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| **Can SLS help with health condition monitoring of disturbed forest stands?** |
| **Introduction:**Climate changes and increasingly frequent forest disturbances might cause large-scale deterioration of health condition, which can even lead to dieback of forest ecosystems. Such processes result in changes of horizontal and vertical structure of forest stands (canopy cover openness, defoliation, degradation of tree crown). Satellite Laser Scanning (SLS) missions such as GEDI (Global Ecosystem Dynamics Investigation; NASA) and ICESat-2 (Ice, Cloud and land Elevation Satellite; NASA) provide global measurements of forest spatial structure. SLS data has been widely used to derive products focused mainly on forest height and biomass estimation, but it also offers robust metrics describing vertical structure of forest stands. We hypothesised that GEDI vertical structure parameters can be used to detect differences in health condition of Norway spruce (*Picea abies* H. Karst) forest stands. Furthermore, we investigate the potential of using GEDI time series in forest health monitoring model. **Methods:**Study area covered two national parks located in the Tatra Mountains: Polish - TPN, 211.97 km2 and Slovakian - TANAP, 742.84 km2. We used GEDI data comprised of L2A and L2B products acquired between 2019 and 2022 in growing season (01.06-30.09). Reference 3-D forest structure parameters were simulated based on ALS LiDAR point clouds (2020, TPN) in *gediSimulator* software to assess the accuracy of GEDI metrics. Classified (supervised Random Forest algorithm) Sentinel-2 (ESA) satellite imageries were used to derive healthy and standing dead forest stand mask for each analysed year. GEDI metrics were stratified into 5.0 m height classes and intersected with healthy and dead forest class areas. GEDI Canopy Cover (CC), Plant Area Index (PAI), Plant Area Volume Density (PAVD) and Foliage Height Diversity (FHD) parameter values were compared in health condition stratification classes. GEDI time series metrics located in dead Norway spruce stands were used to analyse changes of selected parameters over time.**Results:**Analyses conducted in 5.0 m height strata showed that PAI, CC, and PAVD were significantly different (Kruskal-Wallis test, 0.05 significance level) for standing dead and healthy Norway spruce stands. Mean values of these metrics were lower for dead stands compared to healthy forest (i.e. PAI: dead=1.61; healthy=2.31; CC: dead=38.3%; healthy=70.2%; PAVD: dead=0.025; healthy=0.087 for 20-25 m forest height class), indicating a degradation of dead forest canopy. GEDI time series analysis showed consistent decrease of CC and PAI parameters (i.e. CC: 2019=47.7%, 2020=44.2%, 2021=30.2%, 2022=23.2%; PAI: 2019=1.66, 2020=1.53, 2021=0.94, 2022=0.73), indicating dynamic decay of the forest stand.**Conclusion:**Obtained results confirm that GEDI laser beams can detect the differences in vertical structure of standing dead and healthy forest stands, as well as track its changes over time. GEDI metrics have potential to be integrated with other remote sensing data (i.e. Sentinel-1,-2; ESA) and fused in forest health monitoring model, which is still under investigation.  |