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Theory article

Study on the spatial variation of sensitivity of soil nutrient system in Xinjiang, China

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Supplementary Information

Table S1

LUI calculation dataset information based on county.

Dimension	Index	Formula	Property explanation
Input	Mechanical input index [a]	Total power of agricultural machinery/cultivated land area	Total power of agricultural machinery: total power of tractors, supporting agricultural tools and water-saving irrigation machinery (kw)
	Fertilizer input index [a]	Amount of fertilizer applied/cultivated land area	Amount of fertilizer applied: total amount of nitrogen fertilizer, phosphorus fertilizer, potassium fertilizer and organic fertilizer (t)
	Irrigation index [a]	Effective irrigation area/cultivated land area	Unit of effective irrigation area: hm^2
	Electricity consumption index [a]	Rural electricity consumption/cultivated land area	Unit of rural electricity consumption: kw·h
	Labor input index [a]	Number of agricultural labor force/cultivated land area	The number of agricultural labor force is the number of people engaged in agriculture
Output	Grain yield per unit [a]	Total grain output/cultivated land area	Total grain output: total output of wheat, barley, maize and rice (t)
	Average land output [a]	Total agricultural output/cultivated land area	Unit of total agricultural output: RMB 10,000 yuan

System	Multiple crop index [a]	Sown area of crops/cultivated area	Unit of effective sown area of crops: hm^2
	Yield gap index [b]	1/(maximum grain yield per unit - average grain yield per unit)	Unit of maximum grain yield per unit and average grain yield per unit: kg
	Cultivated land utilization index [a]	$W \times (A_1 \times L_1 + \ldots\ldots + A_n \times L_n)$	W is the proportion of sown area of main crops in cultivated land (%); A is the unit yield of main crops (kg); L is the sowing area of main crops (hm^2); 1......n is the main crop type

Note: a means the data is from *Xinjiang Statistical Yearbook* (2010-2020); b indicates that the data is obtained through investigation with the county-level competent agricultural department; the unit of cultivated land area is hm^2.

Table S2

LUI dataset index weight.

Index	Mechanical input index	Fertilizer input index	Irrigation index	Electricity consumption index	Labor input index	Grain yield per unit	Average land output	Multiple crop index	Yield gap index	Cultivated land utilization index
Weight	0.059	0.153	0.064	0.155	0.114	0.013	0.093	0.062	0.142	0.143

Table S3

Climate tendency rate of temperature and precipitation in entire Xinjiang and farming divisions (/10a).

Farming divisions	Temperature (°C)	Precipitation (㎜)
1960~2008 entire Xinjiang (A)	0.332*	15.401*
2009~2019 entire Xinjiang (A)	1.086*	-11.924*
Southern part of Junggar Basin (B)	0.131*	1.870*
Northern part of Junggar Basin (C)	0.194*	-2.581*
Ili River Valley (D)	0.411*	-0.734*
Tuha Basin (E)	0.038*	0.654*
Western part of Tarim Basin (F)	0.217*	-0.247*
Southern part of Tarim Basin (G)	0.102*	2.125*
Northern part of Tarim Basin (H)	0.230*	0.828*

Note: * means it has passed Mann-Kendall significance test that is α≤0.05.

Table S4

Selection of spatial interpolation model of soil nutrients.

Year	Soil nutrients	R^2	RSS	Model
2009	Total nitrogen	0.938	3.404E-0.6	Spherical
	Available phosphorus	0.895	7.344E-0.4	Exponential
	Rapid available potassium	0.872	1.322E-0.3	Exponential
	Organic matter	0.868	8.543E-0.3	Exponential
2019	Total nitrogen	0.935	2.517E-0.6	Spherical
	Available phosphorus	0.891	0.666E-0.5	Exponential
	Rapid available potassium	0.875	2.290E-0.4	Exponential
	Organic matter	0.891	2.506E-0.4	Exponential

Table S5

Sensitivity classes.

Class	Index	Sensitivity
I	$0.00 \leq |S| < 0.05$	Minimum sensitivity
II	$0.05 \leq |S| < 0.20$	Medium
III	$0.20 \leq |S| < 1.00$	High
IV	$1.00 \leq |S|$	Very high

Table S6

Grading standard of of second general survey of soil nutrients in China.

Nutrient	Grades					
	Extremely abundant	Abundant	More abundant	Medium	Short	Extremely short
Total nitrogen (g/kg)	>2.0	1.5~2.0	1.0~1.5	0.75~1.0	0.5~0.75	≤0.5
Available phosphorus (mg/kg)	>40	20~40	10~20	5~10	3~5	≤3
Rapid available potassium (mg/kg)	>200	150~200	100~150	50~100	30~50	≤30
Organic matter (g/kg)	>40	30~40	20~30	10~20	6~10	≤6
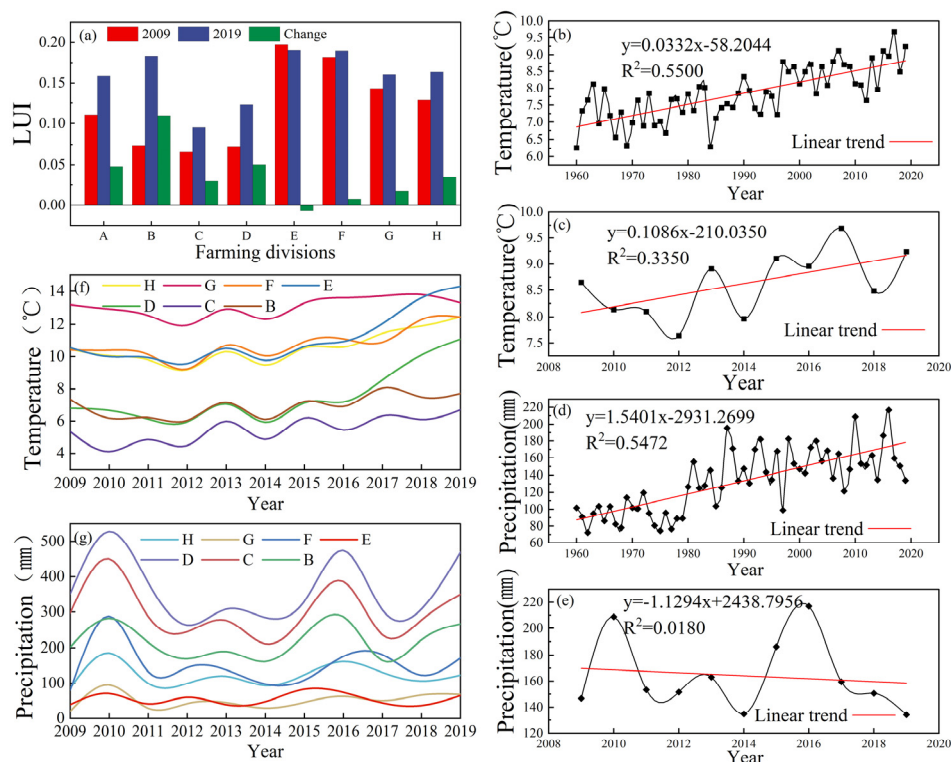
Fig S1. Time Series Changes of LUI, Temperature and Precipitation in Xinjiang and Farming Divisions. (a): LUI changes in Xinjiang and 7 farming divisions. (b): Average value and variation trend of temperature during 1960-2019. (c): Average value and variation trend of temperature during 2009-2019. (d): Average value and variation trend of precipitation during 1960-2019. (d): Average value and variation trend of precipitation during 2009-2019. (f): Variation of temperature in 7 farming divisions. (g): Variation of precipitation in 7 farming divisions.
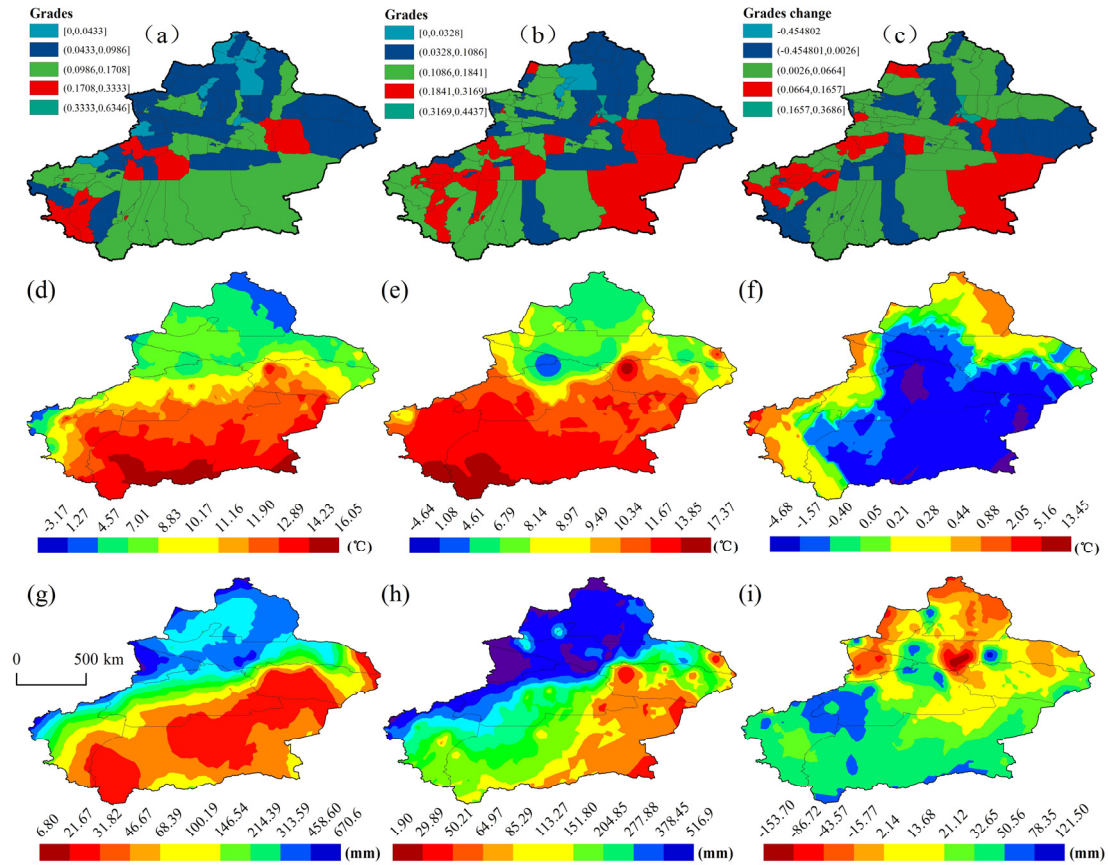
Fig S2. Spatial Variation of LUI, temperature and precipitation in Xinjiang. (a): Spatial distribution of LUI in 2009. (b): Spatial distribution of LUI in 2019. (c): LUI variation during 2009-2019. (d): Spatial distribution of temperature in 2009. (e): Spatial distribution of temperature in 2019. (f): Spatial distribution of temperature variation during 2009-2019. (g): Spatial distribution of precipitation in 2009. (h): Spatial distribution of precipitation in 2019. (i): Spatial distribution of precipitation variation during 2009-2019. Annual average of temperature and precipitation usage.
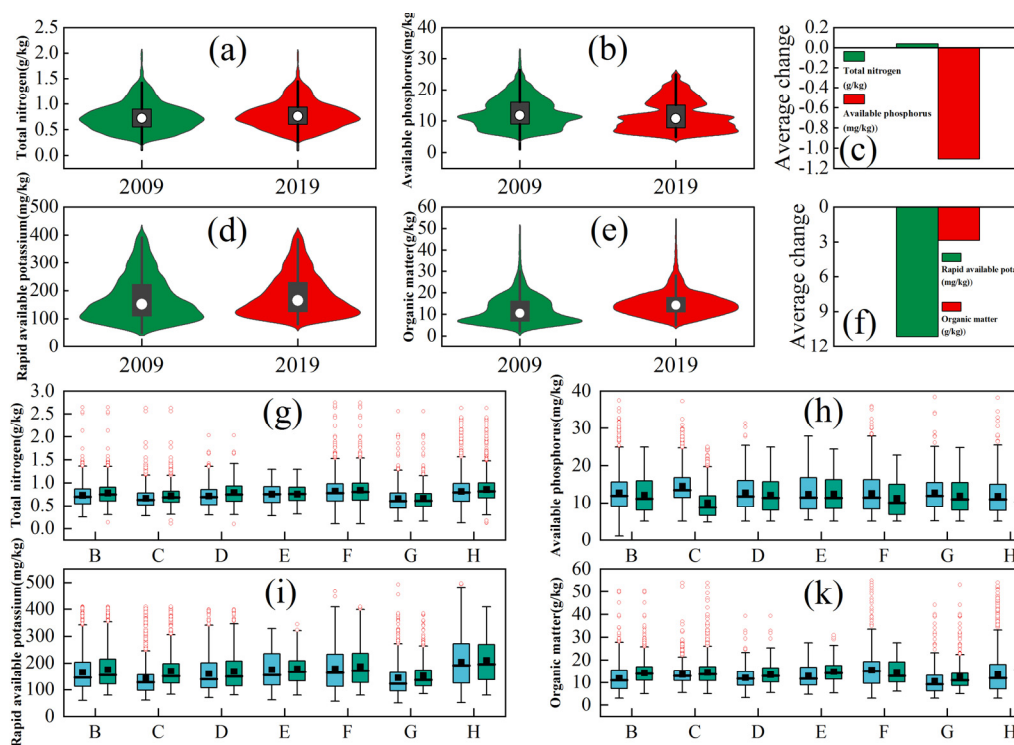
Fig S3. Change of soil nutrients in Xinjiang and farming divisions. (a), (b), (d) and (e) are the statistics of soil total nitrogen, available phosphorus, rapid available potassium and organic matter content in 2009 and 2019, respectively. (c): Average value changes of total nitrogen and available phosphorus during 2009-2019. (f): Average value changes of rapid available potassium and organic matter during 2009-2019. (g), (h), (i) and (k) are the statistics of soil total nitrogen, available phosphorus, rapid available potassium and organic matter content in 7 farming divisions, respectively.
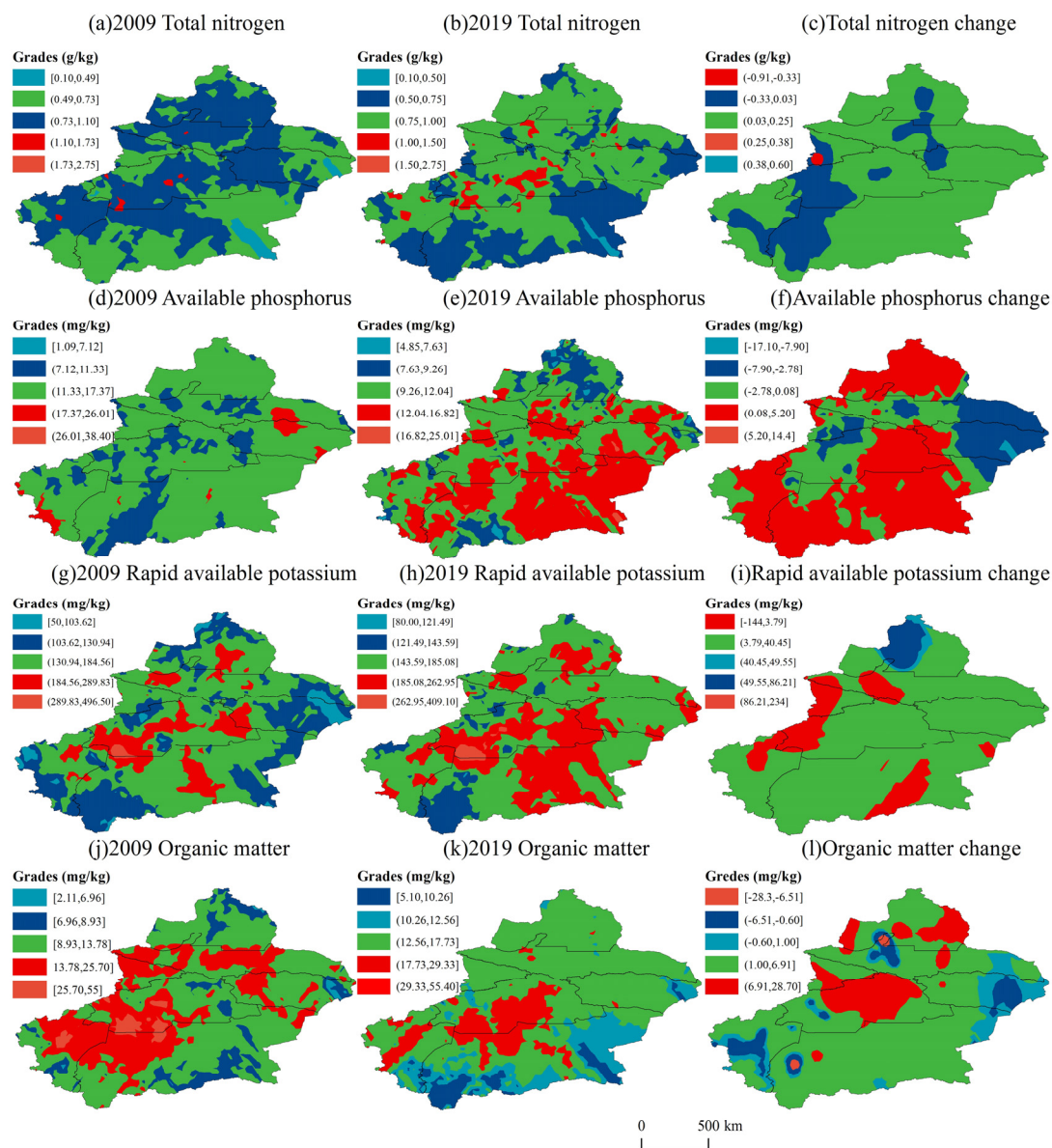
Fig S4. Spatial variation of soil nutrients in Xinjiang.