRI-ESM2-0 (SSP 585)	1950-2100	1990-2100	40
10	BMP: PSB crop rotation	MRI-ESM2-0 (SSP 585)	1950-2100	1990-2100	40
11	Future agricultural practices	MRI-ESM2-0 (SSP 585)	1950-2100	1990-2100	40
12	Agricultural land reduced by 50% and replaced with forest	MRI-ESM2-0 (SSP 585)	1950-2100	1990-2100	40

Table S7. Agricultural operation inputs for PSB crop rotation.

Year 1			
Potato			
Date:	Operation:	Type:	Application Rate:
15-May	Till	Disk Plow	-
30-May	Fertilize	17-17-17	1000 kg ha ⁻¹ (170 kg N ha ⁻¹)
31-May	Plant	Potato	-
15-Sep	Harvest and Kill	Potato	-
30-Sep	Till	Mouldboard Plow	-
Year 2			

Soybean			
Date:	Operation:	Type:	Application Rate:
15-May	Till	Disk Plow	-
30-May	Plant	Soybean	-
15-Sep	Harvest and Kill	Soybean	-
Year 3			
Barley			
Date:	Operation:	Type:	Application Rate:
15-May	Till	Disk Plow	-
16-May	Plant	Barley	-
15-Sep	Harvest and Kill	Barley	-
30-Sep	Till	Mouldboard Plow	-

Table S8. Manually calibrated parameters for all tributaries.

Parameter	Min	Max	Tributary 1	Tributary 2	Tributary 3	Tributary 4	Unit
perco	0	1	0.9	0.9	0.9	0.9	fraction
awc	0.01	1	0.09	0.09	0.09	0.09	mm_H2O /mm
cn2	-40	40	-25	-25	-25	-25	
canmx	0	100	50	50	50	50	mm/ H2O
snomelt_min	0	10	4.5	1	2	4.5	mm/ deg/c/day

esco	0	1	0.95	0.95	0.95	0.95	
cn3_swf	0	1	0.44	0.44	0.44	0.44	
snomelt_tmp	-5	5	2.5	2.5	3	3	degrees
snomelt_max	0	10	4.5	5.5	4.5	4.5	Mm /deg/c/day
alpha	0	1	0.1	0.5	0.1	0.1	days

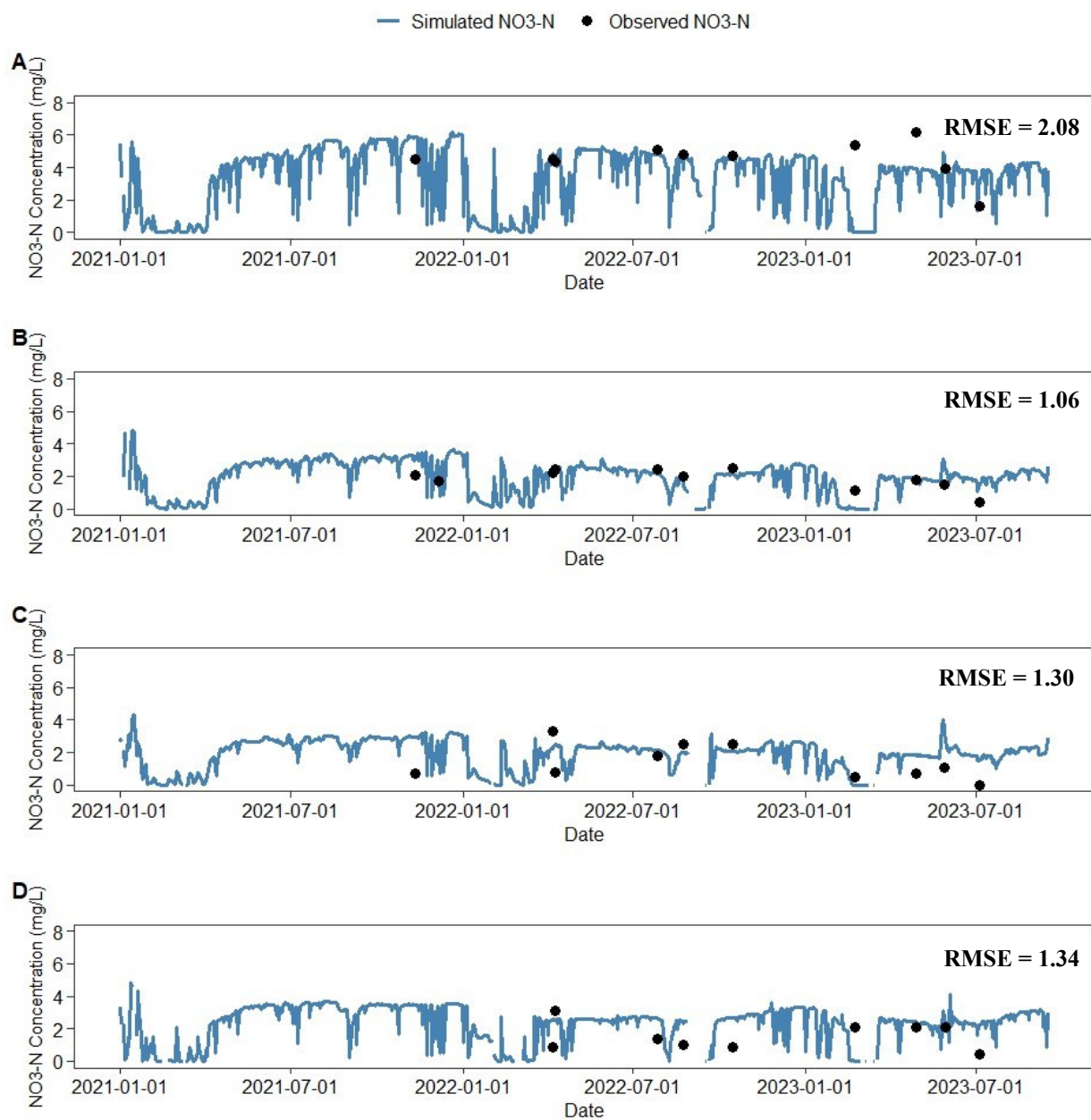


Figure S6. Calibrated model NO₃-N output (blue lines) compared with observed concentrations (black dots) for a) Tributary 1, with RMSE = 2.08 mg/L, b) Tributary 2, with RMSE = 1.06 mg/L, c) Tributary 3, with RMSE = 1.30 mg/L, and d) Tributary 4, with RMSE = 1.34 mg/L.

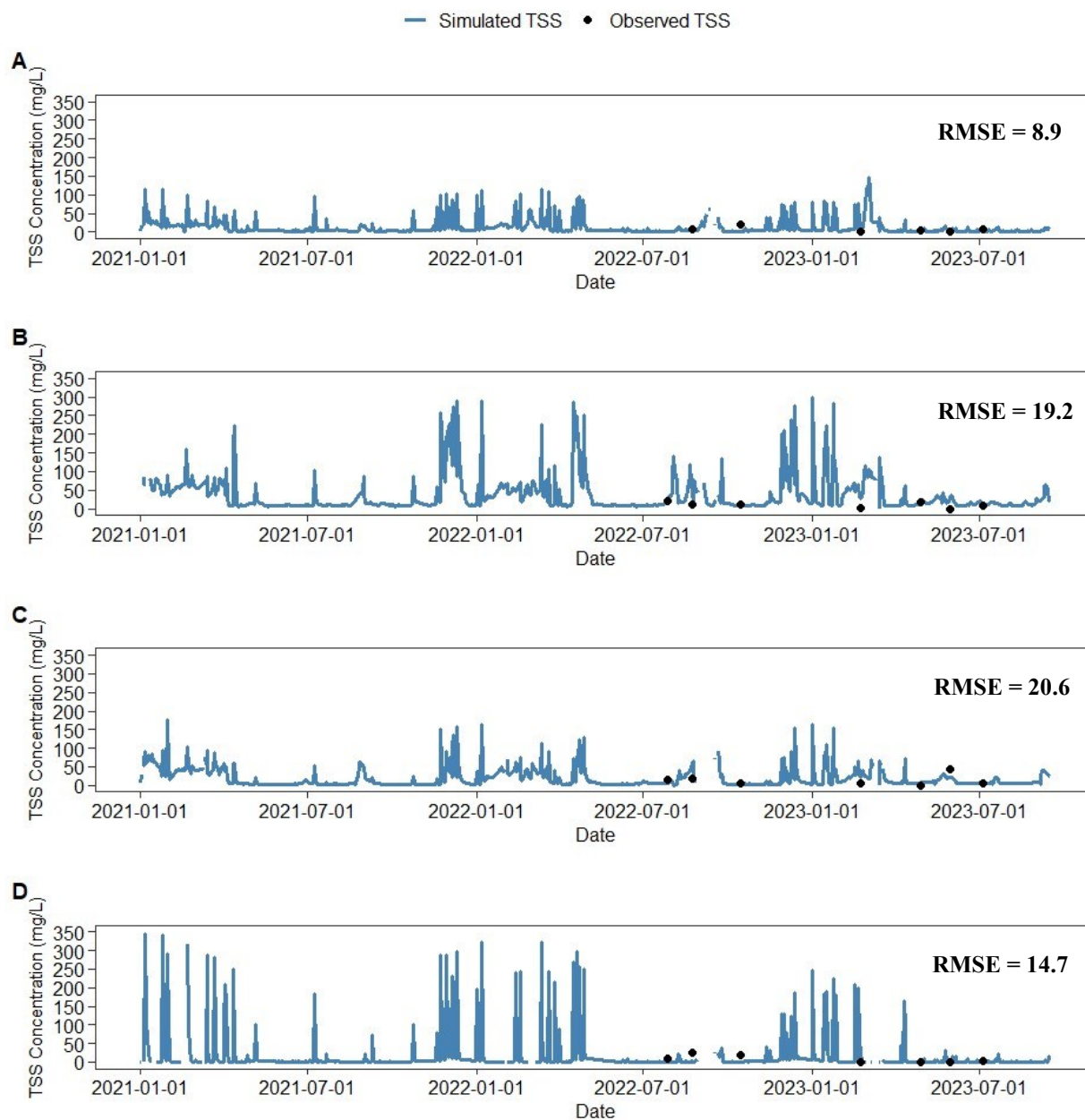


Figure S7. Calibrated model TSS output (blue lines) compared with observed concentrations (black dots) for a) Tributary 1, with RMSE 8.9 mg/L, b) Tributary 2, with RMSE 19.2 mg/L, c) Tributary 3, with RMSE 20.6 mg/L, and d) Tributary 4, with RMSE 14.7 mg/L.

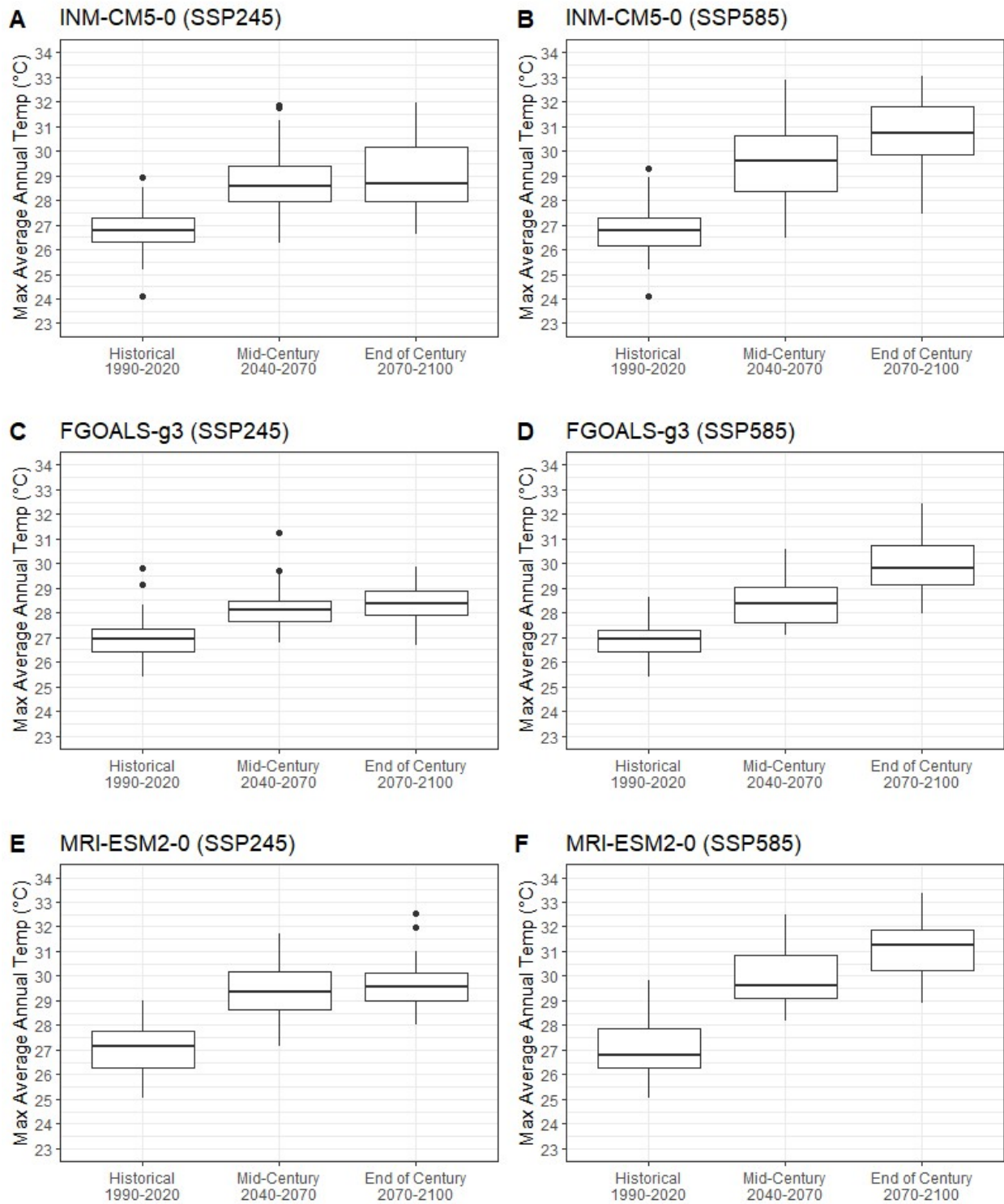


Figure S8. Maximum average annual air temperature for each climate scenario.

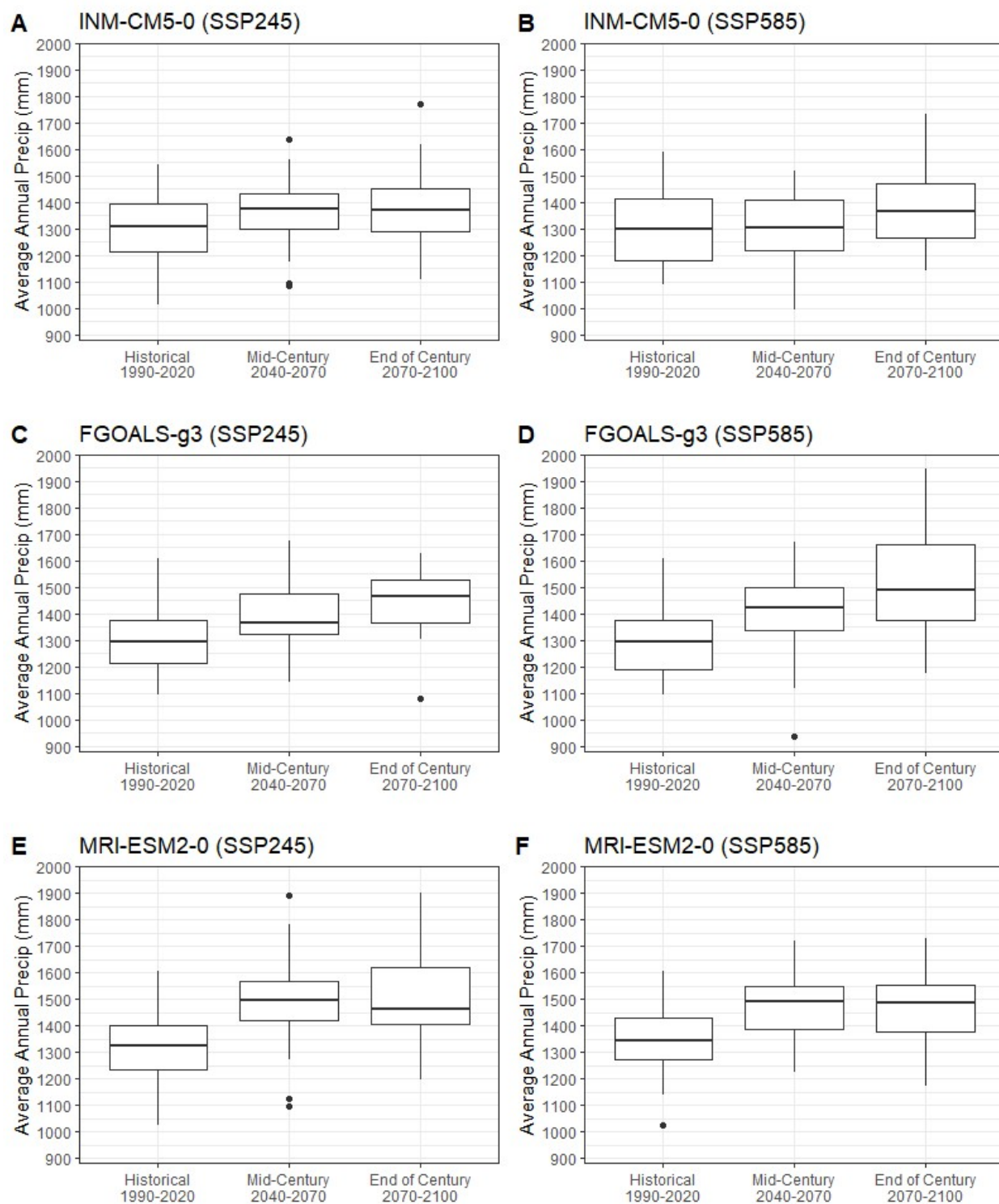


Figure S9. Average annual precipitation for each climate scenario.

Table S9. Land use percentages before and after reduction in crop land by 50%. Row crop rotational land includes barley, corn, pasture/ forage land, potatoes soybeans, spring wheat, and winter wheat.

Landuse	Before	After
Row crop rotational land	43.8%	22.0%
Blueberry	0.1%	0.1%
Broadleaf	15.8%	15.8%
Coniferous	18.7%	40.8%
Exposed land/barren	1.3%	1.3%
Fallow	0.1%	0.1%
Grassland	0.3%	0.3%
Mixedwood	8.4%	8.5%
Shrubland	7.0%	7.0%
Urban/developed	1.1%	1.1%
Wetland	3.2%	3.2%