water

Supplementary Material

Effects of Land Cover and Atmospheric Input on Nutrient Budget in Subtropical Mountainous Rivers, Northeastern Taiwan

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Table S1. Input parameters in Hydrological Response Unit (HRU).

Parameter	Description	Unit	Default Parameters Lower*	Default Parameters Upper	Calibrated Parameters Range in HRUs
sdmax	Max deficit before subsurface flow ceases	m	0.1	0.8	0.27–0.41
vof	Overland flow velocity within area	m hr^{-1}	No default	No default	28.82–121.97
td	Unsaturated zone drainage delay	hr m^{-1}	0.1	40	39.93–86.17
srz0	Root zone storage initially occupied	%	0	1	0.86–0.92
m	Recession parameter	m	0.005	0.025	0.021–0.032
ln(T0)	Saturated transmissivity	m^2 hr^{-1}	-7	8	-0.26–4.77
srzmax	Maximum root zone storage	m	0.005	0.2	0.02–0.08

*Setting lower and upper limitation is combination from Beven and Kirkby, 1979; Beven and Freer, 2001; Page et al., 2007; Metcalfe et al., 2015.

Beven, K. J., Kirkby, M.J.. A physically based, variable contributing area model of basin hydrology, Hydrological Sciences Bulletin, **1979**, 24, 43–69.

Beven, K., Freer, J. A dynamic TOPMODEL, *Hydrol. Process*.**2001** 15, 1993–2011.

Metcalfe, P., Beven, K., Freer, J. 2015. Dynamic TOPMODEL: A new implementation in R and its sensitivity to time and space steps, *Environ. Model. Softw*.**2015**, 72, 155–172.

Page, T., Beven, K. J., Freer, J., Neal, C.. Modelling the chloride signal at Plynlimon, Wales, using a modified dynamic TOPMODEL incorporating conservative chemical mixing (with uncertainty*). Hydrol. Process*. **2007** 21, 292–307.

Table S2 . The estimated annual water quantity (mm), observed volume-weighted mean (VWM) pH and concentrations (μeq L^{-1}) of major elements in precipitation and streamwater measured in 2014 across 19 watersheds.

Sites	Rainwater/ Streamwater	pH	Na^+	K^+	Mg^{2+}	Ca^{2+}	Cl^-	NO_3^-	SO_4^{2-}
				Precipitation					
1	4290	4.64	100.3	17.0	25.8	39.0	107.3	25.2	47.9
3	4270	4.65	101.8	17.0	26.4	39.7	107.8	24.8	47.8
4	4390	4.56	98.1	15.4	24.6	32.6	102.6	26.2	47.7
12	3880	5.05	85.8	16.9	26.4	41.5	90.9	19.7	42.4
14	3550	4.95	93.8	20.7	27.5	43.0	98.7	21.3	45.4
17	3440	4.79	72.8	12.4	19.2	54.3	73.8	17.9	41.2
19	3430	4.79	73.0	12.3	19.4	54.2	73.9	18.0	41.3
				Stream water					
1	3240	6.99	229.1	12.5	94.8	82.9	189.0	24.5	67.8
2	3190	7.03	228.7	11.0	130.9	134.9	172.4	25.9	94.9
3	3240	6.98	227.1	12.0	116.9	121.1	173.9	25.6	84.6
4	3480	7.07	265.6	29.4	249.1	284.1	198.1	214.3	191.3
5	3090	6.99	230.8	15.3	134.7	177.3	159.5	32.5	118.5
6	3360	7.01	227.6	13.1	126.6	137.2	181.8	33.9	98.8
7	3090	7.17	223.1	18.1	157.7	214.4	162.2	65.8	132.1
8	3480	7.25	259.3	24.5	263.3	379.1	176.5	124.4	265.9
9	3360	7.11	227.1	14.9	136.8	164.2	174.0	42.2	108.7
10	2550	7.06	232.0	31.1	186.3	246.3	158.4	121.7	144.3
11	2380	7.27	197.6	10.2	149.8	197.4	139.1	26.6	121.5
12	2880	7.01	207.8	12.4	155.5	188.9	139.9	23.7	126.3
13	2470	7.18	180.0	9.8	160.8	203.3	102.5	27.3	128.9
14	2550	6.99	193.7	10.1	159.8	201.3	122.5	25.5	129.1
15	2470	7.07	200.3	12.4	173.5	217.3	132.6	30.1	139.7
16	3010	7.19	213.0	15.5	162.3	200.3	151.1	37.1	132.7
17	2590	6.91	194.4	15.8	201.5	234.9	100.4	28.7	141.5
18	3580	6.69	247.9	22.8	167.8	160.7	172.9	150.4	104.9
19	2600	7.03	204.9	17.0	196.2	230.9	108.4	29.9	132.7

Table S3. The annual total fluxes of precipitation input and stream water output of major elements in 2014 across 19 watersheds.

Sites	Na^+	K^+	Mg^{2+}	Ca^{2+}	Cl^-	NO_3^-	SO_4^{2-}
			Precipitation (kg ha^{-1} yr^{-1})				
1	97.8	28.1	13.3	33.1	161.6	14.9	32.5
3	98.8	28.1	13.6	33.5	161.5	14.7	32.3
4	97.8	26.1	12.9	28.2	157.9	15.9	33.1
12	75.6	25.2	11.5	31.8	123.5	10.6	26.0
14	75.5	28.3	11.7	30.1	122.5	10.4	25.4
17	56.8	16.4	7.9	36.8	88.8	8.5	22.4
19	57.0	16.3	8.0	36.8	89.0	8.5	22.4
			Stream water (kg ha^{-1} yr^{-1})				
1	166.7	15.5	36.4	52.5	212.4	11.3	34.3
2	164.3	13.4	50.0	84.3	191.1	11.3	47.4
3	166.1	14.9	45.2	77.0	196.4	11.4	43.1

4	209.7	39.3	103.9	195.1	241.5	103.1	105.1
5	160.5	18.1	49.5	107.2	171.2	13.8	57.3
6	171.1	16.7	50.3	89.7	210.9	15.5	51.7
7	155.1	21.3	57.9	129.7	174.1	27.9	63.9
8	204.5	32.8	109.9	260.3	215.1	59.8	146.1
9	170.7	19.0	54.3	107.3	201.9	19.3	56.8
10	133.4	30.3	56.6	123.1	140.6	42.6	57.7
11	106.2	9.3	42.5	92.2	115.4	8.7	45.4
12	134.4	13.6	53.1	106.3	139.7	9.4	56.9
13	99.3	9.2	46.8	97.5	87.2	9.2	49.4
14	111.4	9.9	48.5	100.7	108.7	8.9	51.6
15	110.3	11.5	50.5	104.0	112.7	10.1	53.5
16	143.5	17.6	57.6	117.1	156.8	15.2	62.0
17	114.7	15.5	61.5	118.1	89.6	10.1	56.9
18	199.1	31.1	71.2	112.2	214.2	73.5	58.6
19	119.9	16.9	60.6	117.5	97.8	10.6	54.0

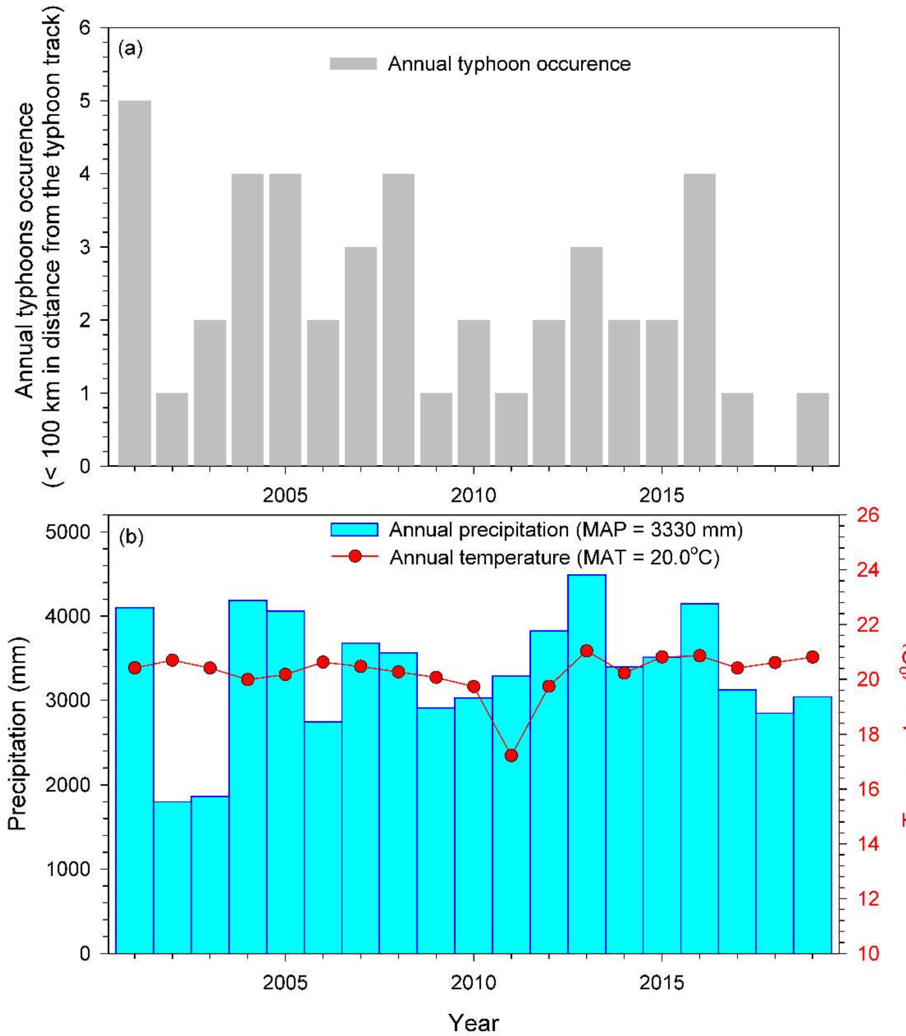

Figure S1. The annual typhoon occurrence (a), annual mean temperature and annual precipitation (b) during the period 2001–2019 based on data from the climate station of C0A530 maintained by Central Weather Bureau (between sites number 8 and number 9) in Figure 1. The typhoon occurrence was defined as those which were < 100 km in distance from the study region to their paths at the closest (Tu et al., 2009). .

Tu, J.Y., Chou, C., and Chu, P.S. The abrupt shift of typhoon activity in the vicinity of Taiwan and its association with western North Pacific-East Asian climate change. *Journal of Climate,* **2009**,22: 3617-3628.

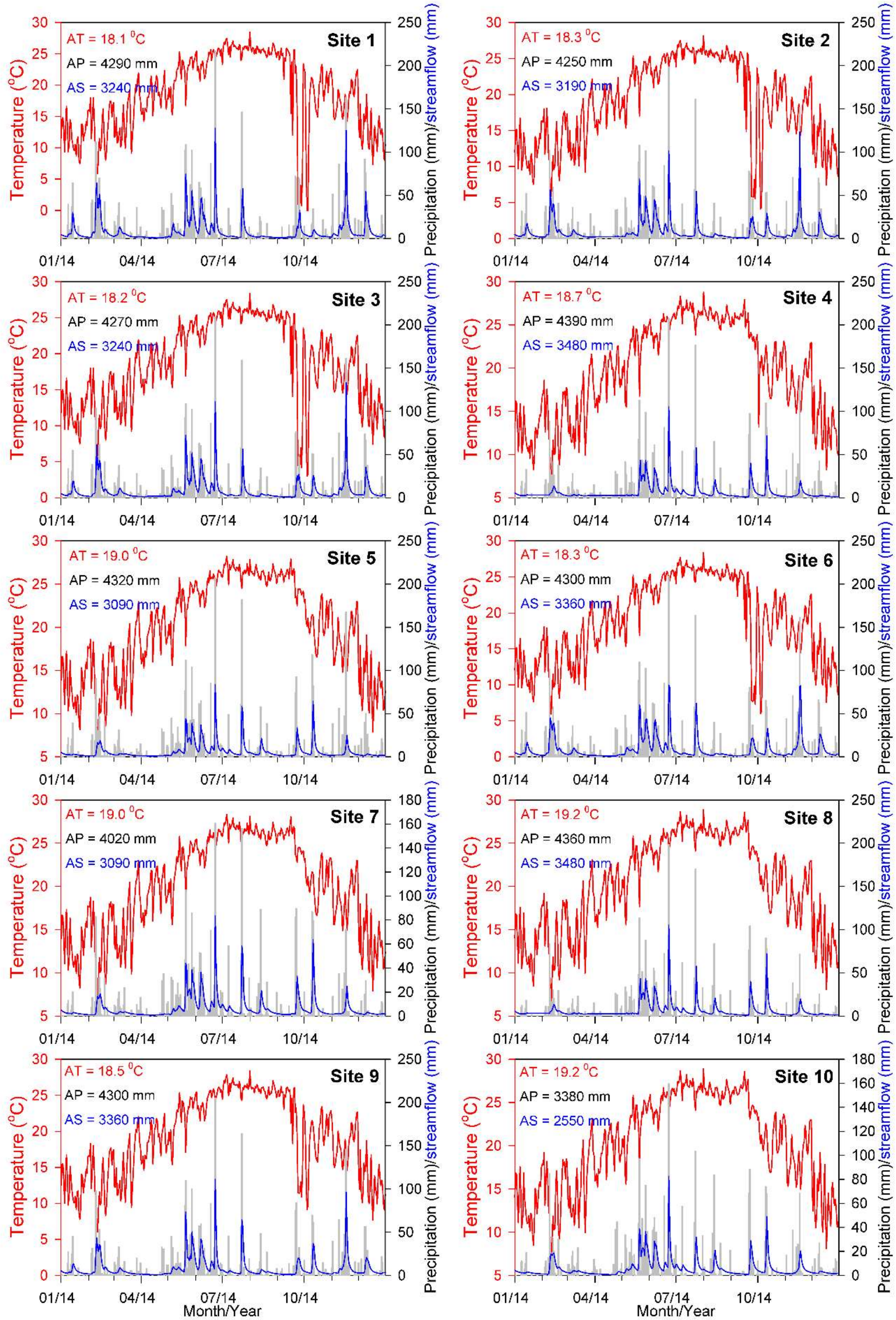

Figure S2. The daily hydro-climate data of 18 watersheds in 2014 except for number 19 in Figure 1. The AT, AP, and AS indicate the annual mean temperature, annual precipitation, and annual streamflow, respectively.

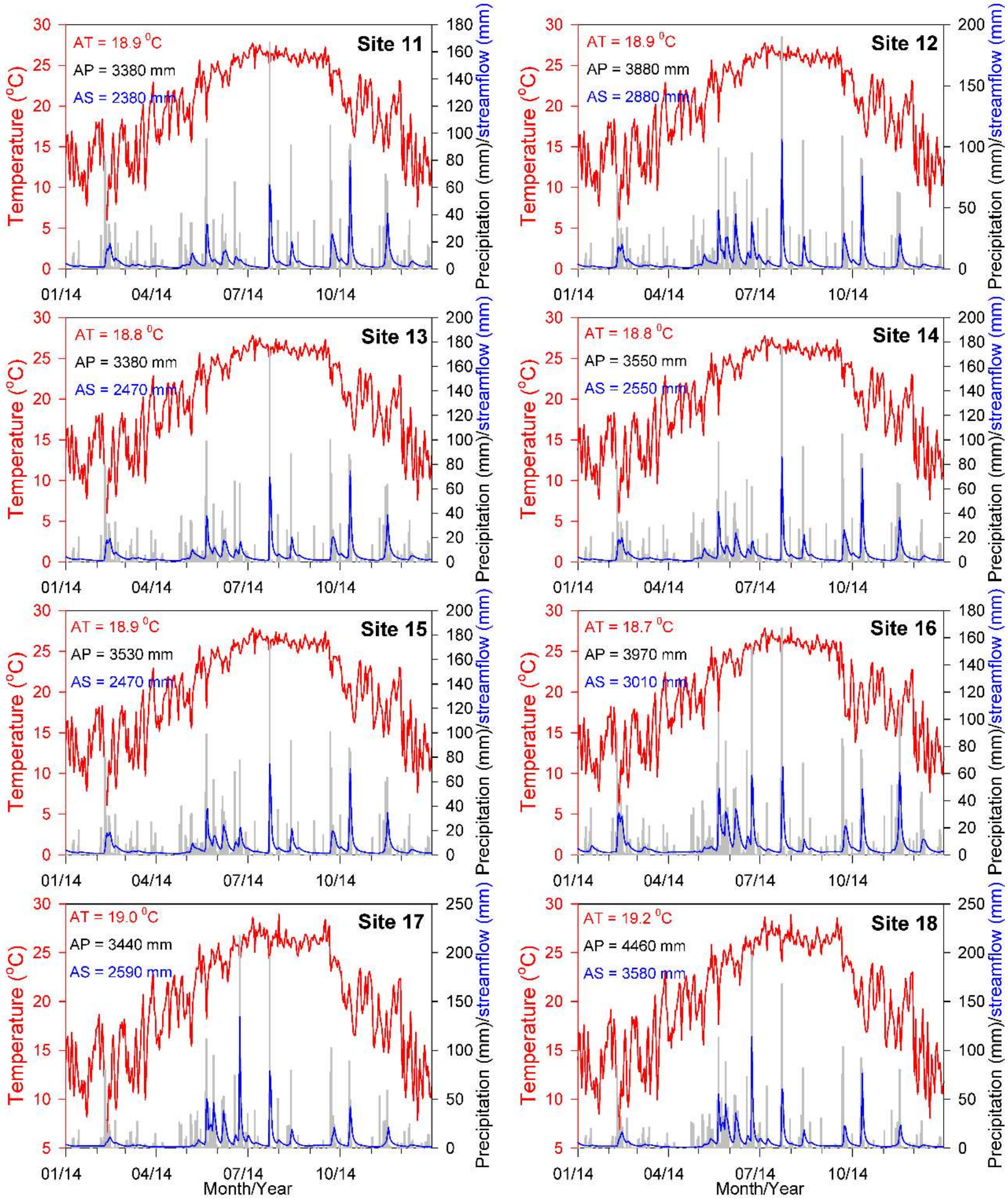

Figure S2. Continued.