Supplementary Information

Direct and indirect interactive effects of climate, topography, and human activities on vegetation dynamics in a semi-humid mountainous system

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Table S1 Significance of driving factors of vegetation change and their significance test results in 2000 and 2020

2000			2020		
Driving Factors	IncMSE (%)	InCMSE.pval	Driving Factors	IncMSE (%)	InCMSE.pval
Pre	184.5264	0.0099	Pre	139.4353	0.0099
Pd	150.7381	0.0099	Tem	129.0642	0.0099
Tem	133.0166	0.0099	Pd	122.0560	0.0099
GDP	129.6172	0.0099	Slop	88.6647	0.0099
LUCC	89.5890	0.0099	GDP	85.7369	0.0099
TK	86.4322	0.0099	TK	78.9309	0.0099
Slop	84.5504	0.0099	OC	66.2986	0.0099
Rii	75.0553	0.0099	LUCC	64.6508	0.0099
TN	64.6090	0.0099	TN	63.6230	0.0099
St	60.9856	0.0099	SOM	57.7466	0.0099
OC	55.0327	0.0099	Rii	56.2604	0.0099
TP	54.4561	0.0099	pH	51.3369	0.0099
SOM	53.3558	0.0198	TP	45.4470	0.0099

Table S2 Calculation method of direct and indirect effects of various driving factors on vegetation based on the SEM method in 2000

2000Pre	Paths	Coefficient of Influence	Name	2000Tem	Paths	Coefficient of Influence	Name
Direct	NDVI~Pre	0.642	a	Direct	NDVI~Tem	0.114	a
	NDVI~Human	0.669	b		NDVI~Human	-0.444	b
	NDVI~Slop	-0.087	c		NDVI~Slop	0.037	c
	NDVI~Soil	0.493	d		NDVI~Soil	-0.175	d
Indirect	Pre~Human	0.503	e	Indirect	Tem~Human	0.429	e
	Slop~Human	0.359	f		Slop~Human	-0.470	f
	Slop~Pre	0.111	g		Slop~Tem	0.229	g
	Soil~Human	-0.595	h		Soil~Human	0.403	h
	Soil~Pre	-0.442	i		Soil~Tem	0.510	i
	Soil ~Slop	0.094	j		Soil ~Slop	-0.059	j
	Paths	**Calculational Methods**	**Effect**		**Paths**	**Calculational Methods**	**Effect**
Indirect	Pre→Soil →NDVI	i × d	-0.218	Indirect	Tem→Soil →NDVI	i*d	-0.089
	Pre→Slop→NDVI	g × c	-0.010		Tem→Slop→NDVI	g × c	0.008
	Slop→Soil→NDVI	j × d	0.046		Slop→Soil→NDVI	j × d	0.010
	Human→Slop→NDVI	f × c	-0.031		Human→Slop→NDVI	f × c	-0.017
	Human→Pre→NDVI	e × a	0.323		Human→Tem→NDVI	e × a	0.049
	Human→Pre→Slop→NDVI	e × g × c	-0.005		Human→Tem→Slop→NDVI	e × g × c	0.004
	Human→Soil→NDVI	h × d	-0.293		Human→Soil→NDVI	h × d	-0.071
Direct	Pre→NDVI	a	0.642	Direct	Tem→NDVI	a	0.114
	Human→NDVI	b	0.669		Human→NDVI	b	-0.444
	Slop→NDVI	c	-0.087		Slop→NDVI	c	0.037
	Soil→NDVI	d	0.493		Soil→NDVI	d	-0.175
Total	NDVI~Pre	a + i × d + g × c	0.414	Total	NDVI~Tem	a + i × d + g × c	0.033
	NDVI~Human	b + f × c + e × a + e × g × c +	0.663		NDVI~Human	b + f × c + e × a + e × g × c +	-0.479
	NDVI~Slop	c + j × d	-0.041		NDVI~Slop	c + j × d	0.047
	NDVI~Soil	d	0.493		NDVI~Soil	d	-0.175

Table S3 Calculation method of direct and indirect effects of various driving factors on vegetation based on the SEM method in 2020

2020Pre	Paths	Coefficient of Influence	Name	2020Tem	Paths	Coefficient of Influence	Name
Direct	NDVI~Pre	0.328	a	**Direct**	NDVI~Tem	0.005	a
	NDVI~Human	-0.489	b		NDVI~Human	-0.562	b
	NDVI~Slop	-0.013	c		NDVI~Slop	0.029	c
	NDVI~Soil	-0.080	d		NDVI~Soil	-0.015	d
Indirect	Pre~Human	-0.301	e	**Indirect**	Tem~Human	0.373	e
	Slop~Human	-0.248	f		Slop~Human	-0.369	f
	Slop~Pre	0.168	g		Slop~Tem	0.162	g
	Soil~Human	-0.232	h		Soil~Human	-0.195	h
	Soil~Pre	0.216	i		Soil~Tem	-0.335	i
	Soil~Slop	0.029	j		Soil~Slop	0.067	j
	Paths	**Calculational Methods**	**Effect**		**Paths**	**Calculational Methods**	**Effect**
Indirect	Pre→Soil→NDVI	i × d	-0.017	Indirect	Tem→Soil→NDVI	i × d	0.005
	Pre→Slop→NDVI	g × c	-0.002		Tem→Slop→NDVI	g × c	0.005
	Slop→Soil→NDVI	j × d	-0.002		Slop→Soil→NDVI	j × d	-0.001
	Human→Slop→NDVI	f × c	0.003		Human→Slop→NDVI	f × c	-0.011
	Human→Pre→NDVI	e × a	-0.099		Human→Tem→NDVI	e × a	0.002
	Human→Pre→Slop→NDVI	e × g × c	0.001		Human→Tem→Slop→NDVI	e × g × c	0.002
	Human→Soil→NDVI	h × d	0.019		Human→Soil→NDVI	h × d	0.003
Direct	Pre→NDVI	a	0.328	Direct	Tem→NDVI	a	0.005
	Human→NDVI	b	-0.489		Human→NDVI	b	-0.562
	Slop→NDVI	c	-0.013		Slop→NDVI	c	0.029
	Soil→NDVI	d	-0.080		Soil→NDVI	d	-0.015
Total	NDVI~Pre	a + i × d + g × c	0.309	Total	NDVI~Tem	a + i × d + g × c	0.015
	NDVI~Human	b + f × c + e × a + e × g × c +	-0.565		NDVI~Human	b + f × c + e × a + e × g × c +	-0.566
	NDVI~Slop	c + j × d	-0.015		NDVI~Slop	c + j × d	0.028
	NDVI~Soil	d	-0.080		NDVI~Soil	d	-0.015

Table S4 Correlation coefficients of different variables with NDVI

Driving factors	Correlation coefficient in 2000	Driving factors	Correlation coefficient in 2020
Tem	-0.195**	Tem	-0.198**
Pre	0.601**	Pre	0.449**
Pd	-0.396**	Pd	-0.377**
GDP	-0.256**	GDP	-0.169**
Rii	-0.032**	Rii	-0.087**
Slop	0.239**	Slop	0.201**
SOM	0.243**	SOM	0.187**
OC	-0.007	OC	-0.012
TN	0.232**	TN	0.180**
TP	0.168**	TP	0.097**
TK	0.124**	TK	0.060**
LUCC	0.025**	LUCC	0.013*
St	-0.381**	pH	-0.356**

**at the 0.01 level (two-tailed), with significant correlation.

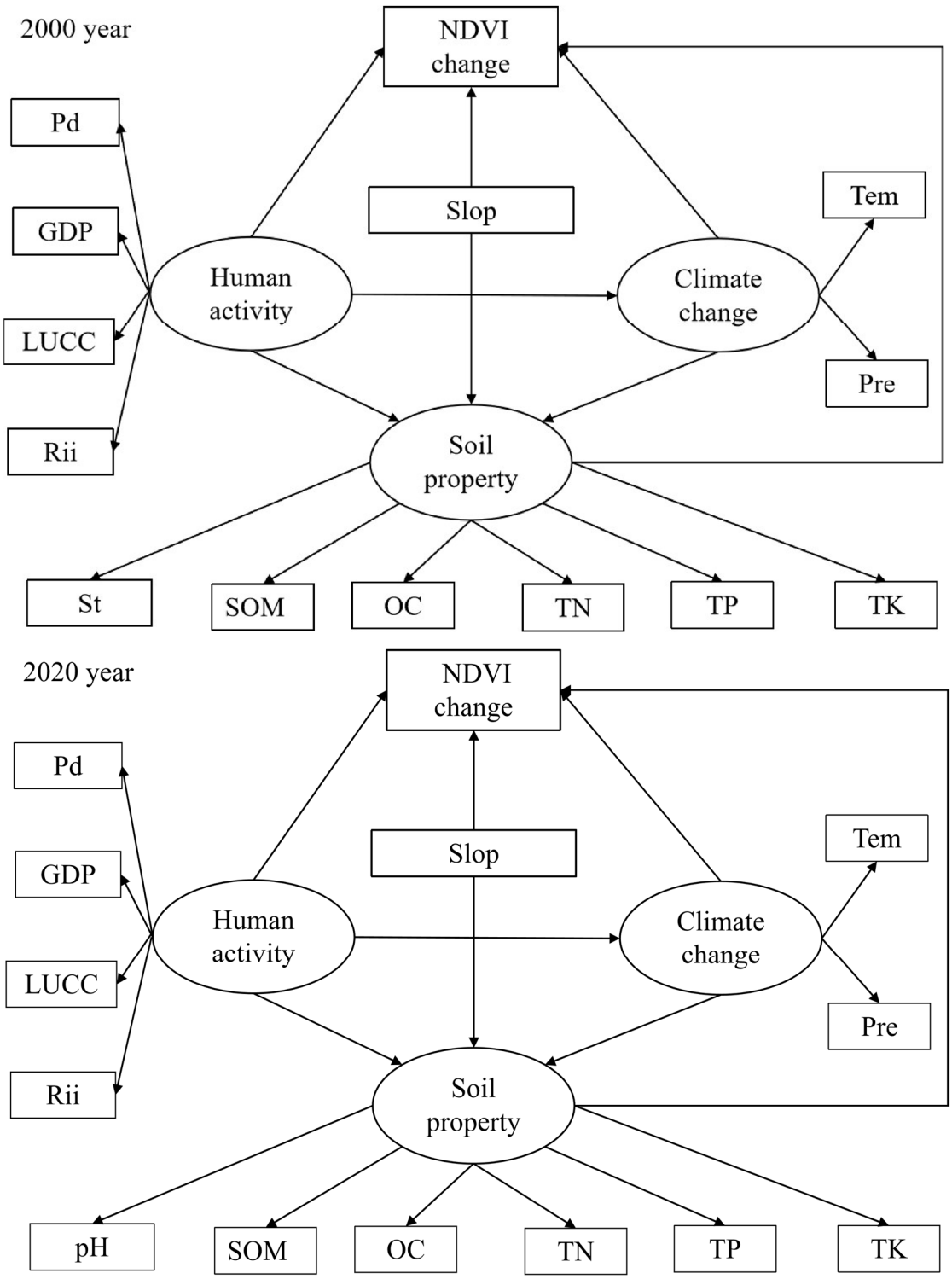


Figure S1. Meta-model of structural equation model of vegetation change and driving factors in 2000 and 2020

(Note: all independent variables in the figure are factors of high importance screened by the RF model; considering the consistency of the spatial data of each factor, the original vegetation data was used in the SEM model)

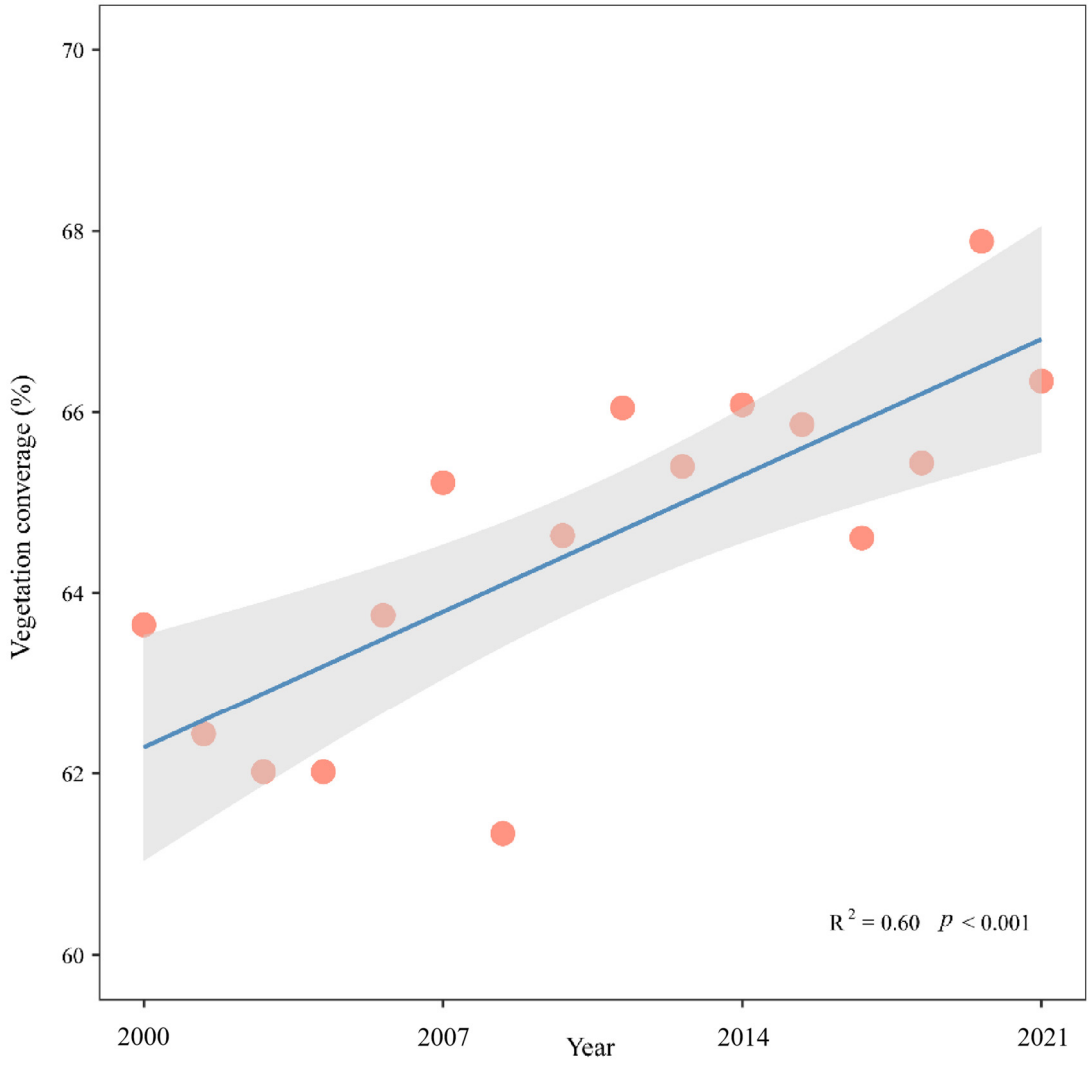


Figure S2. Temporal trends of vegetation cover in Longnan from 2000-2020 (The pink interval indicates 95% confidence interval)

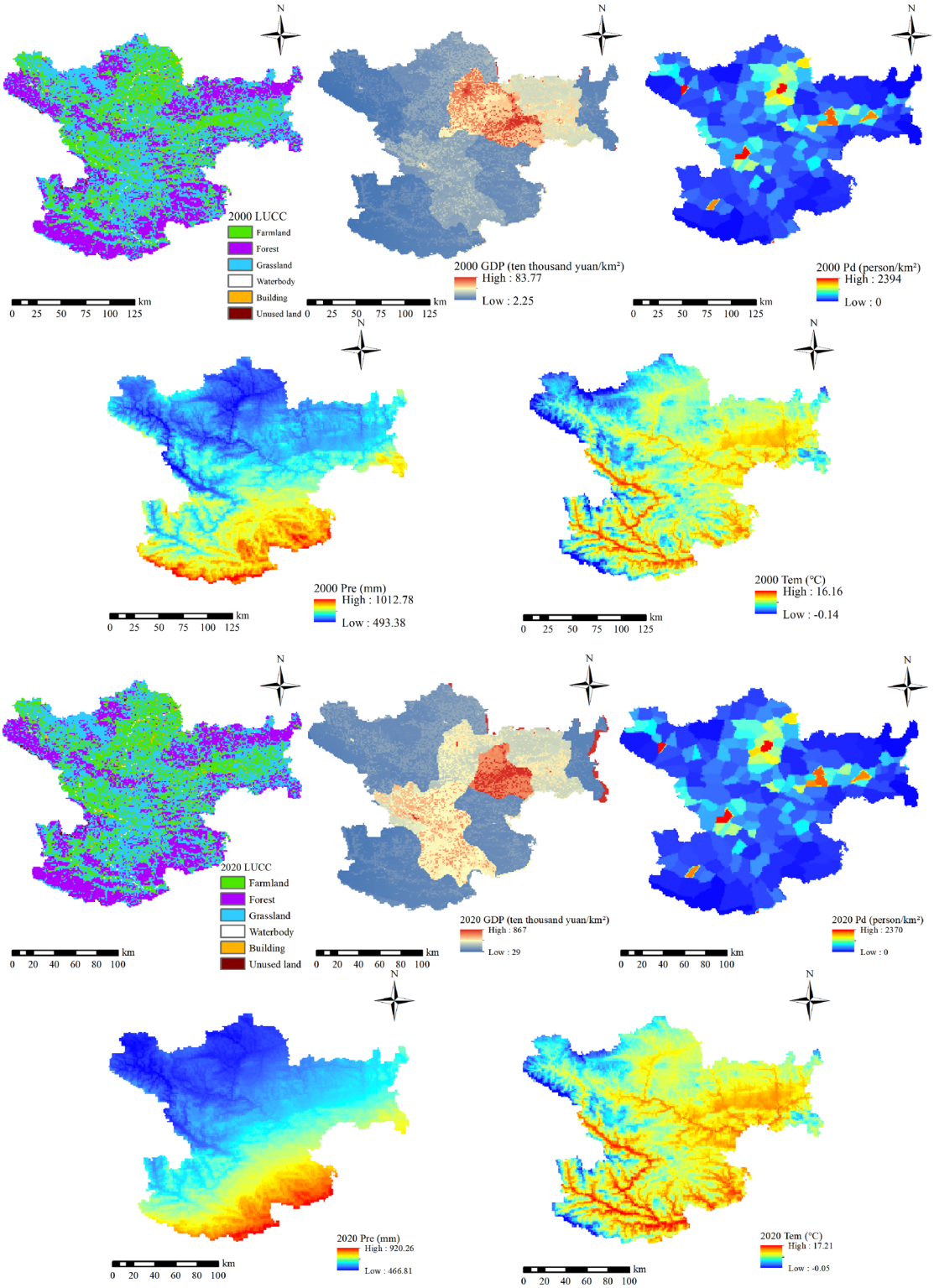


Figure S3. Spatial distribution of land use/cover (LUCC), gross domestic product (GDP), population density (Pd), temperature (Tem) and precipitation (Pre) in Longnan region in 2000/2020

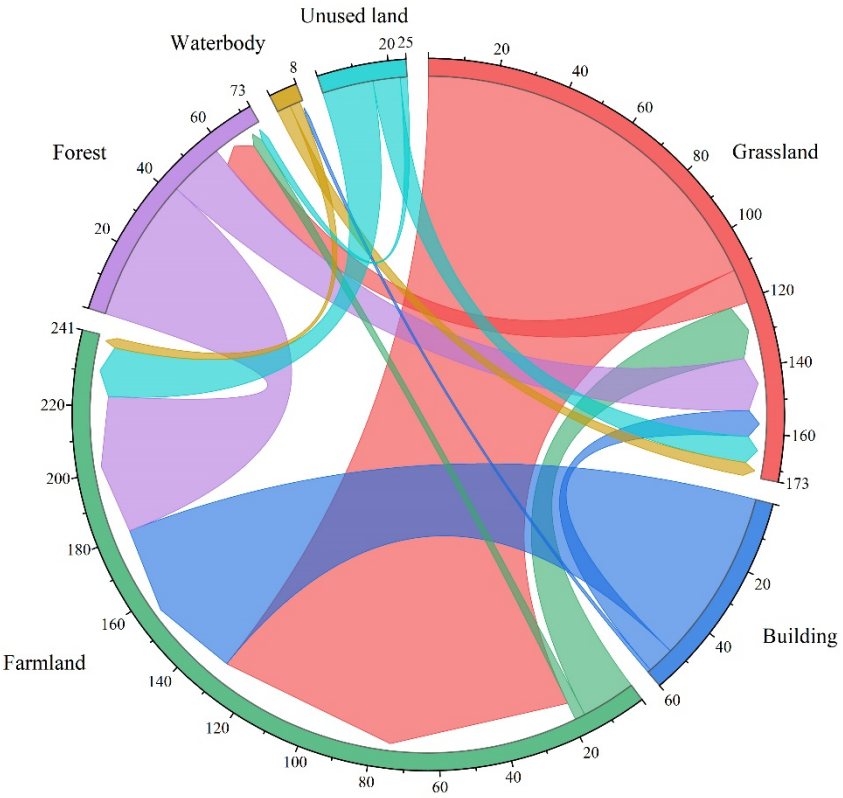


Figure S4. LUCC transfer matrix of Longnan area from 2000-2020 (Unit: km^2)

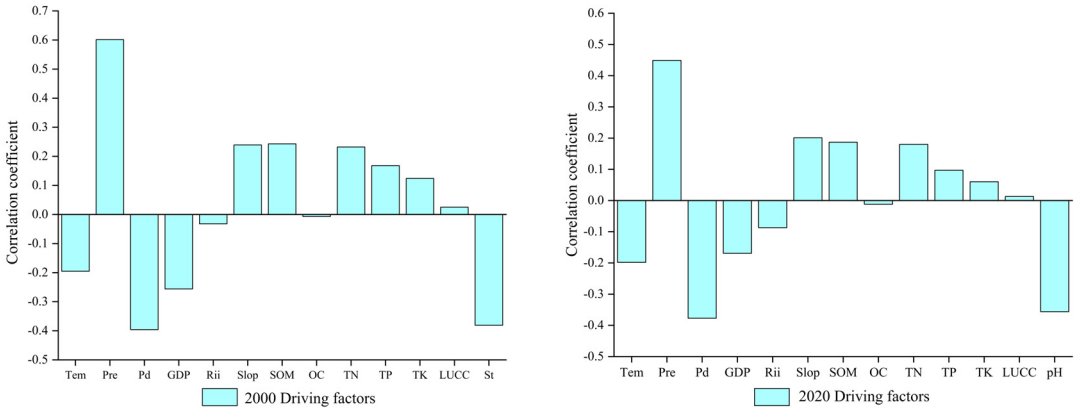


Figure S5. Correlation of different variables with NDVI (Pearson correlation was used to estimate the correlation of continuous variables as well as NDVI changes; spearman correlation was used for LUCC and St categorical variables[6].)