Topography-Based TVDI Correction: A Case Study of Shaanxi Province (Postprint)

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Abstract

In recent years, the Temperature Vegetation Drought Index (TVDI) has been widely applied in remote sensing-based drought monitoring; however, traditional TVDI does not account for the influence of topographic factors on index accuracy. This paper takes Shaanxi Province as a case study, utilizing DEM data to perform elevation correction on land surface temperature, while simultaneously introducing the Normalized Difference Mountain Vegetation Index (NDMVI) to replace the Normalized Difference Vegetation Index (NDVI) in order to mitigate the impact of terrain relief on the vegetation index, thereby constructing a new TVDI. Four types of TVDI were constructed using land surface temperature before and after correction, as well as NDMVI and NDVI, respectively, and the relationships between these four indices and soil moisture and precipitation were analyzed to compare their accuracy in monitoring agricultural drought. The results indicate that elevation and terrain relief have a significant influence on the accuracy of TVDI for drought monitoring. Compared with traditional TVDI, the corrected TVDI exhibited an improved correlation coefficient with relative soil moisture from -0.342 to -0.711, and could more accurately reflect precipitation variation characteristics, demonstrating that the corrected TVDI can more effectively represent regional soil moisture conditions and enable more precise monitoring of agricultural drought.

Full Text

TVDI Modification Based on Topographic Factors: A Case Study in Shaanxi Province

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Abstract: In recent years, the Temperature Vegetation Drought Index (TVDI) has been widely applied in drought monitoring using remote sensing data. However, traditional TVDI does not account for the influence of topographical factors on index accuracy. This paper presents a case study on TVDI modification in Shaanxi Province to reduce the impact of topographic factors on drought monitoring accuracy. DEM data were used to perform elevation correction of surface temperature, NDVI was replaced by the Normalized Difference Mountain Vegetation Index (NDMVI) to reduce the influence of topographic fluctuation on vegetation index, and new TVDI indices were constructed. Four types of TVDI indices were constructed using surface temperature and NDMVI/NDVI before and after correction, and the relationships among these four indices and soil moisture and precipitation were analyzed to compare their accuracy in monitoring agricultural drought. The results showed that elevation and terrain fluctuation significantly affected TVDI precision in drought monitoring. The TVDI after correction of surface temperature and vegetation performed better for drought monitoring compared with traditional TVDI—its correlation coefficient with relative soil humidity increased from 0.342 to 0.711, and it could accurately reflect precipitation changes. The results revealed that the modified TVDI could effectively reflect soil water conditions and could also be used to accurately monitor agricultural drought.

Keywords: drought monitoring; topographic correction; TVDI; NDMVI

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2 Results

2.1 Temperature Correction

The temperature correction accounted for elevation effects on surface temperature. For every 100 m increase in elevation, temperature decreased by approximately 0.6°C. The specific correction coefficients for different elevation ranges are shown in Table 1. After applying the elevation correction to surface temperature data, the correlation between TVDI and soil moisture improved significantly.

2.4 TVDI Analysis

2.4.1 Dry-Wet Edge Fitting Equations Four types of TVDI were constructed: (1) TVDI_n using uncorrected temperature and NDVI, (2) TVDI_nd using DEM-corrected temperature and NDVI, (3) TVDI_m using uncorrected temperature and NDMVI, and (4) TVDI_md using DEM-corrected temperature and NDMVI. The dry-wet edge fitting equations for TVDI_m and TVDI_md are presented in Tables 4 and 5, respectively.

The fitting equations demonstrate strong relationships between vegetation indices and temperature across different time periods, with most R^2 values exceeding 0.85, indicating robust model performance.

2.4.2 TVDI Validation The validation results showed that TVDI_md (using both DEM-corrected temperature and NDMVI) exhibited the strongest correlation with soil relative humidity, with correlation coefficients ranging from -0.342 to -0.711. This represents a substantial improvement over traditional TVDI_n, which showed weaker correlations.

[Figure 6: see original paper]

The relationship between the four TVDI types and soil relative humidity reveals that topographic correction significantly enhances drought monitoring accuracy. TVDI_md consistently outperformed other variants across all elevation zones.

[Figure 7: see original paper]

At the station scale, TVDI_md demonstrated the strongest relationship with precipitation data, confirming its effectiveness in reflecting actual moisture conditions. The improved performance is attributed to: (1) DEM correction reducing elevation-induced temperature variations, and (2) NDMVI minimizing topographic effects on vegetation index calculations.

The results indicate that the modified TVDI, particularly TVDI_md, provides a more accurate tool for agricultural drought monitoring in mountainous regions compared to traditional approaches.

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Note: Figure translations are in progress. See original paper for figures.