Physics and Chemistry of the Earth, Parts A/B/C

Predicting land degradation using Sentinel-2 and environmental variables in the Lepellane catchment of the Greater Sekhukhune District, South Africa

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https://www.sciencedirect.com/science/article/pii/S1474706520303776?via%3Dihub

Abstract

Land degradation is defined as the reduction of biological and economic productivity, which impedes the capacity of the land to provide ecosystem services. There is a need to move towards near real-time monitoring of land degradation using new sensors to detect degraded landscapes. Recently launched Sentinel-2 sensor presents the opportunity to collect high-resolution data regularly. Multi-temporal datasets provide crucial information to isolate evidence of land degradation from temporal changes in vegetation cover incurred as a result of climatic and phenological variability. This study applied an integrated approach involving multi-seasonal Sentinel-2 data with environmental variables (i.e. soil moisture, rainfall, slope, evapotranspiration, elevation, soil temperature, rainfall, soil temperature, aspect and albedo). A stratified random sampling approach based on dominant land cover types were used to assess land degradation. Field plots of 20 m × 20 m were setup with three 50 cm × 50 cm quadrants inside. In each quadrant, the percentage estimation of vegetation cover and Leaf Area Index was measured. The model training and validation was implemented using the Random Forest algorithm based on default parameters. The pooled model represents the dry and wet seasons combined. Results showed that pooled model had higher accuracies for Photosynthetic vegetation (PV) (R2 of 0.89, RMSE-11.46%, relRMSE-8.7%), Non-Photosynthetic Vegetation (NPV) (R2 of 0.93, RMSE-5.64%, relRMSE% 17.72) and Bare Soil (BS) (R2 of 0.92, RMSE 8.7% and relRMSE 11.46%). The pooled environmental model achieved accuracy of PV (R2 of 0.42, RMSE-20.67%, relRMSE 4.83%), NPV (R2 of 0.90, RMSE 6.50% and relRMSE 15%) and (BS R2 of 0.85, RMSE 8.64% and relRMSE% 11.5) in estimating vegetation cover.