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The potential of Sentinel-2 spectral configuration to assess rangeland quality

Abel Ramoelo[1, 2*], Moses Cho1[, 3], Renaud Mathieu1[, 4], Andrew K. Skidmore[5]

[1]Earth Observation Group, Natural Resource and Environment, Council for Scientific and Industrial Research, P.O.Box 395, Pretoria, 0001, South Africa.
[2]Risk and Vulnerability Assessment Centre, University of Limpopo, Sovenga, South Africa;
[3]University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, P. Bag X01, Scottsville, 3209 Pietermaritzburg, South Africa
[4]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Private bag X20 Hatfield, Pretoria 0028
[5]Faculty of Geoinformation and Earth Observation (ITC), University of Twente, P.O.Box 217, 7500 AE, Enschede, The Netherlands

Abstract

Sentinel-2 is intended to improve vegetation assessment at local to global scale. Rangeland quality assessment is crucial for planning and management of grazing areas. Well managed and improved grazing areas lead to higher livestock production, which is a pillar of the rural economy and livelihoods, especially in many parts of the African continent. Leaf nitrogen (N) is an indicator of rangeland quality, and is crucial for understanding ecosystem function and services. Today, estimation of leaf N is possible using field and imaging spectroscopy. However, a few studies based on commercially available multispectral imageries such as WorldView-2 and RapidEye have shown the potential of a red-edge band for accurately predicting and mapping leaf N at the broad landscape scale. Sentinel-2 has two red edge bands. The objective of this study was to investigate the utility of the spectral configuration of Sentinel-2 for estimating leaf N concentration in rangelands and savannas of Southern Africa. Grass canopy reflectance was measured using the FieldSpec 3, Analytical Spectral Device (ASD) in concert with leaf sample collections for leaf N chemical analysis. ASD reflectances were resampled to the spectral bands of Sentinel-2 using published spectral response functions. Random Forest (RF) technique was used to predict leaf N using all thirteen bands. Using leave-one-out cross validation, the RF model explained 90% of leaf N variation, with the root mean square error (RMSE) of 0.04 (6% of the mean). Interestingly, spectral bands centred at 705 nm (red edge) and two shortwave infrared centred at 2190 and 1610 nm were found to be the most important bands in predicting leaf N. These findings concur with previous studies based on spectroscopy, airborne hyperspectral or multispectral imagery, e.g. RapidEye, on the importance of shortwave infrared and red-edge reflectance in the estimation of leaf N. In that sense, the ESA's Sentinel-2 sampling in both spectral regions has a unique spectral configuration, and a high potential to estimate leaf N which is crucial for informing decision makers on rangeland condition monitoring.