Developing new spectral indices for karst rocky desertification monitoring in Southwest China

Yuemin Yue*[a], Kelin Wang[a], Junsheng Li[b] , Bing Zhang[b], Bo Liu[c], Quanjun Jiao[b], Xiaonan Zhang[a]

[a]Institute of Subtropical Agriculture, Chinese Academy of Sciences, Changsha 410125, China;
[b]Center for Earth Observation and Digital Earth, Chinese Academy of Sciences, Beijing 100080;
[c]State Key Lab of Remote Sensing Science, Institute of Remote Sensing Applications, Chinese Academy of Sciences, Beijing 100101, China

* Contact information for corresponding author

Email: hnyym829@163.com

Tel.: +86-731-4615235

Fax: +86-731-4612685

ABSTRACT

Southwest China is one of the largest karst regions (about 540,000km^2) in the world. Karst rocky desertification is a special kind of land desertification developed under violent human impacts on the vulnerable eco-geo-environment of karst ecosystem. The fractional cover of photosynthetic vegetation (PV), non-photosynthetic vegetation (NPV), bare soil and exposed bedrock are key indicators of the extent and degree of land degradation in karst region. The vegetation fractional cover can be estimated approximately from remote sensing with vegetation indices. However, the vegetation indices cannot be easily applicable to all land cover types. The principal objective of this study is thus to identify sources of variability in the spectra related to land degradation in karst region and develops new spectral indices for the monitoring of karst rocky desertification.

Field spectral data were collected simultaneously with the acquisition of fractional cover of PV, NPV, bare soil and exposed bedrock. The tied-spectrum technique, a spectral characteristic normalized method of subtracting the spectral reflectance values within a given wavelength range by the reflectance value at the first wavelength, was exploited for wavelength permutation; while the normalized difference vegetation index (NDVI) and linear spectral unmixing (LSU) approach were used to compare and evaluate the appropriate of the new spectral indices.

The results showed that the visible and near-infrared spectral region provided good separation of PV from NPV or bare soil and exposed bedrock, but NPV and bare soil or exposed weathered bedrock was difficult to identify. The short wavelength infrared (SWIR, 2.1-2.35μm) spectra was the best option for separation of PV, NPV, bare soil and exposed carbonate rock. The tied-spectrum technique well decreased the variability within each land cover type. It was due to the tied-spectrum minimized the contribution of intra-canopy structural variation to nonlinear photon-tissue interactions. The new spectral indices, karst rocky desertification synthesis indices (KRDSI), were then designed based on the concept of tied-spectrum and unique spectral characteristics of main land cover types. Comparing with the use of NDVI and LSU, the KRDSI was more consistent with the field measurement of main land cover fractions because it was insensitive to changes in background brightness and canopy structure. Our study indicates that KRDSI is a useful tool for karst rocky desertification monitoring with remotely sensed data and can directly derive the degradation status of a land in karst region.

Keywords: Reflectance spectra, karst rocky desertification synthesis indices (KRDSI), linear spectral unmixing (LSU), land degradation, karst, Southwest China