UpdATING FOrREST INVENTORYs USING LIDAR AND MULTI-TEMPOral LANDSAT DATA

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ABSTRACT

Recent advances in mass data processing of Landsat imagery, following the 2008 opening of the Landsat archive, combined with more operational applications of airborne light detection and ranging (lidar) data have offered opportunities to utilize both long time series of landscape-level change and detailed forest structure data to augment forest inventories. Lidar can provide detailed information on three-dimensional forest structure and has been utilized both for wall-to-wall and sample-based applications. Sample-based applications of lidar data offer opportunities to address particular strategic forest inventory information needs, at a given point in time, with lower costs than a full wall-to-wall lidar acquisition. Landsat data can provide required wall-to-wall coverage of reflectance data that can be combined with samples of lidar data to provide spatially extensive characterizations of vertical forest structure. Forest change and insights on successional processes can be obtained from time series of Landsat data to further inform models of forest attributes. The aim of this research is to develop capacity for making estimates of forest attributes for forested landscapes by imputing lidar-derived estimates of forest attributes with multi-temporal Landsat data and terrain metrics. Lidar-derived estimates of basal area, Lorey’s mean height, and net merchantable volume were obtained from the British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) for a study site near Kamloops, British Columbia. Single-date and multi-temporal Landsat metrics were calculated for the study area from annual, gap-free Landsat composites representing 1984 – 2014, which were produced by the Canadian Forest Service and the University of British Columbia as part of the National Terrestrial Ecosystem Monitoring System (NTEMS) project. Multi-temporal Landsat metrics included long-term means of vegetation indices, as well as variance and slope measures of vegetation indices through time, while single-date metrics included vegetation indices for a Landsat composite in the year of the lidar flight (2014). We found that imputation models improved significantly with the inclusion of multi-temporal Landsat metrics compared to single-date metrics only (Relative RMSE decreased from 35.1% to 22.9% for basal area, from 25.1% to 17.4% for Lorey’s mean height, and from 49.3% to 33.9% for net merchantable volume). Long-term means and standard deviations of vegetation indices were the most important Landsat variables when both single-date and multi-temporal Landsat metrics were included. These findings will inform future efforts to impute forest attributes with Landsat data in forested areas utilizing limited lidar coverage, and provide opportunities to update estimates of forest attributes in areas where forest inventory information is either out of date or non-existent.