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Multiple Effects of Topographic Factors on Spatio-Temporal Variations of Vegetation Patterns in the Three Parallel Rivers Region, Southeast Qinghai-Tibet Plateau

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Supplementary Materials: The following are available online at www.mdpi.com/xxx/s1, **Table S1**: Classification of topographic factors in the study area, **Figure S1**: Variation characteristics of mean NDVI with different topographic factors, **Figure S2**: Spatial distribution of mean NDVI with different topographic factors during 2000-2019, **Table S2**: Annual mean NDVI area statistics for different topographic factors during2000-2019, **Figure S3**: NDVI trends during 2000-2019 with different topographic factors in the basin (a, b, c show elevation, slope and aspect respectively), **Figure S4**: Spatial distribution of NDVI trends for different topographic factors from 2000 to 2019, **Table S3**: Area statistics of NDVI trends for different stopographic factors from 2000 to 2019, **Table S4**: Parameter estimation and test results of the OLS model, **Figure S5**: Estimation result of regression coefficients obtained through OLS modeling. (Notes: for the entire regression equation, the adjustment R2 is 0.03, F value is 60.76, and $P < 0.01$; the two dashed lines denote that the t-value is equal to −1.96 and 1. 96 respectively; at 0.05 significance level, $t < -1.96$ means a significantly negative correlation, while $t > 1.96$ represents a positive correlation.), **Table S5**: Comparison of model performance between the GWR and OLS models.

Table S1. Classification of topographic factors in the study area.

Class	Elevation(m)	Proportion (%)	Slope(°)	Proportion (%)	Aspect	Proportion (%)
1	<1000m	0.23%	<5°	27.70%	Flat(-1)	0.30%
2	1000—1500m	1.22%	5—8°	11.36%	Shady slope (0—67. 5°，337. 5—360°)	26.13%
3	1500—2000m	3.62%	8—15°	23.82%	Semi-shady slope (67. 5—112. 5°，292. 5—337. 5°)	24.15%
4	2000—2500m	5.08%	15—25°	25.23%	Semi-sunny slope (112. 5—157. 5°，247.5 —292. 5°)	23.87%
5	2500—3000m	4.31%	25—35°	10.40%	Sunny slope (157. 5—247. 5°)	25.55%
6	3000—3500m	4.35%	>35°	1.47%		
7	3500—4000m	7.07%				
8	4000—4500m	19.63%				
9	4500—5000m	42.76%				
10	5000—5500m	11.18%				
11	>5500m	0.55%				

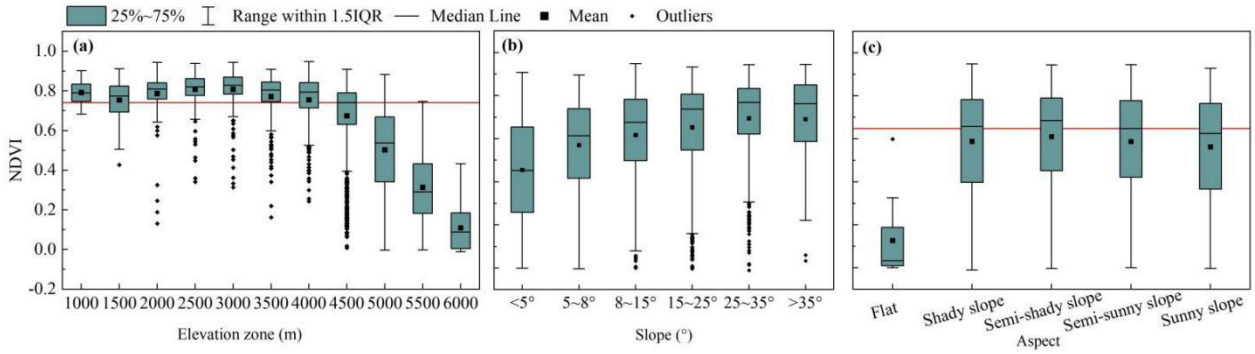

Figure S1. Variation characteristics of mean NDVI with different topographic factors.

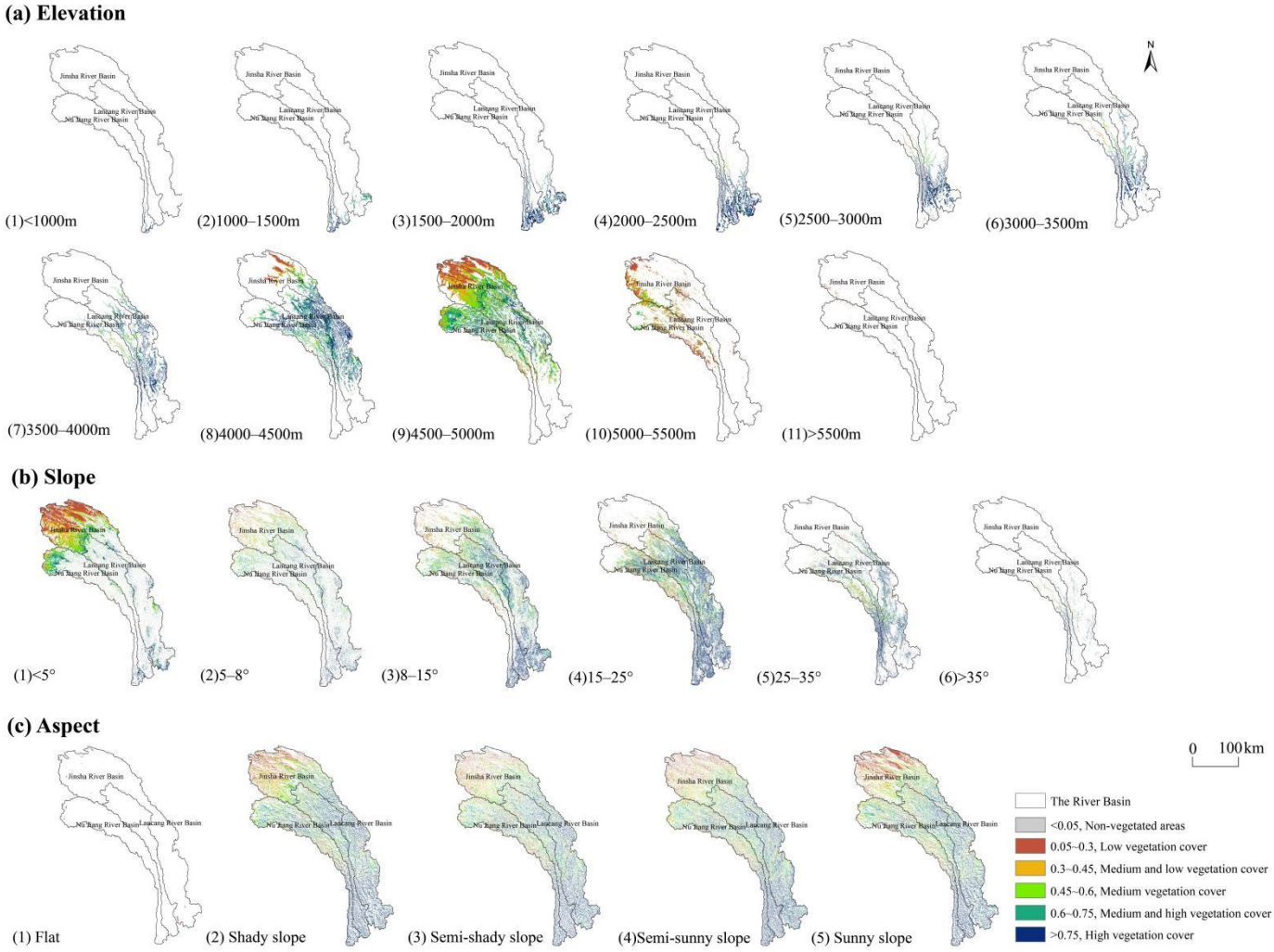

Figure S2. Spatial distribution of mean NDVI with different topographic factors during 2000—2019.

Table S2. Annual mean NDVI area statistics for different topographic factors during2000—2019.

Topographic factors \ Vegetation cover		Non-vegetated areas (NDVI<0.05)	Low vegetation cover (0.05~0.3)	Medium and low vegetation cover (0.3~0.45)	Medium vegetation cover (0.45~0.6)	Medium and high vegetation cover (0.6~0.75)	High vegetation cover (NDVI>0.75)
Elevation	<1000m	-	0.02%	0.11%	1.33%	22.76%	**75.77%**
	1000—1500m	-	0.89%	0.98%	3.99%	28.04%	**66.10%**

	1500—2000m	-	1.04%	0.42%	1.57%	15.91%	**81.06%**
	2000—2500m	-	0.23%	1.05%	1.72%	10.57%	**86.44%**
	2500—3000m	-	1.11%	1.27%	4.13%	10.22%	**83.27%**
	3000—3500m	-	1.53%	2.68%	5.58%	16.82%	**73.39%**
	3500—4000m	-	0.42%	2.17%	6.72%	24.63%	**66.07%**
	4000—4500m	0.25%	7.86%	4.38%	8.39%	34.19%	**44.94%**
	4500—5000m	0.54%	19.18%	18.03%	23.06%	**31.16%**	8.03%
	5000—5500m	2.69%	**50.07%**	23.67%	15.68%	7.65%	0.24%
	>5500m	**54.63%**	43.86%	1.33%	0.17%	0.01%	-
Slope	<5°	1.13%	**32.15%**	19.02%	17.62%	20.69%	9.38%
	5—8°	0.69%	12.75%	14.74%	18.44%	**29.59%**	23.80%
	8—15°	0.90%	9.52%	9.35%	14.96%	30.41%	**34.87%**
	15—25°	0.76%	9.45%	6.88%	10.37%	25.61%	**46.93%**
	25—35°	0.56%	7.59%	6.57%	9.48%	21.30%	**54.50%**
	>35°	1.18%	5.74%	6.86%	10.82%	20.43%	**54.97%**
Aspect	Flat	**57.00%**	38.57%	2.64%	1.09%	0.53%	0.18%
	Shady slope	0.88%	14.25%	12.39%	14.46%	24.74%	**33.28%**
	Semi-shady slope	0.76%	12.93%	11.20%	14.02%	25.83%	**35.25%**
	Semi-sunny slope	0.60%	15.05%	11.01%	14.05%	25.93%	**33.36%**
	Sunny slope	0.56%	20.40%	11.95%	14.54%	24.72%	**27.83%**

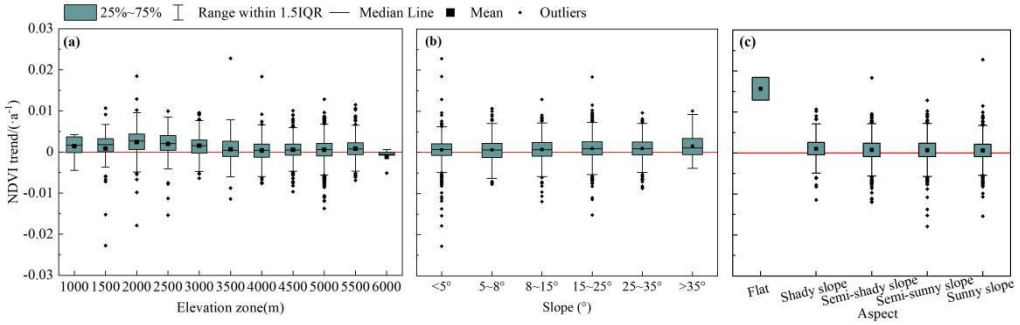

Figure S3. NDVI trends during 2000—2019 with different topographic factors in the basin (a, b, c show elevation, slope and aspect respectively).

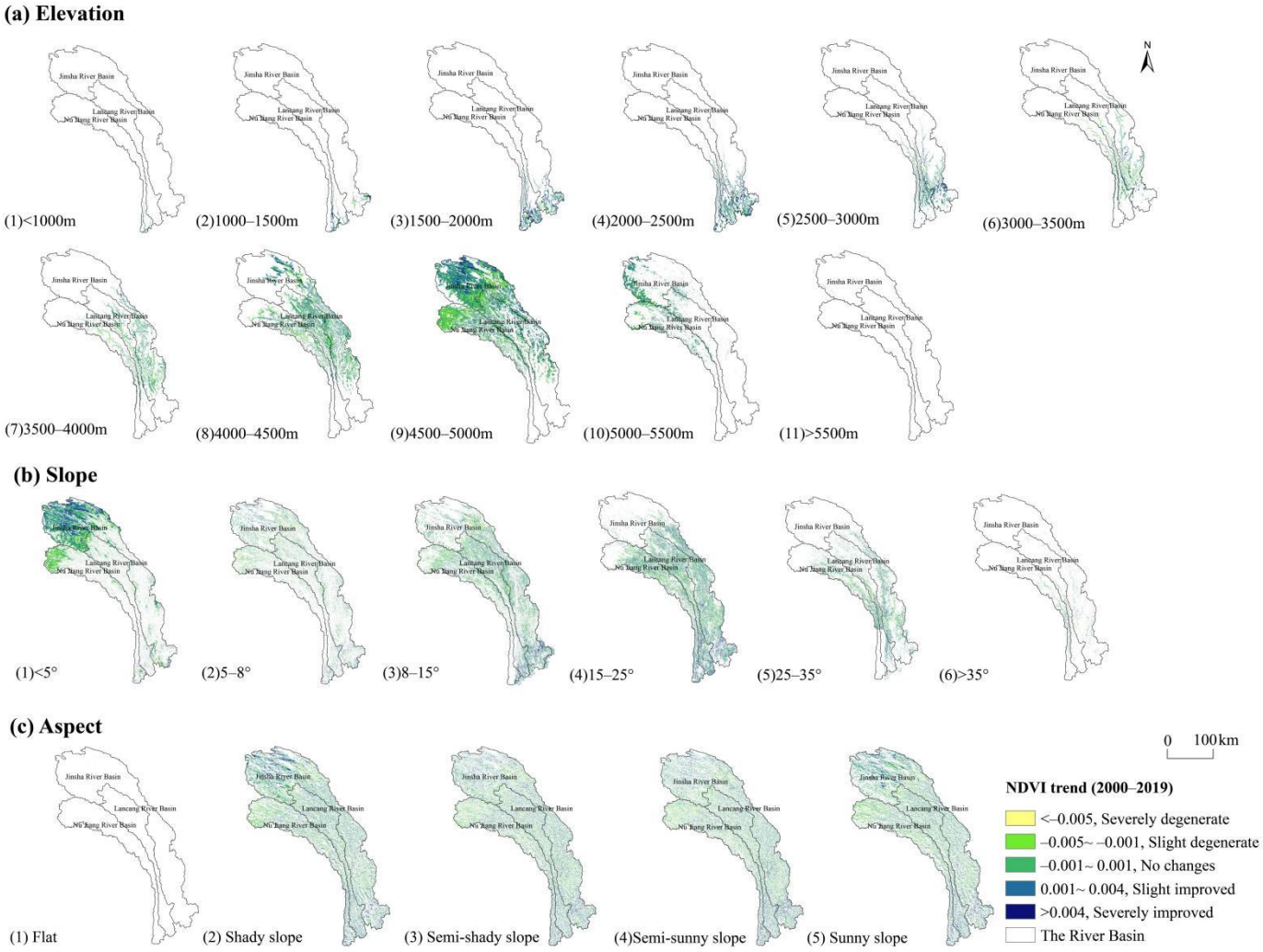

Figure S4. Spatial distribution of NDVI trends for different topographic factors from 2000 to 2019.

Table S3. Area statistics of NDVI trends for different topographic factors from 2000 to 2019.

Topographic factors	NDVI trend	Severely degenerate (S_{NDVI}<-0.005)	Slight degenerate (-0.005 ~ -0.001)	No changes (-0.001~0.01)	Slight improved (0.001~0.004)	Severely improved (S_{NDVI}>0.004)
Elevation	<1000m	5.45%	20.14%	20.19%	**39.13%**	15.10%
	1000—1500m	6.51%	11.96%	18.49%	**41.96%**	21.07%
	1500—2000m	3.55%	9.24%	17.49%	**44.78%**	24.94%
	2000—2500m	1.47%	9.16%	22.41%	**45.74%**	21.22%
	2500—3000m	0.98%	11.29%	27.13%	**43.14%**	17.45%
	3000—3500m	2.70%	22.19%	32.97%	**33.06%**	9.08%
	3500—4000m	2.31%	23.72%	**34.36%**	32.90%	6.71%
	4000—4500m	1.92%	21.85%	**35.04%**	34.81%	6.39%
	4500—5000m	2.33%	22.69%	32.44%	**34.48%**	8.07%
	5000—5500m	1.62%	18.21%	34.04%	**37.19%**	8.93%
	>5500m	1.97%	14.28%	**43.81%**	31.57%	8.37%
Slope	<5°	1.97%	19.23%	35.30%	**37.07%**	6.43%

	5—8°	2.37%	23.38%	32.17%	**33.50%**	8.58%
	8—15°	2.37%	21.63%	30.65%	**34.91%**	10.44%
	15—25°	2.08%	19.11%	29.91%	**37.12%**	11.78%
	25—35°	2.31%	19.03%	29.41%	**36.94%**	12.32%
	>35°	2.60%	21.08%	28.98%	**35.64%**	11.70%
Aspect	Flat	10.86%	21.05%	23.46%	**23.59%**	21.05%
	Shady slope	1.86%	19.05%	31.97%	**37.51%**	9.60%
	Semi-shady slope	2.35%	20.46%	31.06%	**35.93%**	10.20%
	Semi-sunny slope	2.39%	20.88%	31.27%	**35.25%**	10.21%
	Sunny slope	2.23%	20.82%	32.53%	**35.55%**	8.88%

Table S4. Parameter estimation and test results of the OLS model.

Variable	Dominant factors	Coefficient	Std Error	t-Statistic	Probability	VIF
Intercept	Constant term	1226.77	154.58	7.94	0.00***	-
X1	DEM	−0.41	0.03	−13.17	0.00***	1.07
X2	Slope	−1.65	3.17	−0.52	0.60	1.07
X3	Aspect	0.24	0.28	0.87	0.39	1.00

Note: *** indicates that the significance test at 1% level is passed.

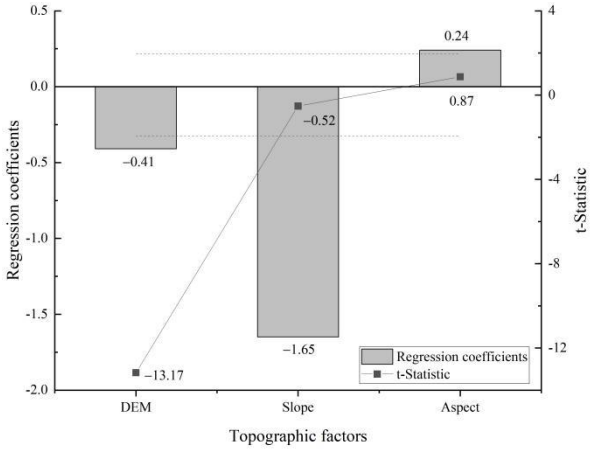

Figure S5. Estimation result of regression coefficients obtained through OLS modeling. (adjustment R^2 is 0.03, F value is 60.76, and $P < 0.01$; the two dashed lines denote that the t-value is equal to −1.96 and 1. 96 respectively; at 0.05 significance level, t < −1.96 means a significantly negative correlation, while t > 1.96 represents a positive correlation.)

Table S5. Comparison of model performance between the GWR and OLS models.

Model parameters	AICc	R^2	Residuals SS	Residuals df	Adjusted R^2	Residuals MS	Residuals F
OLS	90394.77	0.04	20901792171.05	4994.00	0.03	-	-
GWR	88935.99	0.42	12545519136.66	4325.67	0.33	2900250.11	4.31
Improvement	1458.77	0.39	8356273034.39	668.33	-	-	-