Quantitatively distinguish the impact of climate change and human activities on the vegetation changes in Mainland China based on the improved residual method

Yahai Zhang[1], Aizhong Ye[1]

1. State Key Laboratory of Earth Surface and Ecological Resources, Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China

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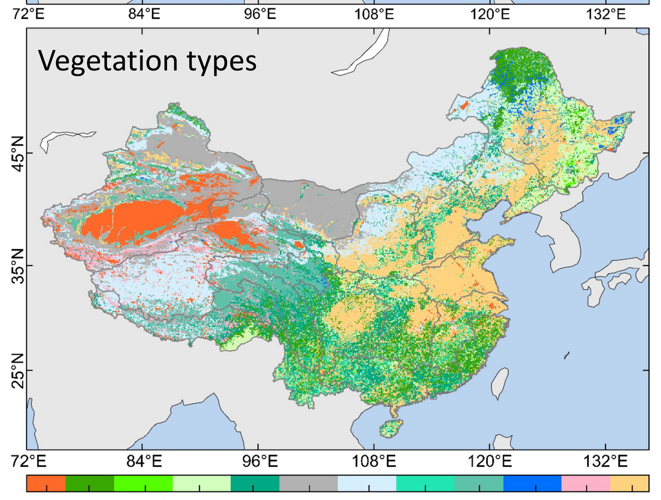
Introduction

Knowledge of the current severe global environmental changes, vegetation has faced the dual challenges posed by climate change and human activities. Quantitatively distinguishing the influence of climate change and human activities on vegetation changes is a key to develop adaptive ecological protection policies.

The residual trend method is a common method to separate and quantitatively analyze climate change and human activities, but for the limitations (Burrell et al., 2017), it must be adjusted and improved.

The study considers the time lag effect of NDVI and climate factors, delineates stages of anthropogenic activity, and adds spatial dimensional modelling to improve the reasonableness and accuracy of the residual trend method. We attempt to quantify Mainland China's response to climate change and human activities.

Data & Methods



Region	Full name	Mean Annual prec. (mm)	Area (km²)
1	Songhua River	535.5	370 973
2	Liao River	566.1	310 117
3	Hai River	515.9	578 092
4	Inland rivers in Xinjiang	168.3	1104104
5	Lower Yellow River	391.0	448 864
6	Upper Yellow River	469.3	504 731
7	Lower Yangtze River	1606.5	324 061
8	Huai River	819.5	415 287
9	Inland rivers in Northern Tibet	199.9	694 413
10	Southeastern River	1705.9	226 496
11	Brahmaputra	876.7	908 881
12	Upper Yangtze River	795.2	399 541
13	Middle and Lower Yangtze River	1276.5	567 237
14	Middle and Upper Yangtze River	1001.1	323 970
15	Pearl River	1700.7	567 520
16	Lancang River	882.2	316 057
17	Inner Mongolia inland river	220.4	1537520

Data

- GIMMS3g **NDVI**, 1982-2015
- China's Ground **Precipitation** 0.5° × 0.5° Grid Data Set version 2.0, 1982-2015
- China's Ground **Temperature** 0.5° × 0.5° Grid Data Set version 2.0, 982-2015

Methods — Improved RESTREND

I. **Pettitt Test** — Define the period of no human activity prior to the year of mutation in each basin.

II. **Regression model**

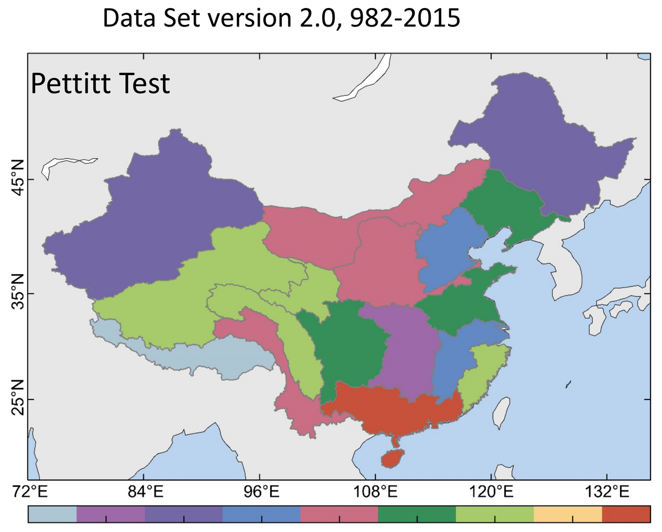
$$NDVI_{pre} = a \times \ln P_{(i,n)} + b \times T_{(i,m)} + c$$

$$NDVI_{res} = NDVI_{obs} - NDVI_{pre}$$

i is the number of month, n and m is the lagged month of 0-3.

$$Climate = \frac{Slope(NDVI_{pre})}{|Slope(NDVI_{pre})| + |Slope(NDVI_{obs})|} \times 100\%$$

$$Human = \frac{Slope(NDVI_{res})}{|Slope(NDVI_{res})| + |Slope(NDVI_{obs})|} \times 100\%$$



$NDVI_{pre}$ —the predicted value of NDVI

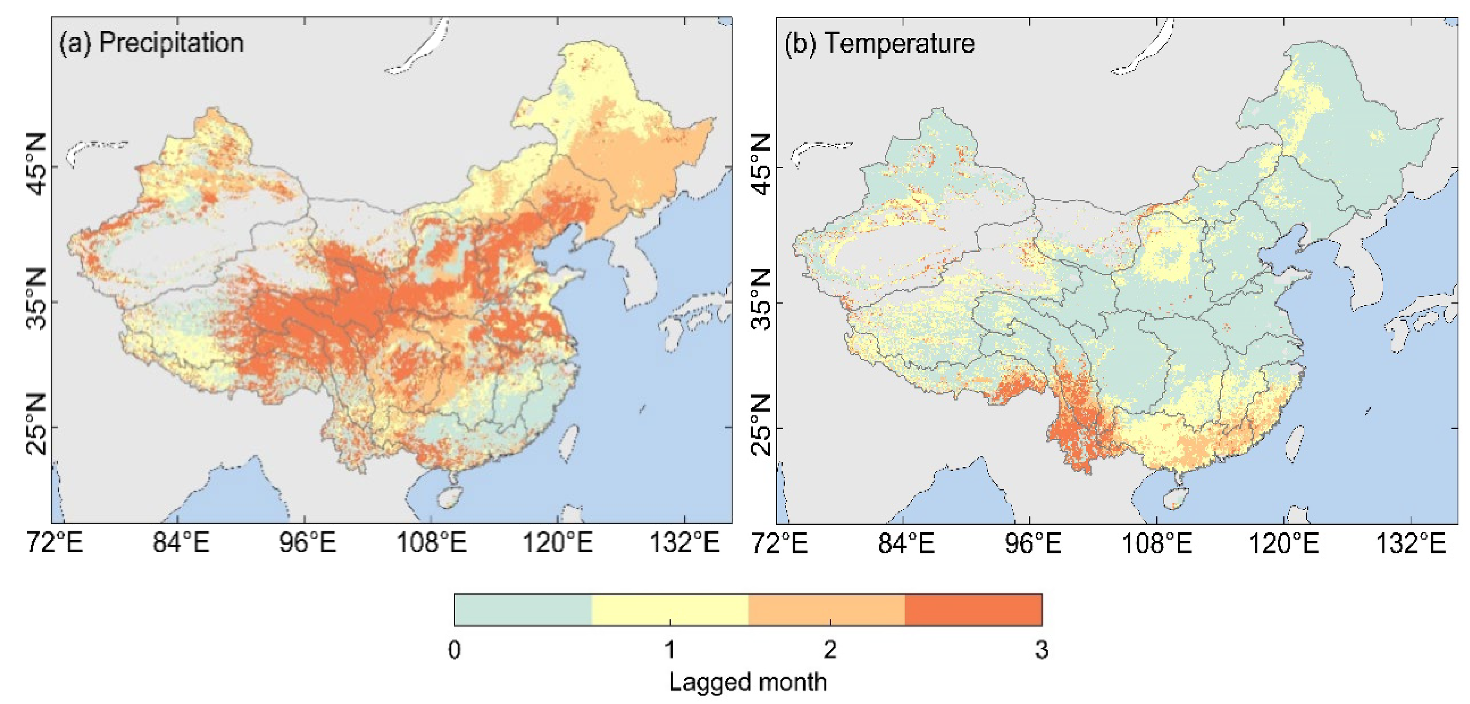
$NDVI_{obs}$ —the observation of NDVI

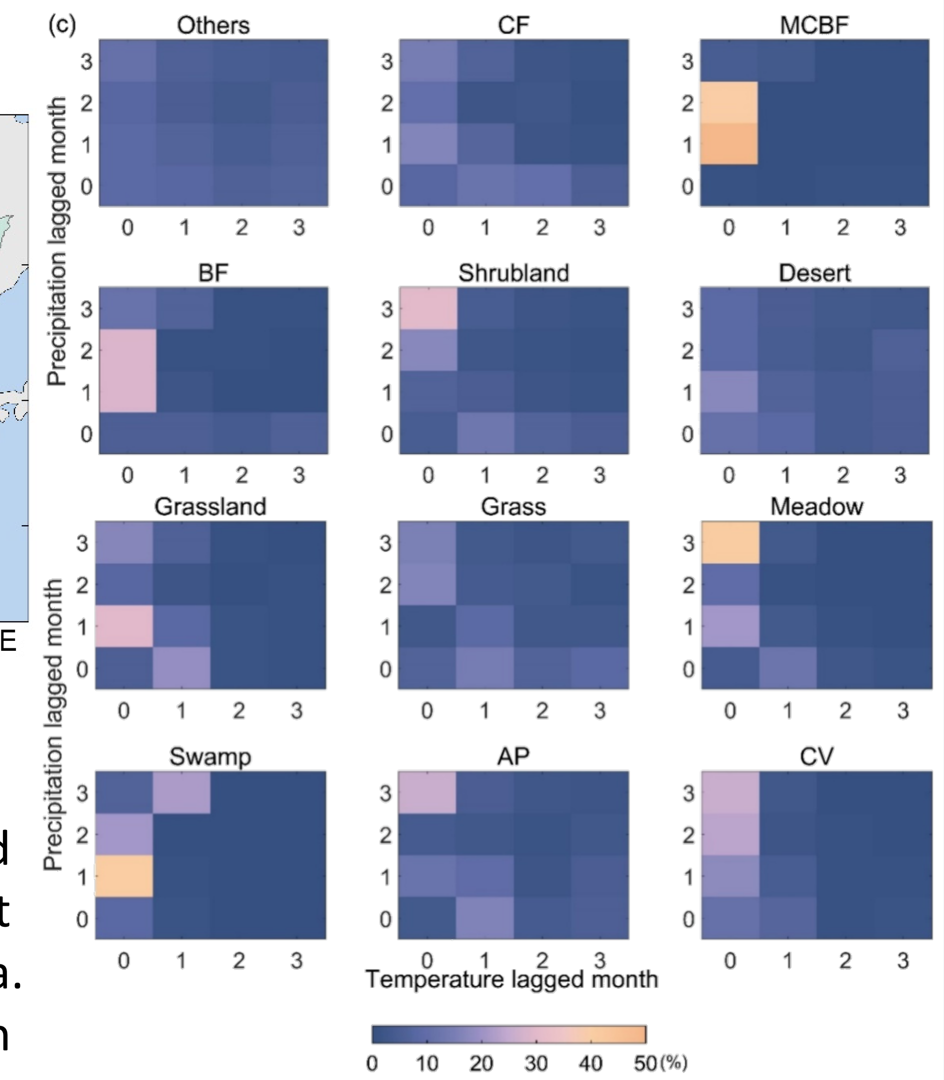
$NDVI_{res}$ —the residual value of NDVI

Results & Discussion

➢The Relationships between NDVI and climate factors

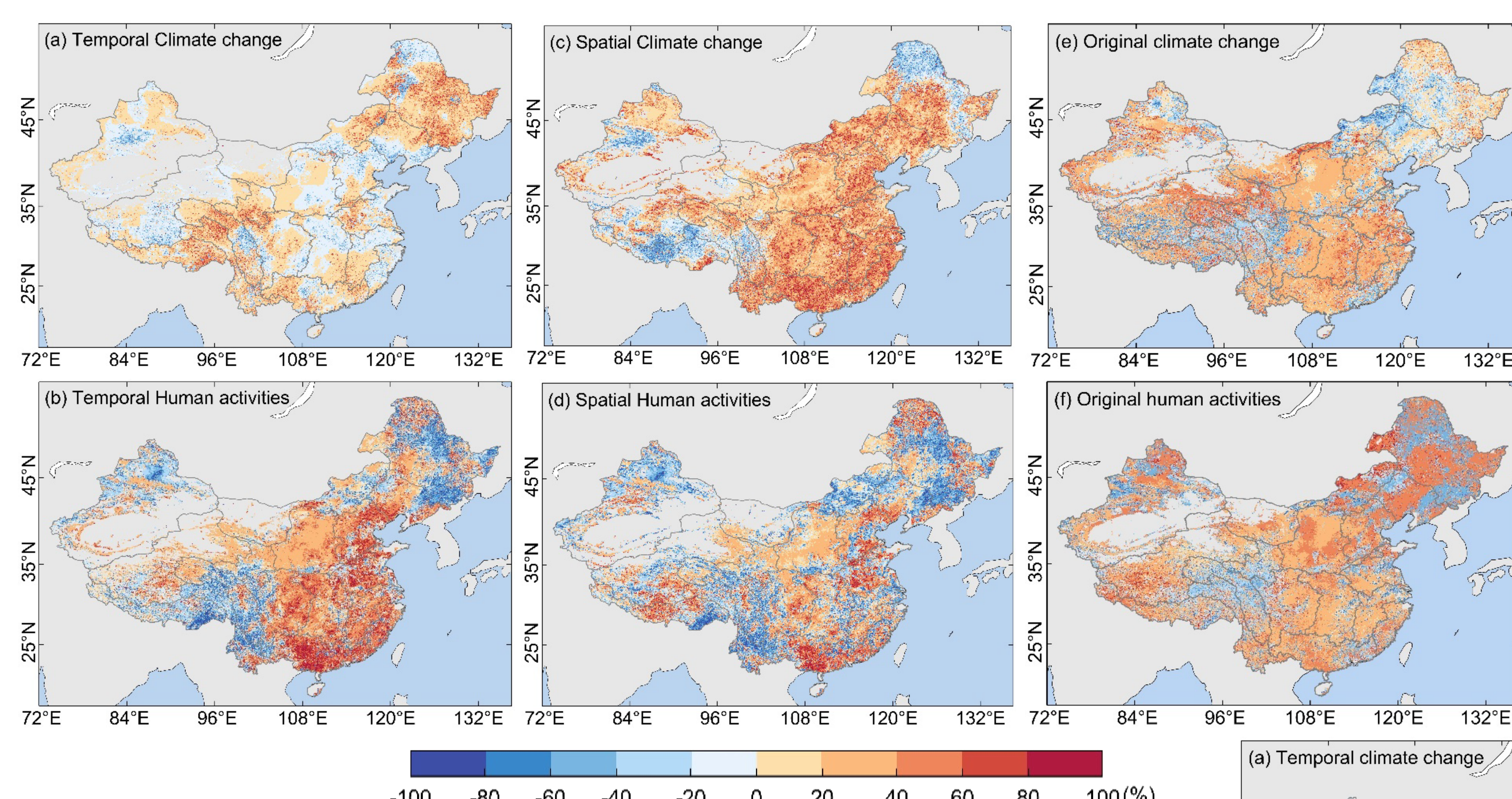
- **The lag-time effect between NDVI and climatic factors**





The time-lag effect of NDVI on precipitation was obtained accounting for 74.77% area in Mainland China. The regions without lagged month are concentrated in the southeast of Mainland China. the same vegetation type also performs different lagged month resulted by the combination of precipitation and temperature.

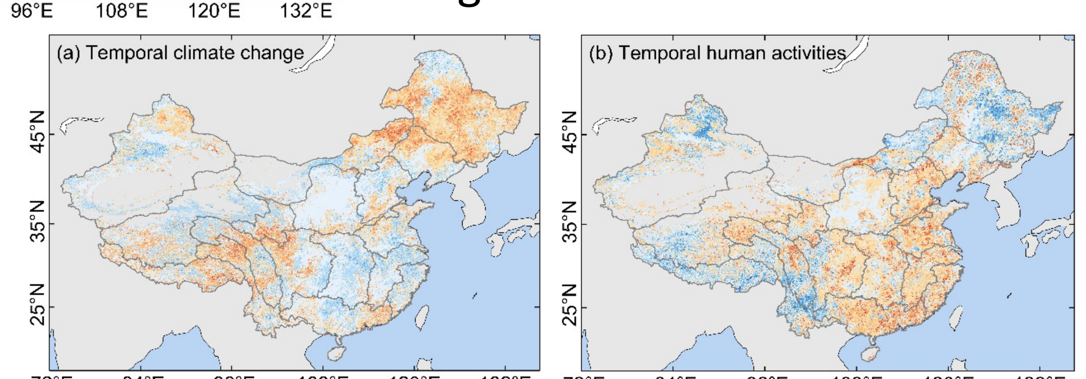
➢The contribution of climate change and human activities to NDVI change

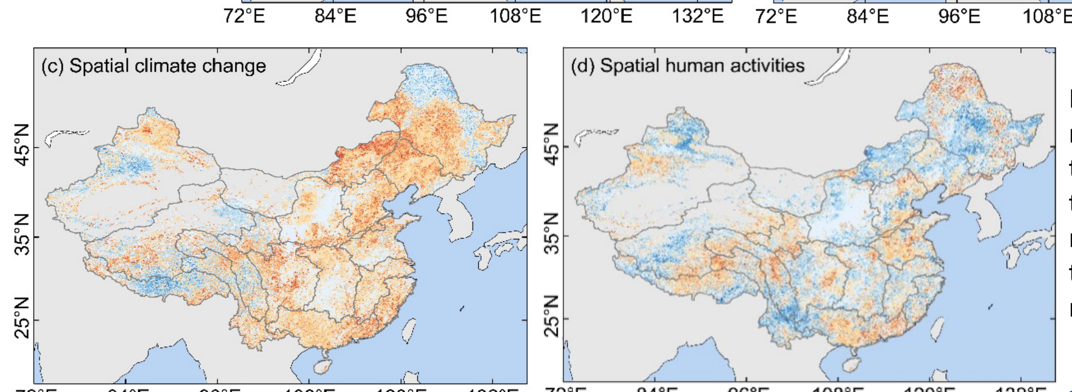


The contribution of climate change to vegetation in mainland China is 24.73% -45.56% (14.46% -35.95% is the positive contribution) and the contribution of human activities to vegetation change is 54.45% -75.27% (33.54% -50.52% is the positive contribution).

The contribution of human activities to vegetation change is greater than that of climate change in Mainland China.

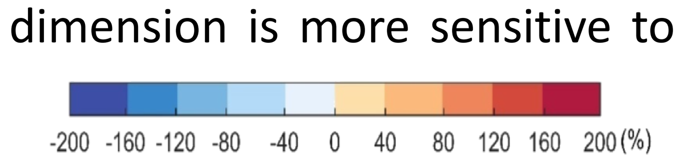
The smallest change in the improved results is seen in the yellow river basin (Upper Yellow River and Lower Yellow River). Songhua River with a significant increase in the contribution of climate change (10.86%-20.40%)

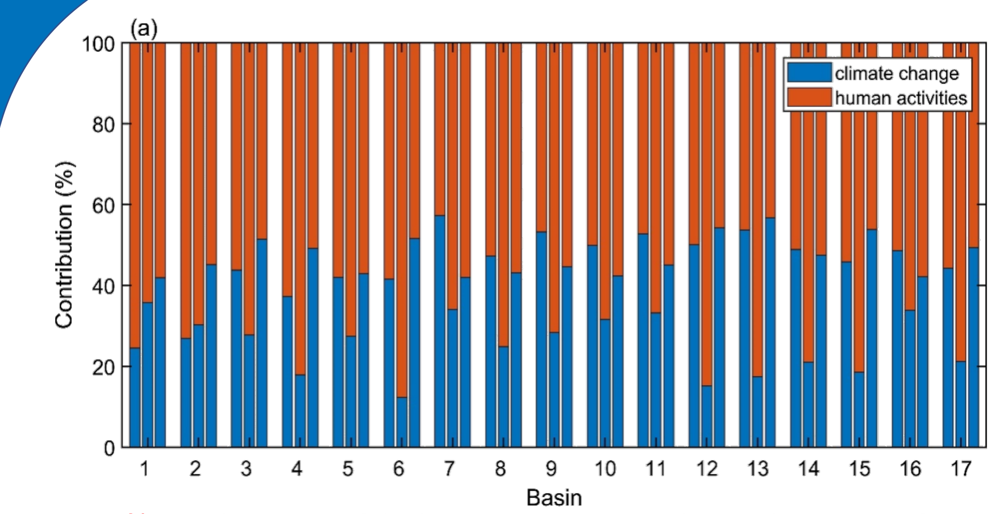




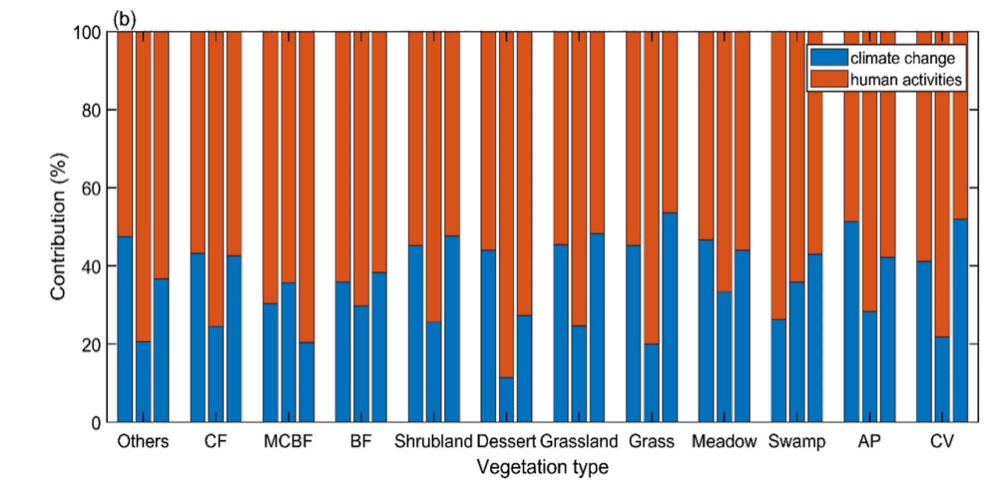
Note: Improved results minus the results of the original residual trend method.

The improved residual trend method results in a more accurate calculation of the contribution rate to climate change for the time dimension, while the space dimension is more sensitive to human activity.





Note: The names of the basins correspond to the number codes referred to in Table in Data part



With the improvement of the residual trend method, the contribution rate of human activities in the Yellow River, the Yangtze River, Southeast River and Pearl River has increased significantly

Human activities show a positive effect on the temporal dimension of Grass (26.49%) and CV (20.84%) . The negative effects of human activities were in MCBF (9.53%-18.76%) and BF (1.34%-8.16%).

Conclusions

The improved residual trend method improves the accuracy of the calculation of the contribution rate of climate change and human activities to the effects of vegetation change in the temporal and spatial dimensions, respectively.

The contribution of climate change to vegetation is 24.73%-45.56%; the contribution rate of human activities to vegetation is 54.45%-75.27% in Mainland China.

The joint effect of climate change and human activities has promoted the improvement of vegetation coverage in the Loess Plateau, North China Plain and most of South Mainland China

More attention has been paid to human activities, we cannot ignore the impact of climate change.

References

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