Land

Supporting Information for

Topography, soil elemental stoichiometry and landscape structure determine the nitrogen and phosphorus loadings of agricultural catchments in the subtropics

Yong Li [1,2,3], Yi Wang [4], Ji Liu [2], Meihui Wang [5], Jianlin Shen [2], Xinliang Liu [2]

[1] State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China

[2] Key Laboratory of Agro-ecological Processes in Subtropical Regions and Changsha Research Station for Agricultural & Environmental Monitoring, Institute of Subtropical Agriculture, Chinese Academy of Sciences, Hunan 410125, China

[3] Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Victoria 3010, Australia

[4] College of Resources and Environmental Engineering, Ludong University, Yantai 264025, China

[5] College of Geography, Nanning Normal University, Nanning, China

Contents of this file

Tables S1 to S2

Figures S1 to S6

Additional Supporting Information (Files uploaded separately)

Datasets S1 to S2

Introduction

This supporting information file contains two tables, six figures and two datasets for the nine studied agricultural catchments (FULING, FEIYUE, XINGSHA, JIUXIYUAN, GUANJIA, JIANSHAN, TUOJIA, NANYUE and WANGZIYUAN) in Jinjing Town of Hunan Province in the subtropics of Central China.

Table S1 presented the descriptive statistics (e.g., mean, median, min, max, standard deviation, excess kurtosis and skewness) of the stream flow-weighted total nitrogen and phosphorus concentrations (TN_wc, mg N L^{-1} and TP_wc mg P L^{-1}) and the indicators of topography, soil and landscape of the nine studied catchments. The topography characteristics include the area (AREA), average elevation (ELEVATION, m), average slope (SLOPE, %) and average elevation-relief ratio (ERR, dimensionless) of the catchments. Soil properties or indicators include the soil pH (pH), the areal average contents of sand (SAND: 0.05 - 2 mm, %), silt (SILT: 0.002 - 0.05 mm, %), clay (CLAY: <0.002 mm, %), soil organic carbon (SOC, g C kg^{-1}), total soil nitrogen (TSN, g N kg^{-1}) and total soil phosphorus (TSP, g P kg^{-1}), and the areal average elemental ratios of soil carbon to nitrogen (SOIL_CNR, mol mol^{-1}), soil carbon to phosphorus (SOIL_CPR, mol mol^{-1}) and soil nitrogen to phosphorus (SOIL_NPR, mol mol^{-1}). The landscape indicators include the landscape composition: the areal percentages of woodlands (Woodland, %), paddy fields (Paddy, %), tea fields (Tea, %), residential areas (Resident, %), roads (Road, %), ponds (Pond, %) and rivers (River, %), the landscape configuration: the largest patch index (LPI, %), the edge density (ED, m per ha), the patch density (PD, patches per 100 ha), the aggregation index (AI, %), the patch cohesion index (COHESION, no dimension), the related circumscribing circle index (CIRCLE, no dimension), the landscape shape index (SHAPE, no dimension), the fractal dimension index (FRAC, no dimension), and the Shannon's diversity index (SHDI, no dimension), and the landscape management: the human population density

(POPU, people per ha), the livestock population density (LSD_AU, AU per ha), the N input density (Ninput, kg N ha^{-1} yr^{-1}) and the P input density (Pinput, kg P ha^{-1} yr^{-1}). The same abbreviations apply hereafter. These basic statistical analyses were carried out by using the R software.

Table S2 provided the spatial autocorrelations of TN_wc, TP_wc and the indicators of topography, soil and landscape in the nine studied catchments. These spatial autocorrelation analyses were carried out by using the ESRI ARCGIS software.

Figures S1-S3 showed the Pearson's correlation matrices of TN_wc and the indicators of topography, soil and landscape in the nine studied catchments. These correlation analyses were carried out by using the R software.

Figures S4-S6 showed the Pearson's correlation matrices of TP_wc and the indicators of topography, soil and landscape in the nine studied catchments. These correlation analyses were carried out by using the R software.

Dataset S1, named as WRR_yli_ds01.docx, presented the summary of the observed annual stream flow (Flow, mm yr^{-1}) and annual average concentrations of total nitrogen (TN, mg L^{-1}) and total phosphorus (TP, mg L^{-1}) in stream water of the nine studied catchments during 2011-2016. It is in a Microsoft word 2010 format. In this dataset, all catchments had six years observations (2011-2016), except for XINGSHA and JIUXIYUAN with only five years observations (2012-2016) due to lacking resources when we started our study.

Dataset S2, named as WRR_yli_ds02.xlsx, provided the full calculation details for the nitrogen (Ninput) and phosphorus (Pinput) input densities in the nine studied catchments. It is in a Microsoft excel 2010 format.

Table S1. Descriptive statistics of the stream flow-weighted total nitrogen and phosphorus concentrations and the indicators of topography, soil and landscape of the nine studied catchments.

Item	Mean	Median	Min	Max	Standard deviation	Excess kurtosis	Skewness
TN_wc	2.708	2.999	1.322	3.440	0.756	-1.082	-0.739
TP_wc	0.176	0.183	0.049	0.282	0.076	-0.989	-0.096
AREA	24.90	9.69	0.09	73.36	25.51	-0.844	0.850
ELEVATION	135.92	122.64	98.28	187.43	33.45	-1.691	0.434
SLOPE	17.65	14.72	11.86	27.78	5.964	-1.340	0.813
ERR	0.432	0.423	0.373	0.513	0.039	0.904	0.783
SAND	29.81	31.29	17.71	48.52	9.164	0.181	0.664
SILT	40.43	37.50	27.29	55.21	8.041	-0.162	0.427
CLAY	23.75	23.29	19.98	27.43	2.166	-0.215	0.118
pH	3.912	3.940	3.730	4.050	0.089	0.645	-0.722
SOC	8.210	7.973	6.741	10.151	1.087	-0.799	0.513
TSN	1.494	1.529	1.166	1.785	0.187	-0.424	-0.427
TSP	0.424	0.436	0.356	0.456	0.031	0.748	-1.208
SOIL_CNR	9.579	9.640	8.520	10.850	0.873	-1.745	0.145
SOIL_CPR	82.54	81.05	70.29	99.56	9.035	-0.498	0.603
SOIL_NPR	10.24	9.97	8.49	12.90	1.453	-0.775	0.577
Woodland	67.28	60.15	51.84	99.82	14.72	1.080	1.309
Paddy	24.57	29.32	0.00	34.79	10.73	1.732	-1.454
Tea	3.780	4.520	0.000	10.370	3.065	0.868	0.866
Resident	2.294	2.890	0.000	3.270	1.030	1.176	-1.353
Road	0.254	0.240	0.000	0.910	0.255	5.079	1.998
Pond	1.578	1.530	0.000	2.750	0.813	-0.114	-0.464
River	0.242	0.220	0.010	0.620	0.202	-0.680	0.406
LPI	49.69	42.42	27.22	99.82	21.79	1.868	1.446
ED	167.26	182.22	12.14	244.21	59.52	5.796	-2.070
CIRCLE	0.569	0.566	0.540	0.594	0.018	-1.064	0.126
SHAPE	1.546	1.490	1.430	1.840	0.121	3.316	1.789
FRAC	1.118	1.106	1.099	1.215	0.035	8.392	2.865

PD	61.10	63.82	20.23	101.20	21.68	0.805	-0.113
AI	95.76	95.44	93.94	99.26	1.357	5.469	1.958
COHESION	99.63	99.70	99.12	99.87	0.221	2.131	-1.373
SHDI	0.843	1.013	0.013	1.133	0.332	3.924	-1.945
LSD_AU	0.584	0.550	0.000	1.380	0.403	0.376	0.782
POPU	2.517	2.420	0.000	4.650	1.234	1.151	-0.425
Ninput	178.80	196.92	38.93	273.66	67.41	0.673	-0.859
Pinput	25.19	26.10	1.34	46.65	12.71	0.440	-0.154

Table S2. Spatial autocorrelations of the stream flow-weighted total nitrogen and phosphorus concentrations and the indicators of topography, soil and landscape of the nine studied catchments.

Indicator	Moran's Index	Expected Index	Variance	*z*-score	*p*-value
TN_wc	0.175	-0.143	0.019	2.308	0.021
TP_wc	0.142	-0.143	0.019	2.087	0.037
Area	-0.135	-0.143	0.019	0.06	0.952
ELEVATION	0.143	-0.125	0.011	2.505	0.012
ERR	0.135	-0.125	0.011	2.453	0.013
SLOPE	0.129	-0.125	0.011	2.375	0.018
SAND	0.246	-0.143	0.018	2.867	0.004
SILT	0.286	-0.143	0.019	3.15	0.002
CLAY	-0.315	-0.143	0.018	-1.275	0.202
pH	-0.153	-0.143	0.018	-0.079	0.937
SOC	0.248	-0.143	0.019	2.843	0.004
TSN	0.065	-0.143	0.019	1.516	0.130
TSP	-0.136	-0.143	0.018	0.053	0.958
SOIL_CNR	-0.203	-0.143	0.019	-0.436	0.663
SOIL_CPR	0.12	-0.143	0.019	1.917	0.055
SOIL_NPR	0.043	-0.143	0.019	1.354	0.176
Woodland	0.065	-0.143	0.018	1.541	0.123
Paddy	0.035	-0.143	0.018	1.332	0.183
Tea	0.061	-0.143	0.018	1.516	0.130
Resident	0.059	-0.143	0.018	1.498	0.134
Road	-0.173	-0.143	0.016	-0.241	0.810
Pond	0.06	-0.143	0.019	1.485	0.138
River	0.013	-0.143	0.019	1.142	0.254
LPI	0.043	-0.143	0.018	1.391	0.164
ED	-0.141	-0.143	0.016	0.014	0.989
PD	-0.013	-0.125	0.012	1.034	0.301
AI	-0.134	-0.143	0.016	0.072	0.942
COHESION	-0.016	-0.143	0.017	0.97	0.332
CIRCLE	0.154	-0.143	0.019	2.162	0.031
SHAPE	-0.099	-0.143	0.017	0.333	0.739
FRAC	-0.21	-0.143	0.015	-0.548	0.583
SHDI	-0.046	-0.143	0.017	0.746	0.456
LSD_AU	-0.054	-0.143	0.018	0.657	0.511
POPU	-0.247	-0.143	0.018	-0.78	0.435
Ninput	0.035	-0.143	0.018	1.319	0.187
Pinput	-0.007	-0.143	0.018	1.006	0.314

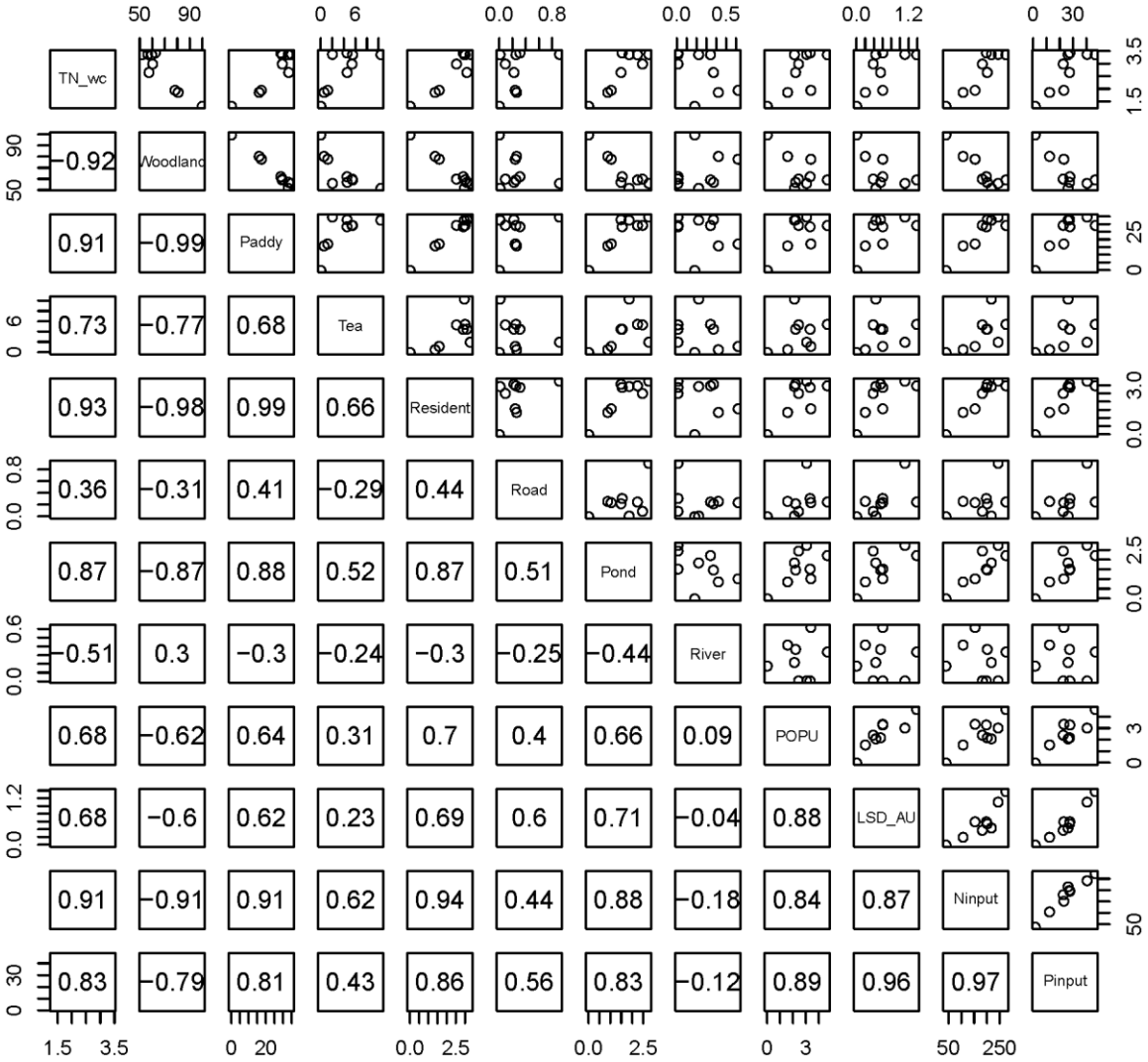

Figure S1. Pearson's correlation matrix of the stream flow-weighted total nitrogen concentration and the landscape metrics for composition and management of the nine studied catchments. Ninput and Pinput include N and P inputs from airborne deposition, fertilizer application and human & livestock faeces, respectively; and they are calculated in Dataset S2.

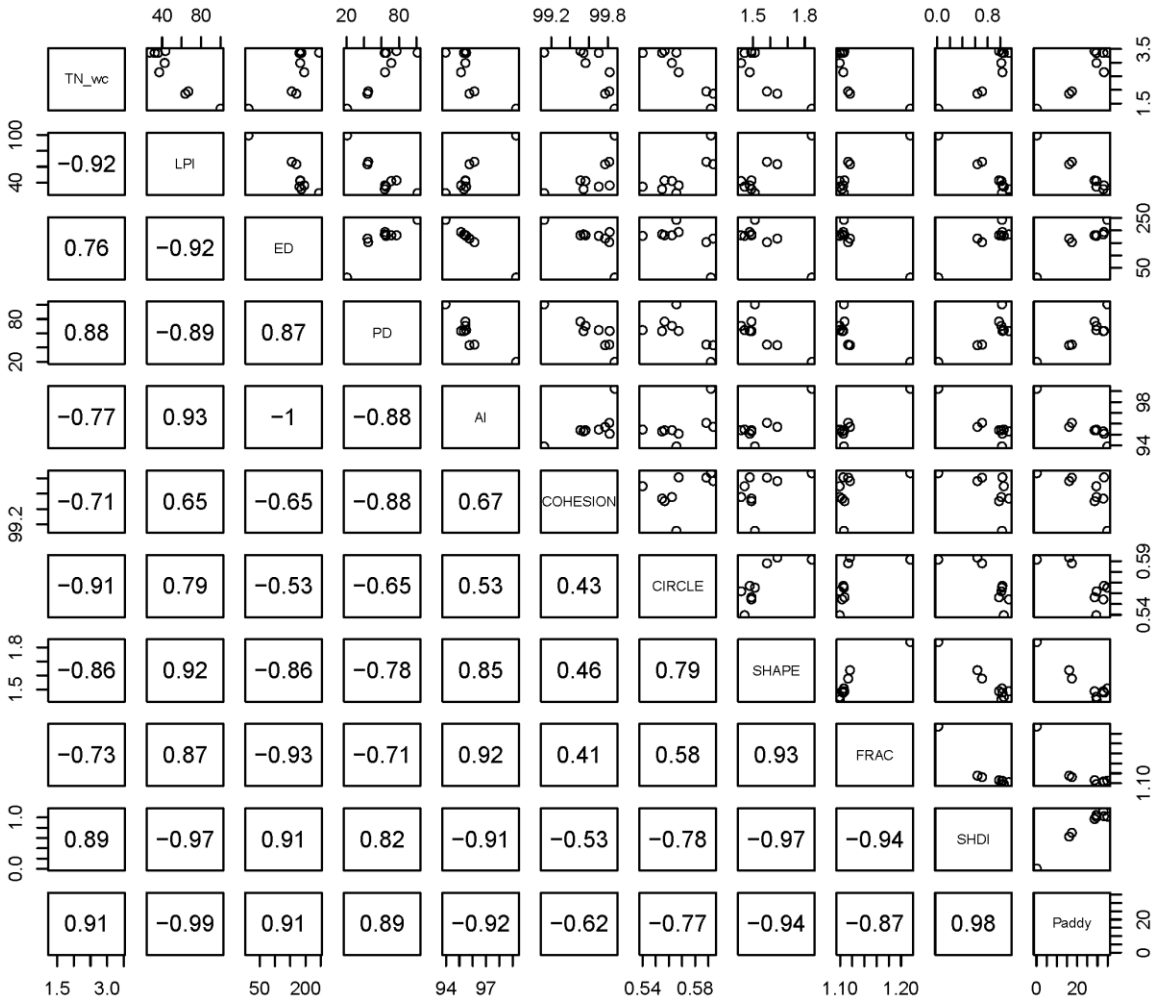

Figure S2. Pearson's correlation matrix of the stream flow-weighted total nitrogen concentration and the landscape metrics for configuration of the nine studied catchments. LPI, ED, PD, AI, COHESION, CIRCLE, SHAPE, FRAC and SHDI are defined in Table 3.

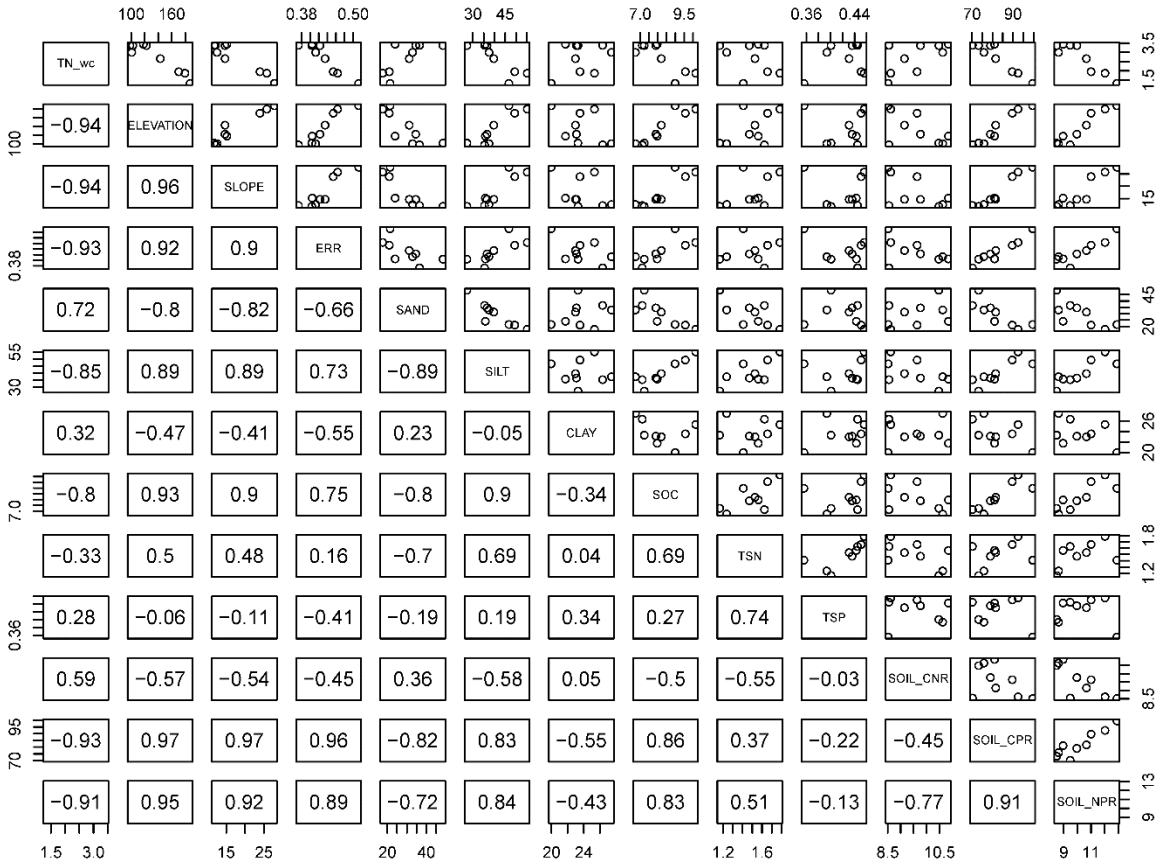

Figure S3. Pearson's correlation matrix of the stream flow-weighted total nitrogen concentration, the topographical characteristics and the soil properties of the nine studied catchments.

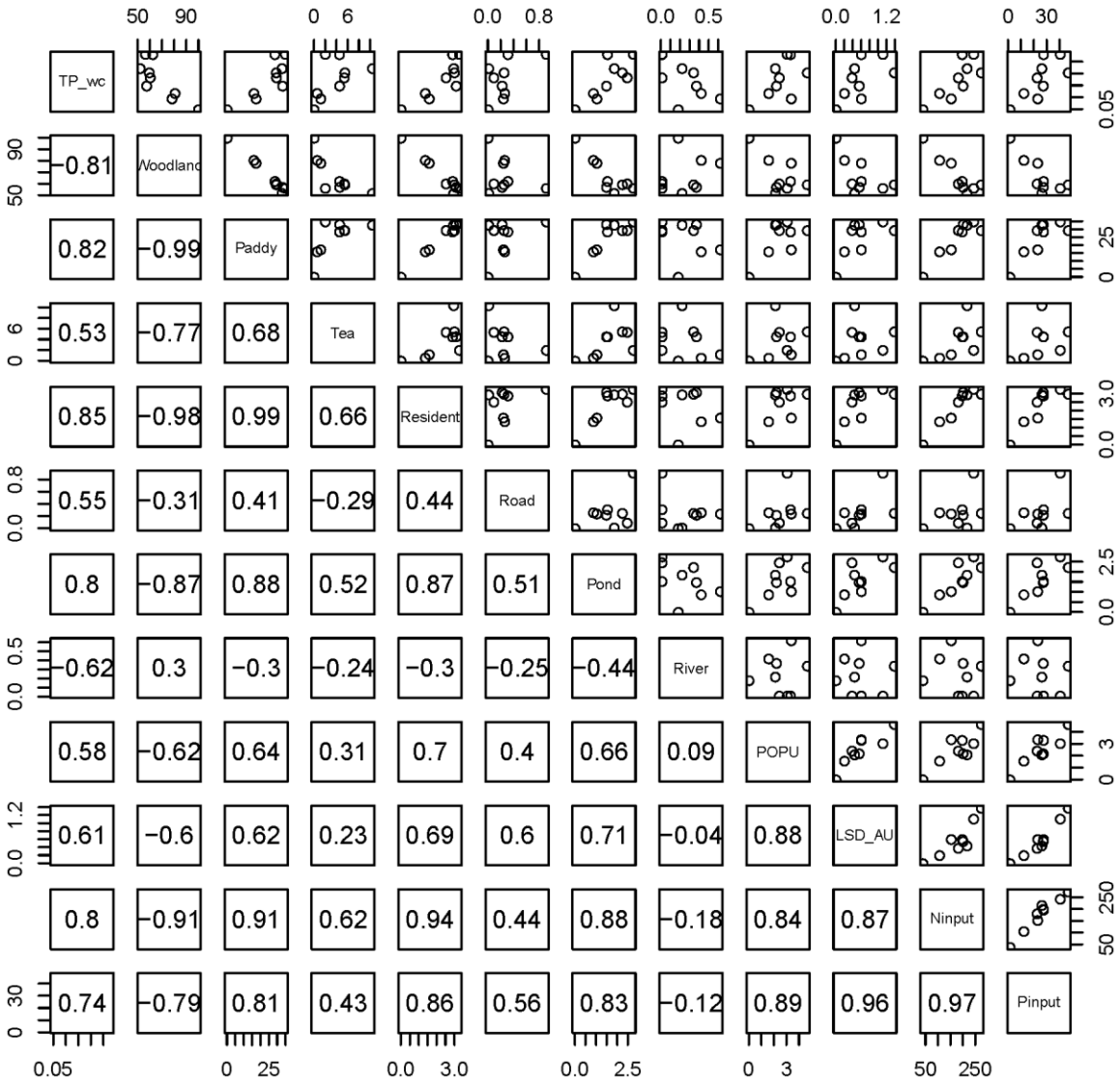

Figure S4. Pearson's correlation matrix of the stream flow-weighted total phosphorus concentration and the landscape metrics for composition and management of the nine studied catchments. Ninput and Pinput include N and P inputs from airborne deposition, fertilizer application and human & livestock faeces, respectively; and they are calculated in Dataset S2.

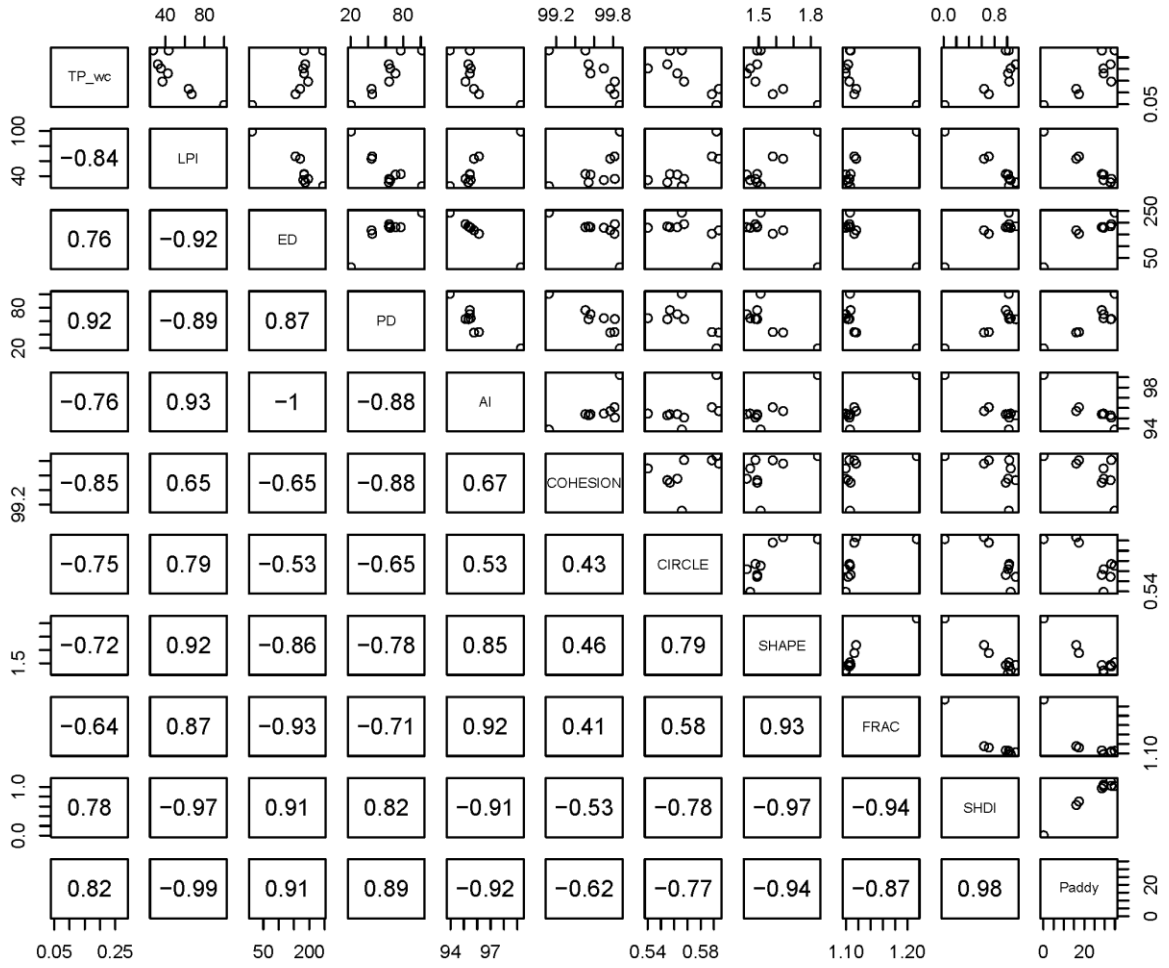

Figure S5. Pearson's correlation matrix of the stream flow-weighted total phosphorus concentration and the landscape metrics for configuration of the nine studied catchments. LPI, ED, PD, AI, COHESION, CIRCLE, SHAPE, FRAC and SHDI are defined in Table 3.

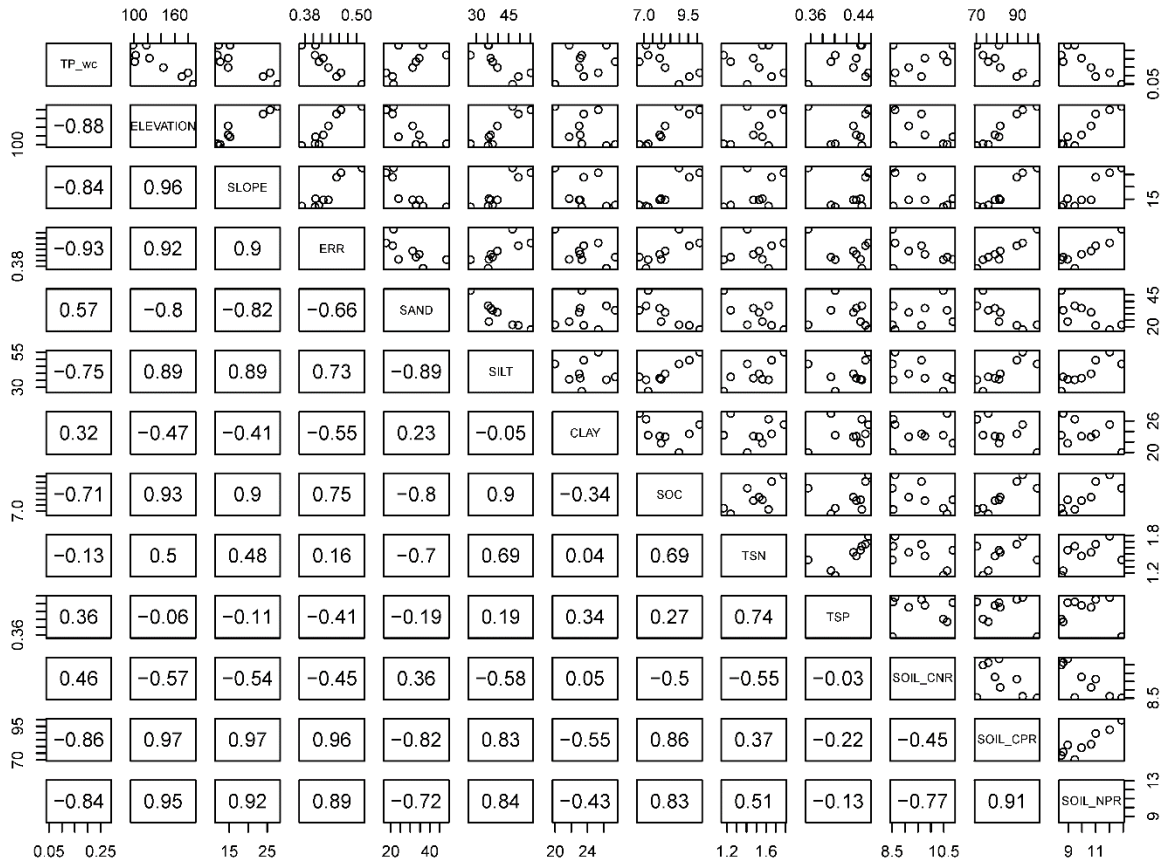

Figure S6. Pearson's correlation matrix of the stream flow-weighted total phosphorus concentration, the topographical characteristics and the soil properties of the nine studied catchments.

Dataset S1. Summary of the observed annual stream flow (Flow, mm yr^{-1}) and annual average concentrations of total nitrogen (TN, mg L^{-1}) and total phosphorus (TP, mg L^{-1}) in stream water of the nine studied catchments during 2011-2016.

WRR_yli_ds01.docx (uploaded separately)

Dataset S2. Calculation of the nitrogen and phosphorus input densities of the nine studied catchments.

WRR_yli_ds02.xlsx (uploaded separately)