SWAT Modeling of Water Quantity and Quality in the Tennessee River Basin: Spatiotemporal Calibration and Validation

Supplement

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Table S1. Types of SWAT Calibration

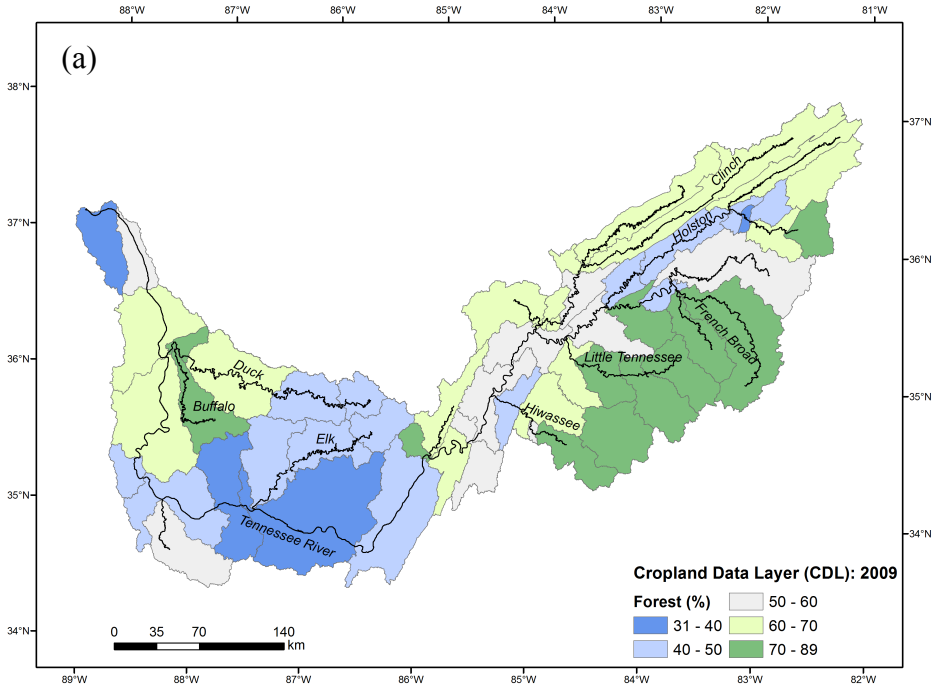
Type ID	Response variables	Units	Notes
0	Daily streamflow	m^3/s	Parameter 1–14
2	Daily reservoir storage	10^4 m^3	Parameter 1–14
3	Daily soil water content	mm	Parameter 1–14
10	Monthly streamflow	m^3/s	Parameter 1–14
11	Monthly runoff: subbasin or HUC8	mm	Parameter 1–14
20	Monthly Flux: nutrient • NO_3+NO_2 • NO_3 • TN • TP • Sediment	Metric tons	Parameter 15–39 • TP = OrgP + SolP • TN = NO_3 + NO_2 + NH_4 + OrgN
21	Monthly Flux: Sediment	Metric tons	Parameter 15–21
22	Monthly Flux: N • TN • NO_3+NO_2 • NO_3	Metric tons	Parameter 22–30
23	Monthly Flux: TP	Metric tons	Parameter 15–21, 31–39
24	Monthly Flux: Sediment + TP	Metric tons	Parameter 15–21, 31–39
30	Monthly Concentration: nutrient • NO_3+NO_2 • NO_3 • TN • TP • Sediment	mg/L	Parameter 15–39
31	Monthly Concentration: Sediment	mg/L	Parameter 15–21
32	Monthly Concentration: N • TN • NO_3+NO_2 • NO_3	mg/L	Parameter 22–30
33	Monthly Concentration: TP	mg/L	Parameter 15–21, 31–39
34	Monthly Concentration: Sediment + TP	mg/L	Parameter 15–21, 31–39

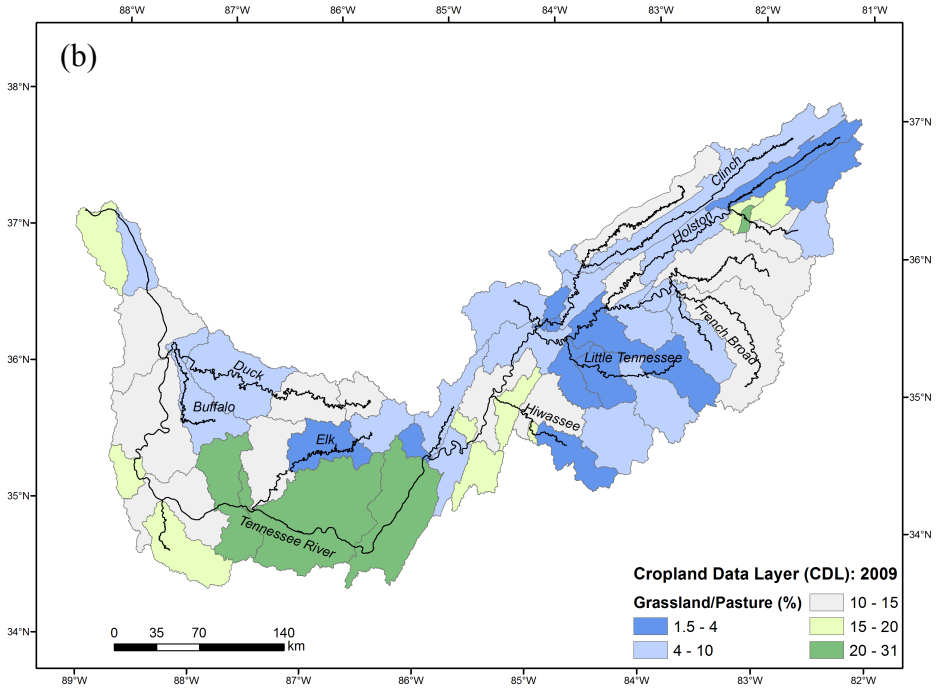
Table S2. Model performance in calibration and validation of water quality

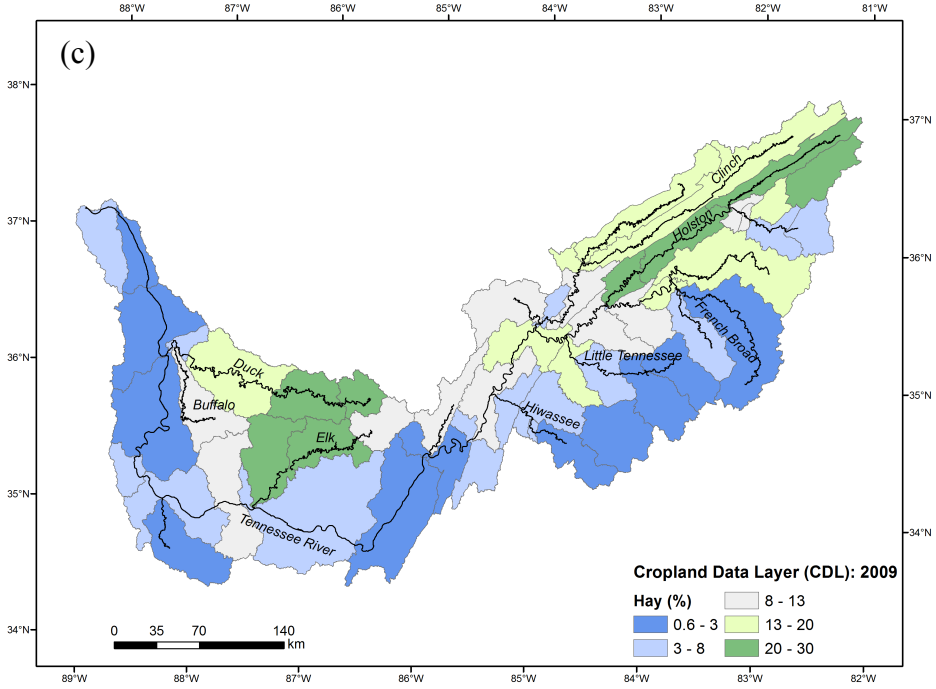
Analyte	Metrics[a]	Calibration (1997–2006)	Validation (2007–2013)	All (1997–2013)
Sediment				
	NSE	0.06	−0.50	−0.18
	PBIAS (%)	21	18	20
	r^2	0.32	0.06	0.19
TP				
	NSE	0.44	−2.54	0.09
	PBIAS (%)	2	−75	−25
	r^2	0.47	0.44	0.27
TN				
	NSE	0.38	−0.32	0.09
	PBIAS (%)	−11	−54	−28
	r^2	0.40	0.44	0.35
NO_3+NO_2				
	NSE	−0.25	−2.79	−1.15
	PBIAS (%)	−80	−157	−109
	r^2	0.27	0.27	0.22

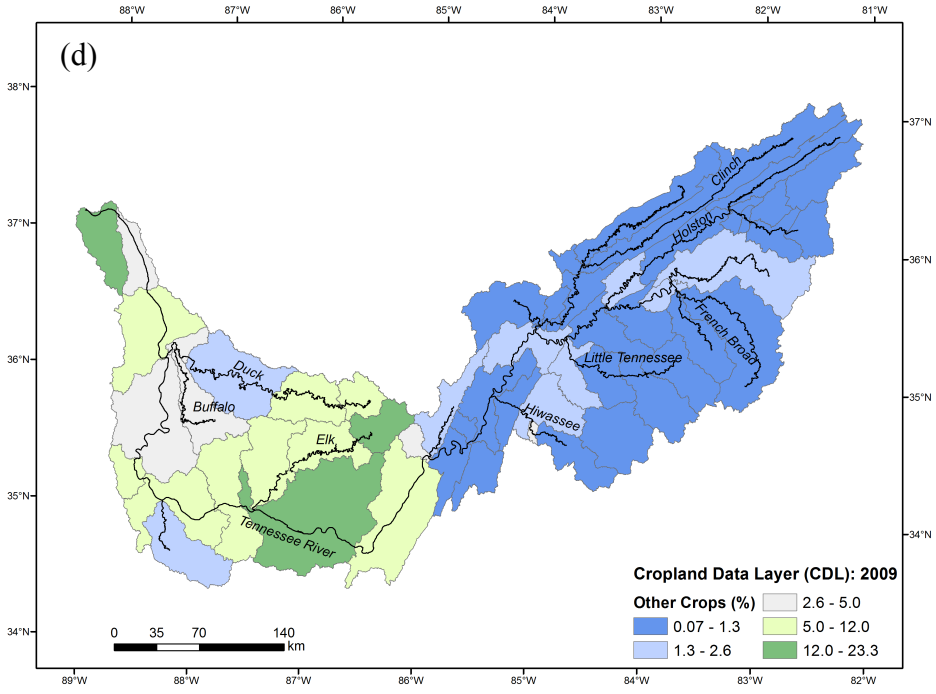
[a]NSE: Nash-Sutcliffe Efficiency; PBIAS: Percent Bias; r^2: squared correlation coefficient.

Figures


(a)
Clinch
Holston
French Broad
Little Tennessee
Hiwassee
Duck
Buffalo
Elk
Tennessee River
Cropland Data Layer (CDL): 2009
Forest (%)
31 - 40
40 - 50
50 - 60
60 - 70
70 - 89
0 35 70 140
km


(b)
Clinch
Holston
French Broad
Little Tennessee
Hiwassee
Duck
Buffalo
Elk
Tennessee River
Cropland Data Layer (CDL): 2009
Grassland/Pasture (%)
1.5 - 4
4 - 10
10 - 15
15 - 20
20 - 31
0 35 70 140
km


(c)
Clinch
Holston
French Broad
Little Tennessee
Hiwassee
Duck
Buffalo
Elk
Tennessee River
Cropland Data Layer (CDL): 2009
Hay (%)
0.6 - 3
3 - 8
8 - 13
13 - 20
20 - 30
0 35 70 140
km


(d)
Clinch
Holston
French Broad
Little Tennessee
Hiwassee
Duck
Buffalo
Elk
Tennessee River
Cropland Data Layer (CDL): 2009
Other Crops (%)
0.07 - 1.3
1.3 - 2.6
2.6 - 5.0
5.0 - 12.0
12.0 - 23.3
0 35 70 140
km

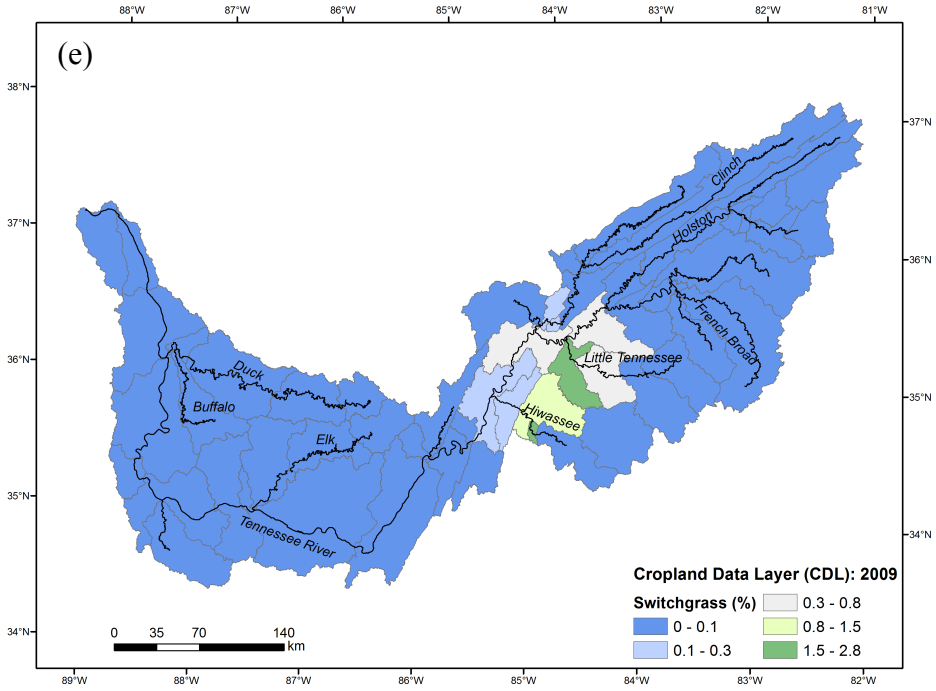


Figure S1. Fractions of land-cover types in 55 subbasins of the Tennessee River Basin. (a) Forest, (b) Grassland/Pasture, (c) Hay, (d) Other Crops, and (e) Switchgrass. Data source: Cropland Data Layer (CDL) 2009.

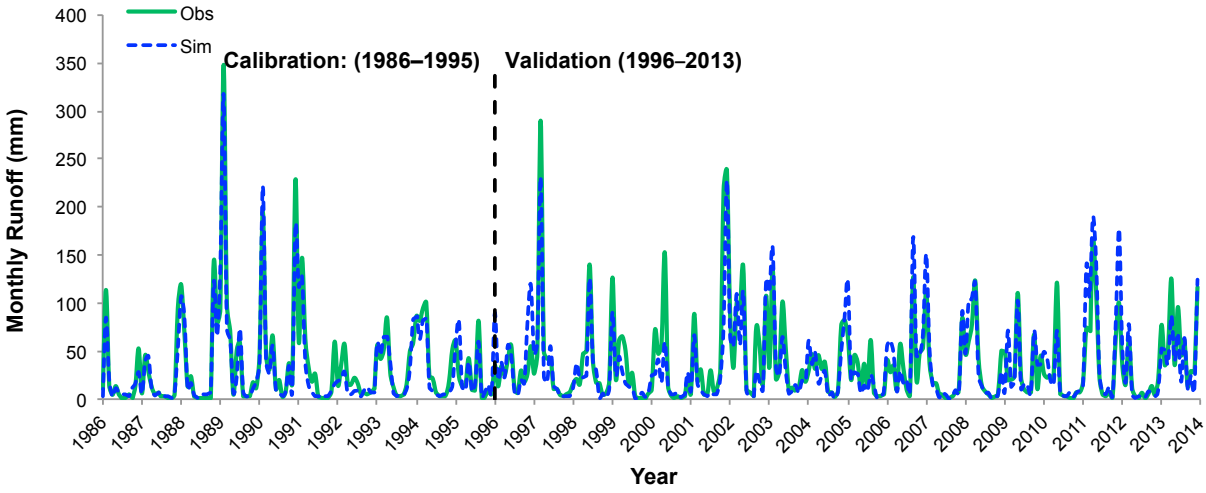


Figure S2. Comparison between SWAT-simulated (Sim) and USGS (Obs) monthly runoff in HUC8-06040006

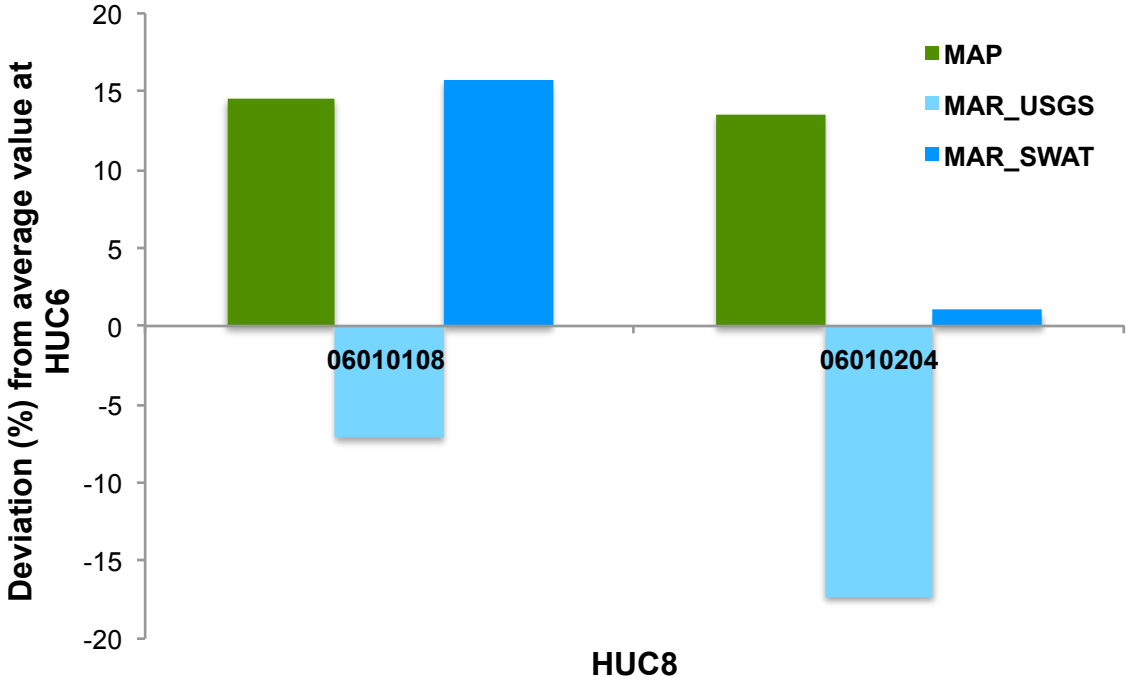
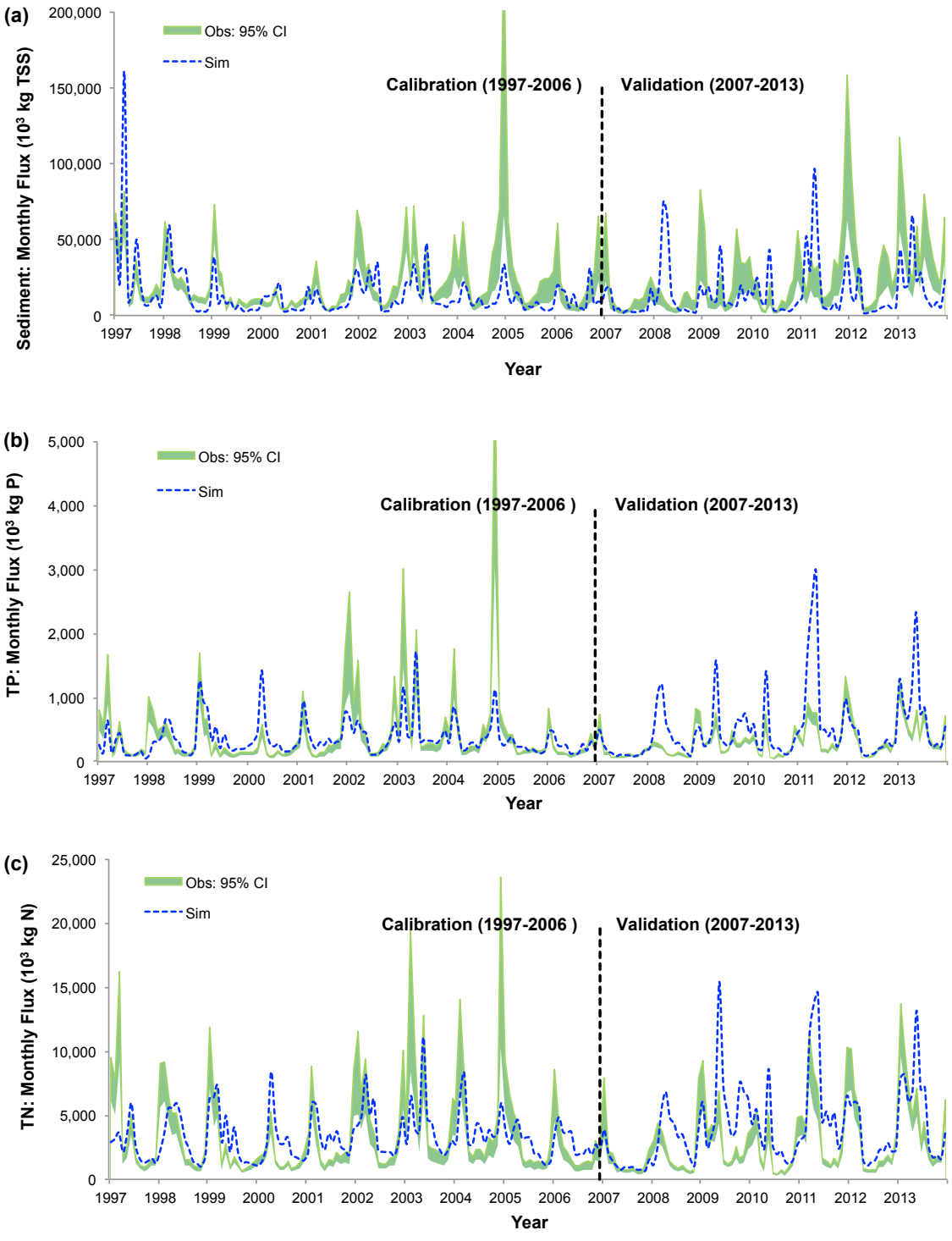


Figure S3. Percentage deviation between two HUC8s (06010108 and 06010204) and their respective HUC6 units (060101 and 060102) in mean annual precipitation (MAP) and USGS-estimated and SWAT-simulated mean annual runoff (MAR)


(a)
Obs: 95% CI
Sim
Calibration (1997-2006)
Validation (2007-2013)
Sediment: Monthly Flux (10³ kg TSS)
200,000
150,000
100,000
50,000
0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
(b)
Obs: 95% CI
Sim
Calibration (1997-2006)
Validation (2007-2013)
TP: Monthly Flux (10³ kg P)
5,000
4,000
3,000
2,000
1,000
0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
(c)
Obs: 95% CI
Sim
Calibration (1997-2006)
Validation (2007-2013)
TN: Monthly Flux (10³ kg N)
25,000
20,000
15,000
10,000
5,000
0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year

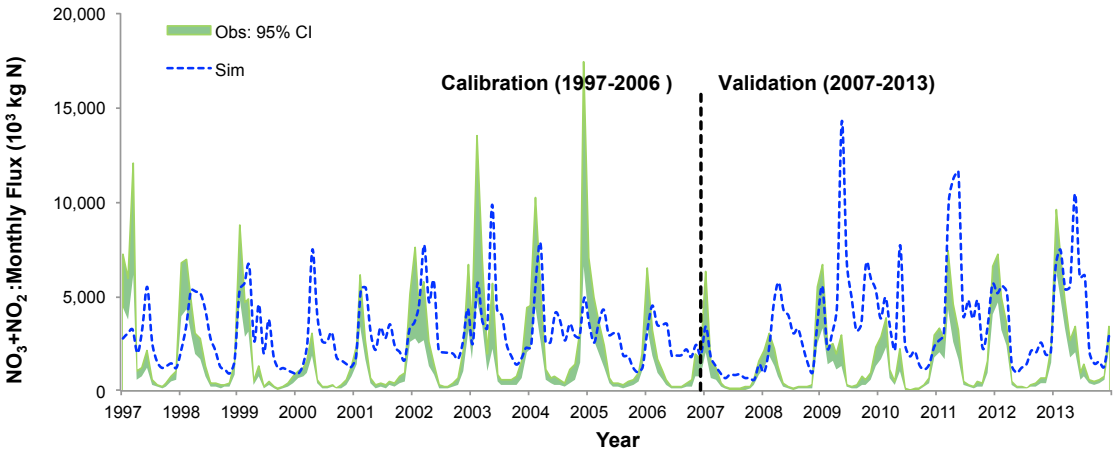
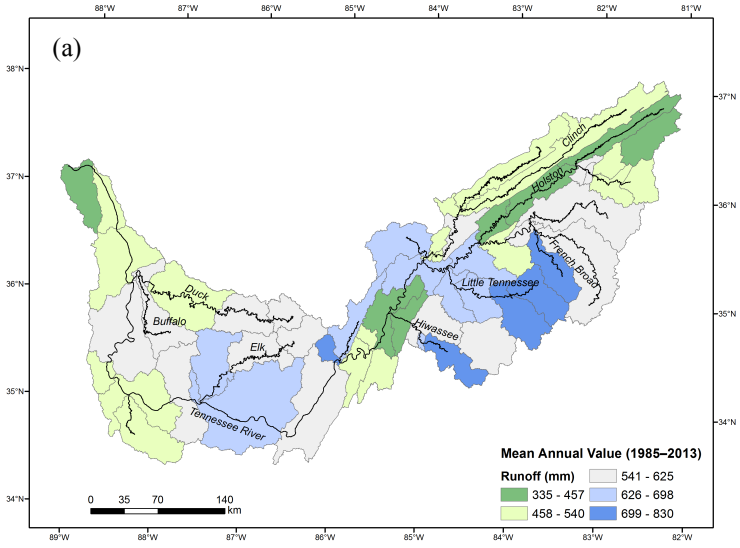
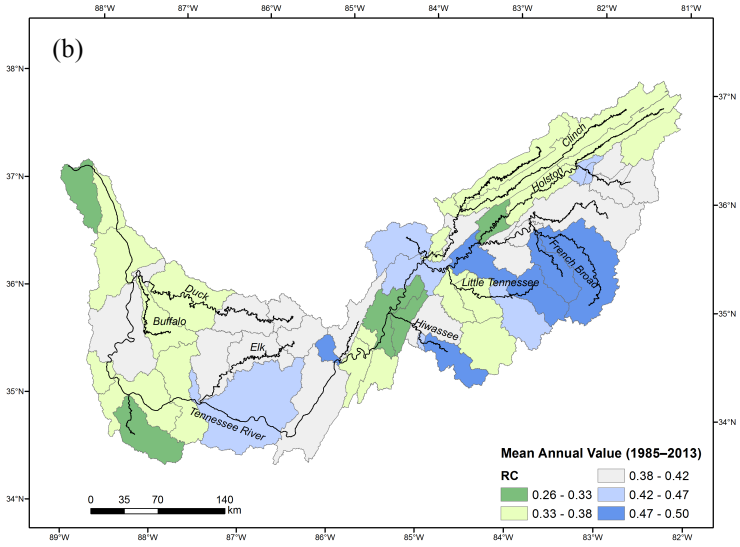
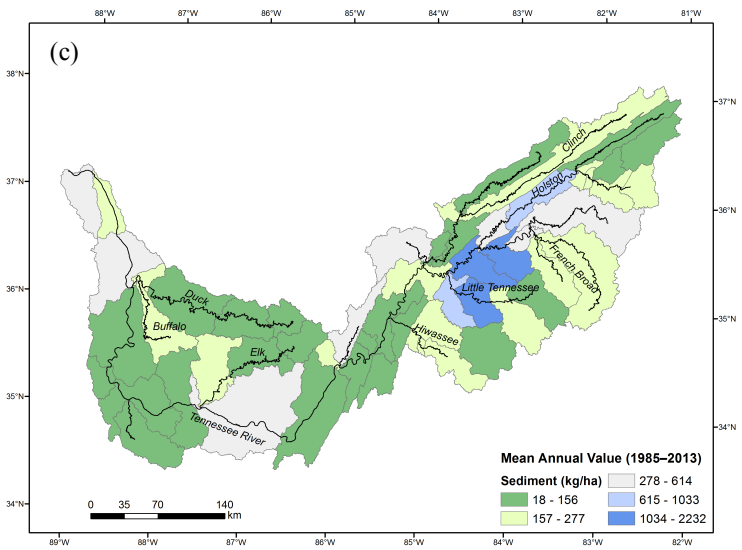
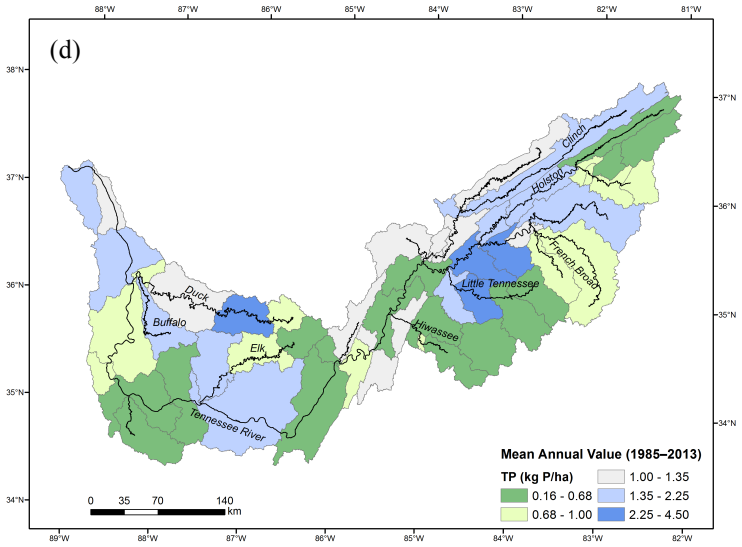


Figure S4. Comparison between SWAT-simulated (Sim) and LOADEST-estimated (Obs) monthly nutrient flux through the outlet of the Tennessee River Basin. (a) Sediment, (b) TP, (c) TN, (d) NO_3+NO_2. 95% CI denotes the 95% confidence interval on LOADEST estimates (Obs).


(a)
Clinch
Holston
French Broad
Little Tennessee
Hiwassee
Duck
Buffalo
Elk
Tennessee River
Mean Annual Value (1985–2013)
Runoff (mm)
335 - 457
458 - 540
541 - 625
626 - 698
699 - 830
0 35 70 140
km


(b)
Clinch
Holston
French Broad
Little Tennessee
Hiwassee
Duck
Buffalo
Elk
Tennessee River
Mean Annual Value (1985–2013)
RC
0.26 - 0.33
0.33 - 0.38
0.38 - 0.42
0.42 - 0.47
0.47 - 0.50
0 35 70 140
km


(c)
Clinch
Holston
French Broad
Little Tennessee
Hiwassee
Duck
Buffalo
Elk
Tennessee River
Mean Annual Value (1985–2013)
Sediment (kg/ha)
18 - 156
157 - 277
278 - 614
615 - 1033
1034 - 2232
0 35 70 140
km


(d)
Clinch
Holston
French Broad
Little Tennessee
Hiwassee
Duck
Buffalo
Elk
Tennessee River
Mean Annual Value (1985–2013)
TP (kg P/ha)
0.16 - 0.68
0.68 - 1.00
1.00 - 1.35
1.35 - 2.25
2.25 - 4.50
0 35 70 140
km

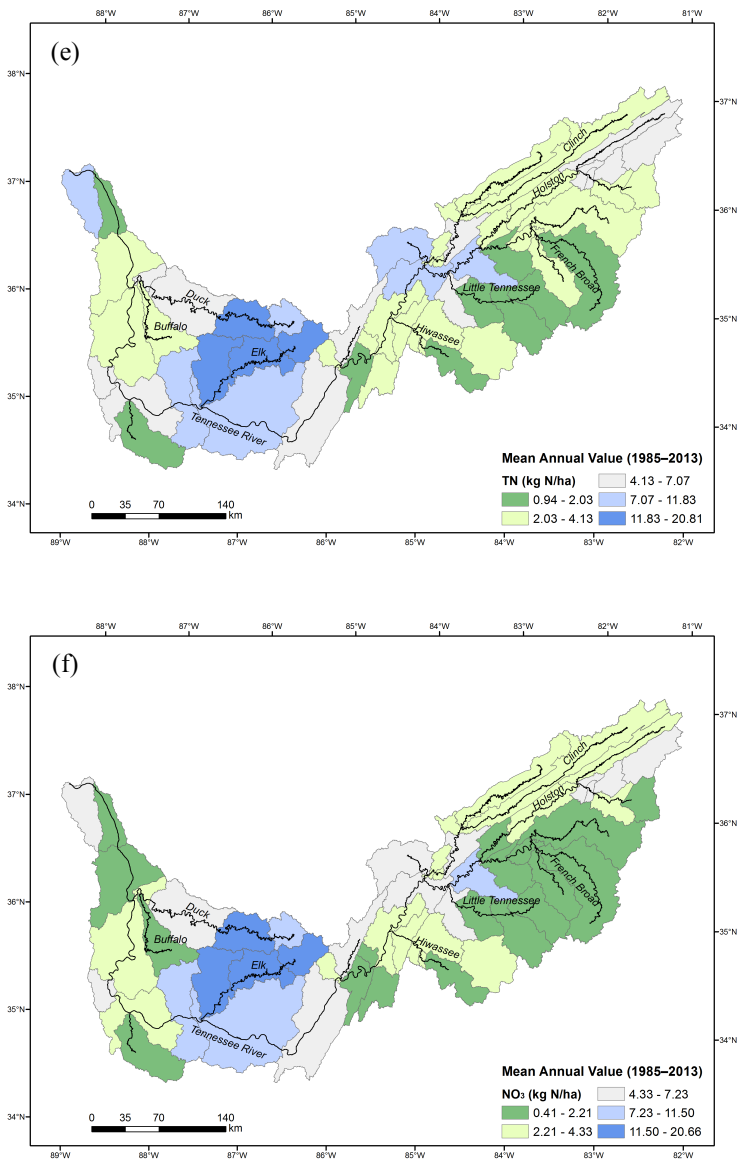


Figure S5. Spatial distribution of SWAT-simulated mean annual loads at 55 subbasins: (a) runoff (mm), (b) runoff coefficient (RC), (c) sediment loading (kg TSS/ha), (d) TP loading (kg P/ha), (e) TN loading (kg N/ha), (f) NO_3 (kg N/ha)