Supplementary Material

Landscape patterns and topographic features affect seasonal river water quality at catchment and buffer scales

Li Deng [1], Wanshu Li [2,4], Xiaojie Liu [2,4,*], Yazhu Wang [3], Lingqing Wang [2,4]

[1] *Ecological Environment Planning and Environmental Protection Technology Center of Qinghai Province, Xining 810007, China*

[2] *Key Laboratory of Natural Resource Coupling Process and Effects, Ministry of Natural Resources, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China*

[3] *Key Laboratory of Watershed Geographic Sciences, Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing 210008, China*

[4] *University of Chinese Academy of Sciences, Beijing 100049, China*

*Corresponding author: Xiaojie Liu (liuxj@igsnrr.ac.cn)

Table S1 Descriptions of landscape metrics used in the study.

Classification	Variable	Description
Topographic feature metrics	Regional slope (Slope)	The mean slope of the study region.
	Regional relief (HD)	The elevation difference in the study region [1].
	Hypsometric integral (HI)	$HI = (H_{mean} - H_{min}) / (H_{max} - H_{min})$, where H_{max}, H_{min} and H_{mean} represent the highest point, lowest point and the average elevation of the region, respectively.
Landscape pattern metrics [2]	Cropland	The proportion of cropland in the study region.
	Forest	The proportion of forest in the study region.
	Shrubland	The proportion of shrubland in the study region.
	Grassland	The proportion of grassland in the study region.
	Water	The proportion of water area in the study region.
	Barren land	The proportion of barren land in the study region.
	Impervious layer	The proportion of impervious layer in the study region.
	Patch density (PD)	Number of patches per unit area of the respective land cover type (number per 100 hectares).
	Landscape shape index (LSI)	Measures the perimeter-to-area ratio for the landscape at the class level.
	Largest patch index (LPI)	Proportion of total landscape area occupied by the largest patch in the patch type.

Table S2 Summaries for landscape metrics from 2018 to 2020 at catchment and buffer scales.

Variable	Catchment scale 2018		2019		2020		Buffer scale 2018		2019		2020	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Slope (°)	9.23	4.80	9.23	4.80	9.23	4.80	4.42	3.61	4.42	3.61	4.42	3.61
HD (m)	951.00	473.77	951.00	473.77	951.00	473.77	13.00	11.61	13.00	11.61	13.00	11.61
HI	0.14	0.07	0.14	0.07	0.14	0.07	0.41	0.14	0.41	0.14	0.41	0.14
Cropland (%)	47.93	16.30	48.18	16.05	49.72	14.93	26.19	30.83	26.54	30.50	34.37	28.97
Forest (%)	27.26	23.50	26.89	23.24	25.17	22.16	6.07	17.17	6.07	17.17	3.21	9.09
Grassland (%)	2.79	1.79	2.75	1.76	2.68	1.77	2.50	7.07	2.14	6.06	1.07	3.03
Water (%)	3.07	4.04	3.02	3.94	2.81	3.65	13.3	15.18	10.53	14.15	9.76	14.49
Impervious layer (%)	18.91	8.00	19.11	8.11	19.58	8.36	51.94	30.17	54.72	31.54	51.58	30.73
PD_{crop} (n km^{-2})	3.04	1.39	2.88	1.32	2.61	1.08	43.89	33.58	47.86	29.25	51.83	33.52
PD_{for} (n km^{-2})	1.51	0.93	1.38	0.84	1.52	0.98	3.97	11.22	3.97	11.22	7.94	22.45
PD_{gra} (n km^{-2})	3.33	2.51	3.19	2.41	3.08	2.39	7.94	22.45	7.94	22.45	7.94	22.40
PD_{wat} (n km^{-2})	0.51	0.59	0.48	0.56	0.50	0.59	36.2	36.20	36.20	36.20	31.99	33.94
PD_{imp} (n km^{-2})	2.36	0.65	2.35	0.64	2.36	0.63	48.1	24.40	48.10	24.40	48.10	24.40
LSI_{crop}	67.86	26.92	65.10	25.62	64.08	25.33	1.37	0.86	1.49	0.69	1.52	0.67
LSI_{for}	42.93	18.87	40.72	18.20	40.70	18.54	0.18	0.51	0.18	0.51	0.20	0.56
LSI_{gra}	69.47	41.16	67.51	39.99	65.88	39.44	0.21	0.59	0.28	0.78	0.19	0.53
LSI_{wat}	29.73	32.66	28.35	30.71	27.84	30.51	0.89	0.76	0.87	0.75	0.83	0.73
LSI_{imp}	69.68	38.41	68.40	36.91	67.92	36.14	1.51	0.31	1.52	0.30	1.48	0.32
LPI_{crop} (%)	35.30	20.31	35.51	20.02	36.45	19.92	22.85	30.72	23.20	30.44	28.58	29.50
LPI_{for} (%)	14.62	16.89	14.53	16.85	12.14	15.56	6.79	19.19	6.79	19.19	2.14	6.06
LPI_{gra} (%)	0.11	0.10	0.11	0.10	0.11	0.11	1.79	5.05	1.43	4.04	0.71	2.02
LPI_{wat} (%)	1.06	1.24	1.06	1.25	1.03	1.22	8.24	9.94	6.09	8.82	6.09	8.82

LPI_{imp} (%)	6.87	3.94	6.95	4.00	7.31	4.20	50.30	31.16	52.45	32.49	50.30	31.16

The content in parentheses represents the unit. HI, LSI_{crop}, LSI_{for}, LSI_{gra}, LSI_{wat}, and LSI_{imp} have no units. Abbreviations: SD, standard deviation; Slope, regional slope; HD, regional relief; HI, hypsometric integral. Cropland, Forest, Grassland, Water, and Impervious layer represent the proportion of cropland, forest, grassland, water, and impervious layer, respectively. PD_{crop}, PD_{for}, PD_{gra}, PD_{wat}, and PD_{imp}, represent patch density of cropland, forest, grassland, water, and impervious layer, respectively. LSI_{crop}, LSI_{for}, LSI_{gra}, LSI_{wat}, and LSI_{imp}, represent the landscape shape index of cropland, forest, grassland, water, and impervious layer, respectively. LPI_{crop}, LPI_{for}, LPI_{gra}, LPI_{wat}, and LPI_{imp}, denote the largest patch index of cropland, forest, grassland, water, and impervious layer, respectively.

.

Table S3

The explained variation proportion of redundancy analysis (RDA) for the water quality with landscape metrics as constraining variables.

Scale	Season	Explained variation (%)		
		First axis	Second axis	Total
Catchment scale	Wet season	40.2***	7.8*	53.3***
	Dry season	51.7***	15.0***	71.8***
Buffer scale	Wet season	39.0***	7.9*	54.4***
	Dry season	44.7***	6.8	55.1***

* and *** indicate the statistical significances at $p < 0.05$ and $p < 0.001$, respectively.
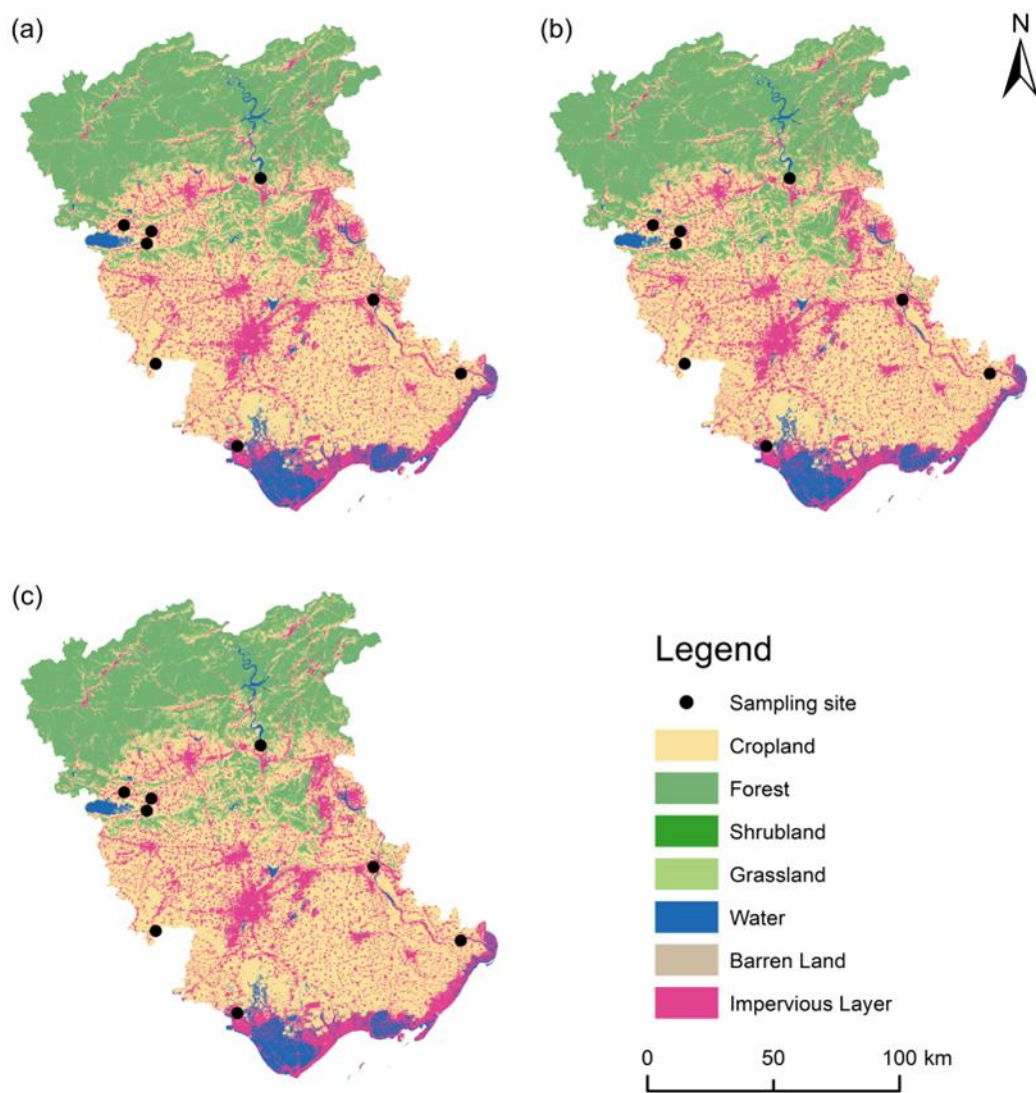
Figure. S1. Land cover of the study region in 2018 (a), 2019 (b), and 2020 (c).

References

1. Ai, L.; Shi, Z.H.; Yin, W.; Huang, X. Spatial and Seasonal Patterns in Stream Water Contamination across Mountainous Watersheds: Linkage with Landscape Characteristics. *Journal of Hydrology* **2015**, *523*, 398–408, doi:10.1016/j.jhydrol.2015.01.082.

2. Wu, J.; Lu, J. Spatial Scale Effects of Landscape Metrics on Stream Water Quality and Their Seasonal Changes. *Water Research* **2021**, *191*, 116811, doi:10.1016/j.watres.2021.116811.