Spatio-Temporal Variations of Vegetation Coverage Based on EVI: 
A Case Study in Tuwei River Basin

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Abstract. Tuwei River Basin is a sensitive region of soil erosion, which located in midstream of Yellow River. The vegetation coverage is one of the most important factors to affect the amount of soil erosion. In order to analyze the dynamic change of vegetation coverage in Tuwei River Basin from 2000 to 2013, MODIS Enhanced Vegetation Index (EVI) data were used to extract the series characteristics of vegetation changes. The method for reconstructing EVI time-series data set based on the Time series reconstruction Savitzky-Golay filter was application for noise reduction. Finally, we analyzed the spatial and temporal variations of the vegetation coverage in the Tuwei River Basin. The results showed that from 2000 to 2013 the total vegetation coverage had a trend of improvement and ecological conditions were getting for the better.

Introduction

Vegetation is the connection of soil, atmosphere and water and serves as an indicator for the ecological environment change [1] which is important to global energy circulation and biogeochemical circulation of substances [2]. Vegetation coverage couples natural environmental changes and human activities, and is an essential index to describe the ecological system [3]. Study of Spatio-temporal changes in vegetation coverage is an important basis for further understanding the interactions among territorial ecosystems and the climatic systems [4]. Vegetation coverage monitoring based on remote sensing has become a major technique [5]. EVI provides improved sensitivity in high biomass regions while minimizing soil and atmosphere influences. The EVI data has several advantages over the NDVI, and is used as an indicator to monitor vegetation changes.

Tuwei River Basin is located in Loess plateau, where had been influenced by the Grain for Green Project (GGP) initiated in 1999. The GGP had grown more forests and shifted from degraded wasteland, and farmland to healthier manmade forests and grassland, which had great potential to improve vegetation coverage of the Loess plateau [6]. To understand the effect of GGP on vegetation variation in the Tuwei River Basin, the vegetation coverage will be investigated. The primary objective of this study is to analyze long term vegetation dynamics in Tuwei River Basin based on the EVI data.

Study Area

Tuwei River Basin is located in the middle reaches of the Yellow River region. The region lies within latitudes within 109°57′~110°31′E and 38°16′~39°01′N. The area of basin is 3294 km². Tuwei River Basin is deep in the landscape patterns of aeolian sandy grass shoal region and loess hilly-gully region. The terrain is high in the northwest and low in the southeast. Primary land use types are grassland, agricultural land, and unutilized land, which are accounting for more than 94%. Primary soils are Aeolian sandy soil, loessal soil, heilu soil, and alluvial soil. Climate belongs to typical temperate
continental climate. Annual rainfall is 377.4 mm. Temperature ranges from high in the south to low in the north. Annual mean temperature is 8.7°C.

Materials and Methods

In order to indicate the changes in the latest vegetation cover, MODIS EVI (MOD13) dataset was used in this research. MODIS EVI data were derived from the MODIS vegetation index product data on the website of the NASA (http://modis.gsfc.nasa.gov/) at a spatial resolution of 1km×1km, and at a 16 days temporal resolution for the period from February 2000 to December 2013.

The data have been processed, including map projection transformation, re-sampling, data format conversion and image clipping on the original MODIS EVI image by study area mask. The EVI data sets were reconstructed based on the Savitzky-Golay filter algorithm to obtain a high-quality data. Remote sensing data process and analysis were performed using Arc/Info 10.0 and ENVI 4.8 image processing software. All statistical analyses were performed using Microsoft Excel 2007.

Results

Temporal Variations

Monthly and annual variation of EVI values from 2000 to 2013 are shown in Fig. 1 and Fig. 2. Monthly mean EVI values in the study area are greater than 0.05 and less than 0.25, which indicates medium vegetation coverage in the Tuwei River Basin. EVI change presents a unimodal distribution, which increases month by month since February, peak is reached in August, and then decline quickly since October.

Annual mean EVI presents a fluctuating increasing trend in the past decade with minimum annual mean value in 2000 and maximum value in 2013, which indicates that vegetation coverage is increased in the Tuwei River Basin since 2001. The variations show a significant trend that the vegetation has been growing rapidly. It demonstrated that the lower coverage areas were decreasing and ecological conditions were getting for the better.

![Figure 1. Monthly mean EVI from 2000 to 2013.](image-url)
Spatial Variations

Figure 3. shows spatial distribution of annual mean EVI value from 2000-2013. The max values of vegetation EVI are mainly distributed in south areas and lower reaches. Spatial distribution patterns indicated that EVI is higher in loess hilly-gully region than in aeolian sandy grass shoal region. The topography and land cover are important factors of influencing vegetation EVI distribution.
Figure 3. Spatial distributions of annual mean EVI from 2000 to 2013.

Summary
EVI data were used to monitor the spatio-temporal of vegetation variation in the Tuwei River Basin. The results show that vegetation variation presents a fluctuating increasing trend in the past decade. All monthly EVI values are between 0.05 and 0.25, and EVI reaches peak in August and then decline
quickly since October. Spatial distribution patterns indicated that EVI is higher in loess hilly-gully region than in aeolian sandy grass shoal region.

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References


