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Using airborne LiDAR to study the spatial distribution of tall trees in Greater Wellington, New Zealand

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Indigenous forests cover 24% of New Zealand's land area and provide highly valued ecosystem services, including climate regulation, habitat for native biota, regulation of soil erosion, and recreation. Despite their importance, information on the number of tall trees (> 30m) and their distribution across different forest classes is scarce. We implement a high-performance tree mapping algorithm that (i) uses local maxima in a canopy height model as initial tree locations, and (ii) accurately identifies the tree top positions by combining a raster-based tree crown delineation approach with information from the digital surface and terrain models. The algorithm includes a check and correction for over-estimated heights of trees on very steep terrain such as cliff edges. Our open-source tree top detection scheme therefore provides a simple and fast method to accurately map overstorey trees in flat, as well as mountainous areas, and can be directly applied to improve existing and build new tree inventories in regions where LiDAR data is available.

We use the algorithm to create the first region-wide spatial inventory of tall trees based on airborne LiDAR measurements in New Zealand – covering the Greater Wellington region. This inventory improves the characterisation of indigenous forests for management and provides a useful baseline for long-term monitoring of forest conditions. We further use the LiDAR-derived surface and elevation models to conduct an in-depth investigation of the influence of topography and land form on tree height in indigenous forests. We develop a theoretical modelling approach for canopy height by combining climate and local topography characteristics which can be used to predict the potential heights of indigenous forests, even for unwooded areas.