ASSESSMENT OF VEGETATION DYNAMICS AND THEIR RESPONSE TO VARIATIONS IN PRECIPITATION AND TEMPERATURE IN THE TIBETAN PLATEAU

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ABSTRACT

There is much evidence to suggest that strong interactions between terrestrial ecosystems and climate variability exist. Referred to as the 'Roof of the World' and the 'Third Pole of the Earth', the Tibetan Plateau (also known as the Qinghai-Xizang Plateau) is well-known both for its high altitude and unique geographical features. The Tibetan Plateau is also a sensitive region for climate change due to its high altitude and large terrain. This sensitivity can be measured by the response of vegetation patterns and their interaction with climate variability in this region. Scientific research on vegetation response to climate conditions over the Tibetan Plateau is rather scarce. This research paper is a first step towards filling this gap. Time series analysis of Normalized Difference Vegetation Index (NDVI) imagery and correlation analyses are effective tools to study land cover changes and their response to climatic variations. This is especially important for regions like the Tibetan Plateau which has a complex ecosystem but lacks a lot of detailed in-situ observation data due to its remoteness, vastness and the severity of its climatic conditions. Based on the SPOT VEGETATION data and in-situ meteorological data from the China Meteorological Administration (CMA), this research aims to quantify the spatial and temporal response of vegetation dynamics to climate variability over the Tibetan Plateau. Since NDVI images are often influenced by clouds and other unfavorable conditions of observation (large viewing angles, atmospheric haze, etc.), reconstructing a cloud free NDVI time series would therefore be the first preprocessing step to facilitate the analysis of vegetation response to climate conditions over the Tibetan Plateau. A time series of 315 SPOT VEGETATION scenes covering the period between 1998 and 2006 has been processed with the Harmonic ANalysis of Time Series (HANTS) algorithm in order to retrieve the governing spatiotemporal pattern of variability. The results of the HANTS algorithm were validated with different vegetation sites in order to compare reconstructed cloud-free time series with the original series. They show a satisfactory correspondence. Our result demonstrates that the HANTS is an effective tool to remove the cloud contamination of satellite images especially for challenging areas like the Tibetan Plateau. The time series analysis also reveals the spatial pattern and temporal (both seasonal and inter-annual time scale) vegetation dynamics over the Tibetan Plateau. Results show that the spatial distribution of NDVI values is in good agreement with general climate pattern over the Tibetan Plateau. Also, the seasonal variation is greatly influenced by the Asian monsoon. The vegetation condition is usually much better in southeastern part of the Tibetan Plateau and it deteriorates gradually to the northwestern part. The inter-annual vegetation evolutions were checked by tendency correlation analysis. In general, for the entire Tibetan Plateau, the vegetation conditions have been improving with 49.87% of the total area increasing, while 29.86% of the area has been seen to decrease in the period from 1998 to 2006. However, the various land covers show different trends, among which the dominant three land covers of alpine and subalpine meadow, alpine and subalpine plain grass and desert grassland increase by 10.45%, 2.45% and 1.65% respectively. Then using a 1 km resolution land cover map from GLC2000, seven meteorological stations were selected for correlation analysis between NDVI and climate conditions which were represented with monthly data for near surface air temperature and precipitation in this research. The seasonal NDVI variations of seven land covers show some similar characteristics. They are characterized by one peak pattern. With the influence of Asian monsoon, vegetation all starts to grow from April or May and reaches the maximum in August. Afterwards, they begin to decrease. However, because of different locations with various climate conditions, the amplitude and peak value of each NDVI curve are different from each other. When considering monthly temperature and precipitation, we find that except for desert grass, all other six land covers show good correlation between climate variables and NDVI and the correlation varies according to the different land covers at different locations. However, there are certain time lags between NDVI and climate variables. A time lag of one month was found between NDVI and temperature. NDVI usually starts to grow when the temperature is above zero Celsius and reaches the

maximum a month later than temperature’s maximum. There is a lag of one to two months between NDVI and precipitation. In most cases, NDVI begins to increase after the first rain and reaches its peak value later than that of precipitation.