

DETECTING SHORT- AND LONG-TERM VEGETATION ANOMALIES IN RESPONSE TO DROUGHT AND CLIMATE CHANGE BY SATELLITE OBSERVATIONS OF LAND SURFACE

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ABSTRACT:

Terrestrial vegetation responses to regional and global climate change in long-term interactions between the vegetation and the environmental and climatic conditions, as well as in short-term interactions driven by insufficient water supply from either precipitation or from surface/ground water for a certain period. Abnormal vegetation development is reflected by anomalies in spectral properties that can be observed by satellite sensors. Particularly in data-scarce environments, observations by satellite sensors have the advantage of covering large areas and having high revisit frequency. Both vegetation index and land surface temperature (LST) have been used for long time as powerful variables to study land surface properties in many research and application fields.

In this paper, multi-spectral radiometric data (associated with land surface variables of vegetation index and land surface temperature) from MODIS are used to detect anomalies of vegetation growth both in short-term period as consequence of different drought severities over different land cover types and in longer-term (about 10 years) in relation to climate change. The study was carried out in the Tibetan-Plateau and its east low elevation basin between 2000 and 2009. The region covers various land cover type and climatic conditions from lower elevation area dominated mainly by various agricultural crops under temperate climate to grassland, shrubs in high elevation areas with arid/semi arid and cold climate, and forest in high elevation area with semi-humidity climate. The land cover types were identified using the ESA GlobCover derived from MERIS fine resolution (300 m) mode data acquired between mid 2005 and mid 2006.

The harmonic analysis based on Fourier transform technique was used to identify, remove and gap-filling cloud contaminated observations in the satellite data for each year in the dataset of vegetation index and LST. The same approach is used to model time series of all available observations to reconstruct the data records for the average year. Anomalies vegetation index and land surface temperature are detected by comparing each year with the average year. Climate variables such as precipitation, air temperature and solar radiation from meteorological stations were also used to help understanding the evolution of the drought process in short-term and the climatic variability as longer

term and to determine relationships between vegetation development and above two processes at different temporal scales.

Particular analysis was done on a severe drought event in 2006. Results showed that land surface variables responded differently as drought evolved. Thermal dynamics represented by land surface temperature showed earlier response to rainfall anomaly when comparing to vegetation photosynthetic activity. The anomaly magnitude in LST in the natural grassland in high elevation area is stronger. Also, In Tibetan Plateau grassland, slight negative rainfall anomaly and positive anomaly in LST in spring-summer has led to better vegetation growth, probably due to permafrost melting which supplied sufficient water to vegetation. Severe drought damage on vegetation occurred if rainfall and LST continuously decreased and increased for a few weeks respectively.

Analysis of yearly amplitudes and annual mean values of both vegetation index and LST derived from Fourier transform showed a positive inter-annual correlation between vegetation condition in the natural grassland at high elevation and precipitation, and positive correlation with temperature in spring indicating relatively warmer climate before the summer monsoon has made preferable conditions for vegetation growth.