A Novel Vegetation Index Approach Using Sentinel-2 Data and Random Forest Algorithm for Estimating Forest Stock Volume in the Helan Mountains, Ningxia, China

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Abstract: Forest stock volume (FSV) is a major indicator of forest ecosystem health and it also plays an important part in understanding the worldwide carbon cycle. A precise comprehension of the distribution patterns and variations of FSV is crucial in the assessment of the sequestration potential of forest carbon and optimization of the management programs of the forest carbon sink. In this study, a novel vegetation index based on Sentinel-2 data for modeling FSV with the random forest (RF) algorithm in Helan Mountains, China has been developed. Among all the other variables and with a correlation coefficient of r = 0.778, the novel vegetation index ($NDVI_{RE}$) developed based on the red-edge bands of the Sentinel-2 data was the most significant. Meanwhile, the model that combined bands and vegetation indices (bands + VIs-based model, BVBM) performed best in the training phase ($R^2 = 0.93$, RMSE = 10.82 m3ha−1) and testing phase ($R^2 = 0.60$, RMSE = 27.05 m3ha−1). Using the best training model, the FSV of the Helan Mountains was first mapped and an accuracy of 80.46% was obtained. The novel vegetation index developed based on the red-edge bands of the Sentinel-2 data and RF algorithm is thus the most effective method to assess the FSV. In addition, this method can provide a new method to estimate the FSV in other areas, especially in the management of forest carbon sequestration.