**Titel:**

Urban Tree Classification in Delft, the Netherlands: Classifying Urban Tree Characteristics with Machine Learning Using Airborne LiDAR and Satellite magery

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**Abstract**

Current urban tree inventories rely heavily on time-consuming manual work and often fail to capture all trees. To effectively monitor the impact of urban trees on their environment and vice versa, an automated method for detecting and grouping trees based on their characteristics is crucial. This research aims to expand current urban tree inventories and cluster trees based on their characteristics. Existing inventories typically include species, age, and height, but trees of the same species and age can vary significantly due to environmental factors. This study focuses on a 500x600 meter area in Delft, encompassing 641 recorded trees from the municipal inventory. An automatic tree detection method using airborne LiDAR (AHN4) point cloud data combined with Random Forest classification was implemented, achieving an accuracy of 85-90%. Individual trees were identified using an existing tree segmentation algorithm, detecting 70% of recorded trees with a mean location difference of 0.71 meters and identifying an additional 460 trees, including those on private land. Despite promising results, limitations include the undetection of small trees (below 3 meters) and classification errors leading to missed detections, multiple identifications for single trees, and false positives. Geometric and reflectance features were extracted. Highresolution, 30cm, spectral images from the SuperView Neo satellites, acquired across three seasons, provided spectral features like tree color and NDVI. Overall resulting in a total of 50 features. This comprehensive inventory allows for clustering of individual trees based on geometric, reflectance, and spectral similarities using a K-means algorithm. The approach enhances urban tree inventories by incorporating new features from airborne Li- DAR and spectral images, such as tree height distribution, crown sphericity, and density. Seasonal changes from spectral images provide insights into tree behavior. These detailed features significantly improve clustering, effectively grouping similar trees together. The findings reveal that trees of the same species in seemingly similar environments exhibit significantly different characteristics. This research offers a method to enhance urban tree inventories and supports long-term studies to reveal how trees respond to urban development, climate change, and ecological dynamics. Correlating tree growth and health with specific locations and climatic conditions can aid in developing sustainable urban planning and conservation strategies.