Analysis of time-series MODIS 250m vegetation index data for vegetation classification in the Wenquan area over the Qinghai-Tibet plateau

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Abstract: Under the influence of climate and environment, vegetation usually has clear phenological characteristics, which can be discovered by time series data from remote sensed methods . The time series of remote sensing data provides a powerful tool to monitor and assess regional variations of vegetation. The time-series AVHRR might also be useful for land cover classification at either local or global scale, as reported in many literatures [1-6]. However, its relatively coarse spatial resolution, generally 1km or 8km, constraints it being used in a detailed vegetation investigation.

Time-series MODIS 250 m Vegetation Index (VI) datasets take some advantages compared with AVHRR VI datasets including high spatial resolution, high temporal resolution (16-day composite period), and free cost which particularly is important when we work with a large study area such as the Qinghai-Tibet plateau with an area of over 2.5 million sq km. Existing studies show that MODIS 250m data are appropriate for large scale vegetation classification mapping[7-13] using various methods they developed. However, the applicability and methodology of such data to the Qinghai-Tibet plateau remain unclear. The objective of this research is to investigate the applicability of the time-series MODIS 250 m Enhanced Vegetation Index (EVI) and Normalized Difference Vegetation Index (NDVI) datasets to vegetation classification in a typical area over the Qinghai-Tibet plateau. A combination of graphical and statistical analysis was used to examine 10-year time-series of MODIS EVI and NDVI data in comparison with vegetation type data from 99 field sites.

HANTS (Harmonic Analysis of Time Series) was used to reconstruct the VI time series data in the pre-processing stage. HANTS helps to reveal the inherent cyclical nature of the internal curves and measure

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vegetation dynamics quantitatively; it is a very effective analytical tool to characterize plant phenology.

Field sites were aggregated by vegetation types (i.e., Alpine grassland, Alpine meadow, Alpine swamp meadow, Alpine shrub), and the 10- year MODIS VI data of those sites were extracted from the original MODIS VI image by a IDL program specifically developed. The 10-year average VI value for each sample point and each vegetation class were calculated. The VI profiles of three periods (germination, maturity and senescence) were analyzed to get unique phenological characteristics for each vegetation type.

Jeffries–Matusita(JM) distance statistic was used to verify the separability of classification between specific vegetation types in the time-series VI data [14]. The JM distance between a pair of class specific probability functions is given by

$$JM(c_j,\ c_k) = \int_x (\sqrt{P(x/c_j} - \sqrt{P(x/c_k})^2 d_x \tag{1}$$

In our study, x denotes a span of VI time series values, and c_j and c_k denote the two vegetation classes. With an assumption of normal distribution, Eq. (1) reduces to $JM=2(1-e^{-B})$

where

$$B = \frac{1}{8}D^2 + \frac{1}{2}\ln\left(\left| \frac{\sum_j + \sum_k}{2} \right| \Big/ \sqrt{\left|\sum_j\right| \left|\sum_k\right|} \right)$$

and

$$D^2 = (\mu_j - \mu_k)^T \left(\frac{\sum_j + \sum_k}{2}\right)^{-1} (\mu_j - \mu_k) \tag{2}$$

In this notation, μ_j and μ_k correspond to expected VI values of two class, Σ_j and Σ_k are unbiased estimates for the class-specific covariance matrices. The JM distance, which can range from 0 to 2, provides a general measure of separability between two classes based on the average distance between their class density functions.

250m MODIS VI datasets were found to have sufficient spatial, spectral, and temporal resolutions to detect unique characteristics for each vegetation type on the Qinghai-Tibet plateau. Although all vegetations' multi-temporal VI datasets have same phenological characteristic during the whole growth season(fig1, fig 2), different vegetation types have distinguished phenological distribution characteristics at different periods (germination, maturity and senescence). Spectral separability between every two types identified by the JM distance was not very good at different growth periods, indicating all vegetation classes were not spectrally separable. According to the distribution characteristics of VI data we found, we will consider the features of the geographical distribution(slope、aspect and elevation) of different vegetation types to complete the map of vegetation classification in near future.

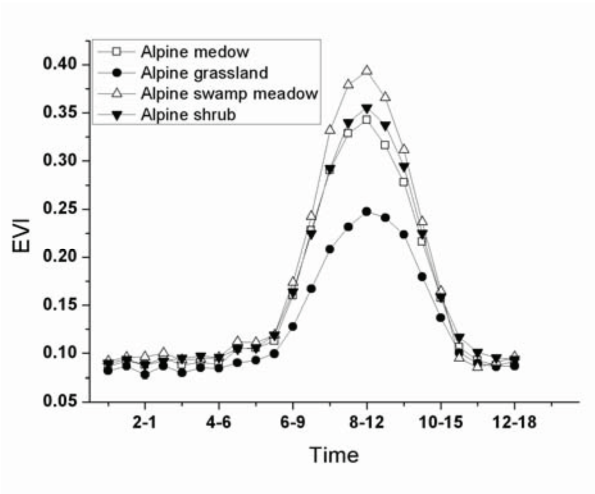

Fig .1. Multi-temporal EVI profiles (average) of the major vegetation types in Wenquan area

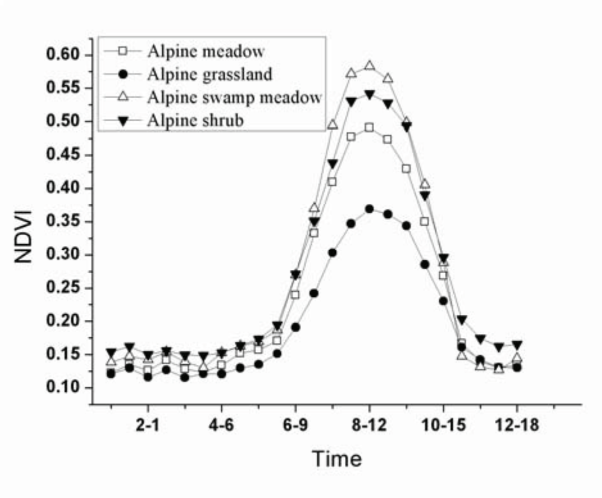

Fig. 2. Multi-temporal NDVI profiles (average) of the major vegetation types in Wenquan area

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