

Airborne small-footprint discrete-return LiDAR data in the assessment of boreal mire surface patterns, vegetation, and habitats

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Boreal mires cover high diversity in species and habitats, many of which are endangered. A need for accurate and cost-efficient vegetation mapping and monitoring of habitats exists in mire conservation, restoration and peatland forestry. LiDAR is excellent new tool for probing the geometry of vegetation and terrain. Modern systems measure the backscattered signal accurately and provide radiometric information. Experiments were carried out in a complex minerotrophic–ombrotrophic eccentric raised bog in southern Finland ($61^{\circ}47'N$, $24.18'E$). First, we tested LiDAR for the modeling of mire surface patterns and the detection of hummocks and hollows. Secondly, the response of different mire vegetation samples in LiDAR intensity was examined. Thirdly, we tested area-based geometric and radiometric features in supervised classification (RF, c-SVM, k-NN) of mire habitats to discover the meaningful LiDAR variables. The vertical accuracy of LiDAR in mire surface modeling was high: 0.05–0.10 m. A binary hummock-hollow model that was estimated from a LiDAR-based elevation model matched flawlessly in aerial images and had moderate explanatory power in habitat classification trials. The intensity of LiDAR in open-mire vegetation was mainly influenced by the surface moisture, and separation of vegetation classes spanning from ombrotrophic to mesotrophic vegetation proved to be difficult. Area-based features that characterize the height distribution of LiDAR points in the canopy were the strongest explanatory variables in the classification of 21 diverse mire site types. Actual qualifying differences in the ground flora were unattainable in the LiDAR data, which resulted in inferior accuracy in the characterization of ecohydrological conditions and nutrient level of open mires and sparsely forested wet sites. Mire habitat classification accuracy with LiDAR surpassed earlier results with optical data. The results suggested that LiDAR constitutes an efficient aid for monitoring applications. We propose the co-use of images and LiDAR for enhanced mapping of open mires and tree species. *In situ* calibration and validation procedures are required until invariant geometric and radiometric features are discovered.

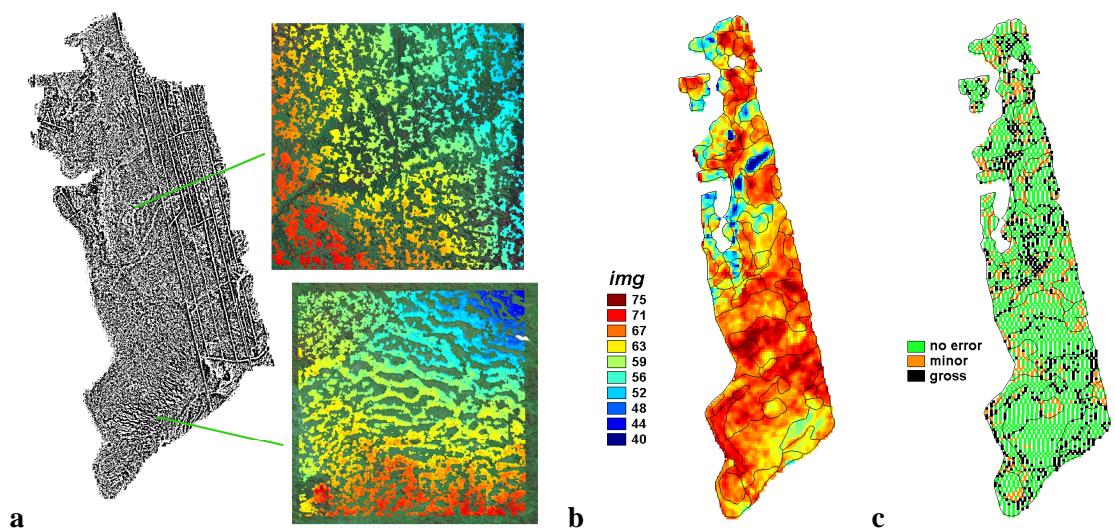


Fig. 1. (a) Binary hummock-hollow model of the 118-ha mire. (b) Intensity map for near-ground returns in 69-ha pristine mire. (c) Traffic-light-results of site type classification in a 10-m grid.