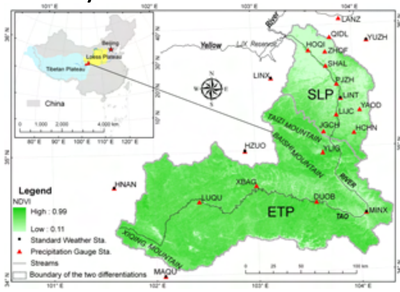
Regional Vegetation Dynamics and Its Response to Climate Change –A Case Study in The Tao River Basin in Northwest China

Changbin Li[1,2], Jiaguo Qi[2,3]Linshan Yang[1], Shuaibing Wang[1] , Wenjin Yang[1] and Gaofeng Zhu[1]

1 Key Laboratory of Western China's Environmental Systems (Ministry of Education), Lanzhou University, Lanzhou, Gansu 730000, China
2 Center for Global Change and Earth Observations, Michigan State University, East Lansing, MI 48823, USA.
3 Zhejiang University, Hangzhou, Zhejiang 310058, China

AGU FALL MEETING
San Francisco | 15–19 December 2014

1 Study area



The study area of Tao River Basin, together with Eastern Tibetan Plateau (ETP), Southwestern Loess Plateau (SLP) and some hydrometeorology stations (11 standard weather stations and 22 precipitation stations). The maximum NDVI (based on MODIS data) was obtained using the maximum-value composite method for 2010.

2 Methodologies

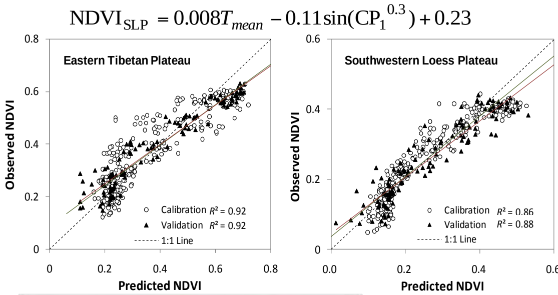
- NDVI data assimilation through a linear regression for time series extension from 1981 to 2010.
- Mann-Kendall (MK) and Sen slope (SS) trend test and Least Square (LS) methods were used to estimate the trend and magnitude of climate and vegetation time series.
- PCA and CA were used to determine the key climatic factors influencing the regional vegetation dynamics.
- Regressive module exploration between NDVI and the key climatic factors was conducted for the response of vegetation dynamics to regional climate change.

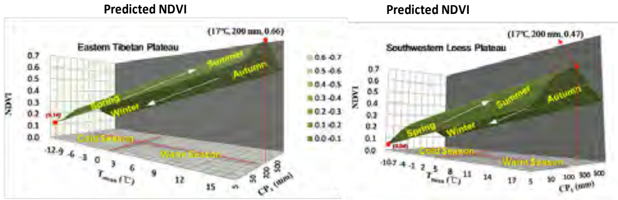
3 Results and discussion

Based on the degree of independence of the parameters (correlation analysis) and the results of the regressive module exploration, we chose mean monthly air temperatures (T_{mean}) and cumulative precipitation (mm) since December of the previous year (CP_1) as the independent parameters to predict NDVI and obtained the following:

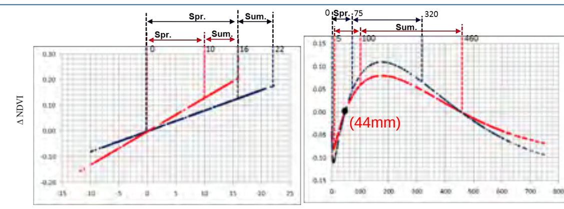
$$NDVI_{ETP} = 0.013T_{mean} - 0.08\sin(CP_1^{0.3}) + 0.35$$

$$NDVI_{SLP} = 0.008T_{mean} - 0.11\sin(CP_1^{0.3}) + 0.23$$

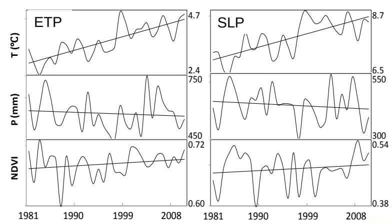




Seasonal relationships between changes in NDVI and the two key climatic factors (Tmean; CP1). The red solid circles are values of NDVI under different heat and water conditions, where the white arrows represent NDVI changes between seasons. The length of these arrows represents changeable magnitude.

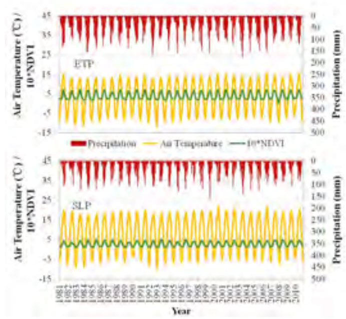


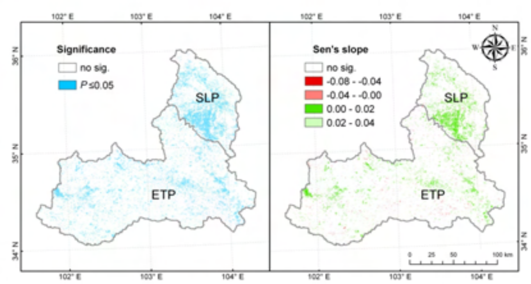
The black solid dot on the left diagram in Figure below is the cumulative spring precipitation threshold (44 mm in this case) required for NDVI to increase (changes of NDVI ≥ 0). This value represents a reasonable precipitation requirement to support spring vegetation growth.



Over the past 30 years, the air temperature and the NDVI increased while the precipitation decreased in the two areas in the TRB. Given a time scale of season or month the characteristics of the variation were different.

Given the data availability and the time period of interest in this area, NDVI remains the only choice and its subtle increase (decadal mean value of 0.03) appears to be questionable. However, if we examine its relative change, then the decadal 0.03 is substantial.





NDVI increased in some areas of the eastern Tibetan Plateau and decreased in others. Overall, NDVI increased slightly during this period in this region. In the southwestern Loess Plateau, NDVI generally increased during the study period.

4 Conclusions

The results indicated an average winter season NDVI value of 0.14 in the ETP but only 0.04 in the SLP. Primarily driven by increasing temperature, vegetation growth has generally been enhanced since 1981; spring NDVI increased by 0.03 every 10 years in the ETP and 0.02 in the SLP.

Further, results from trend analyses suggest vegetation growth in the ETP shifted to earlier-start and earlier-end dates, however in the SLP, the growing season has been extended with an earlier-start and later-end date.

The precipitation threshold for vegetation germination, measured by the cumulative spring rainfall, was found to be 44 mm for both the ETP and SLP.

Acknowledgments: This study was supported by the following grants: the NSFC Project (41001014), the Doctoral Program of Higher Education Research Fund (20110211110011), the NASA LCLUC project (NNX08AH50G) at Michigan State University, and the Fundamental Research Funds for the Central Universities (lzujbky-2014-118).