



Correlation and periodicity analysis between herbage yields and climatic factors in the Tianshan Mountain, China in 22 year periods.

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1. Correlation and periodicity analysis between herbage yields and climatic factors in the Tianshan Mountain, China in 22 year periods.

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Abstract

To analyze the relationship between herbage yields and climatic factors, 22 years of herbage yields and climate data were collected on the northern slope of the Tianshan Mountains region of western China. Using multiple regression analysis, maximum entropy spectrum analysis and cross spectrum analysis, it was clarified that fluctuation of climatic factors affected herbage yields and their periodical variation. The herbage yields were correlated significantly to the four climate factors including annual precipitation, annual means of relative humidity, absolute humidity and percentage of sunshine, but unrelated to the trend variable (the former year yield has little effects on the later) and other climatic factors. These clarified that long term variation of grassland productivity responded directly to changes of some climate factors in typical zone of arid continental climate. The results in co-spectrum and quadrature spectrum analysis revealed that the herbage yields had 4-year period similar to some moisture factors, and with 1/4 period delay. These findings demonstrated further that the fluctuation of some climatic elements (precipitation particularly) was the crucial factor affecting the variations of herbage yields of natural grassland in arid and semiarid ecosystem. The periodical change of vegetation and correlation with climate provide us a way to predict the herbage production according to the climate change, and it was important for the herdsmen to arrange predictively their animal production including rectifying their livestock population in natural grazing land and storing up the supply of forage timely for livestock use in cold season.

Our finding in periodical variation of climatic element and plant yield further demonstrated the crucial driver of some climate factors on formation of herbage yields. The same or similar quasi-4-year period in climatic element and vegetation was due to that periodical variation of climatic element (especially precipitation) directly led to the annual periodical variation of herbage yields. These were almost the same as the second period (3-4 years) of meteorological period, which was obvious in ENSO (El Nino and Southern Oscillation) (Chao, 1979; French, 1979; Huang and Li, 1992; Webb and Lauenroth, 1993; Li and Bai, 1996). These results also were supported by our long term observation (Li and Xu, 1993). Therefore, it could be concluded that under certain meteorological conditions, herbage yields of natural grasslands had the same variation periods, which resulted from climatic factors, especially periodical precipitation.

The finding that ecological response of herbage yields to climatic change usually delayed by 1/4 period was important phenomena. The results were accordant with the biological principle and ecological characteristics of variation of plant growth and yields formation (French, 1979; White and Neild, 1982; Li and Xu, 1993; Webb and Lauenroth, 1993; Espigares and Peco, 1995; Li and Bai, 1996).

Keywords: herbage yield; climatic factor; variation periodicity; maximum entropy spectrum analysis; cross spectrum analysis; multiple regression analysis; Tianshan Mountains.

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