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Sensing the forest through the trees

A data driven approach to Dutch forest monitoring using AHN

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Introduction

In the Netherlands, no primary forests remain; all existing forests have been planted and managed by humans. Since their establishment, Dutch forests have been subject to intensive management or significant anthropogenic influences. Following windthrow events in the 1970s and shifts in the economic landscape during the 1990s, the Dutch Forest Reserve network was created to monitor the natural development of forests with minimal human intervention. Today, this network consists of 59 reserves encompassing a variety of forest types. Although the original monitoring program was discontinued in 2005, it previously tracked 14 key forest characteristics across different plot levels. Wageningen Environmental Research (WENR) now aims to resume limited monitoring, but fieldwork remains costly and labour-intensive. A data-driven approach using the *Actueel Hoogtebestand Nederland* (AHN) datasets, a nationwide Airborne LiDAR dataset, could provide an alternative solution.

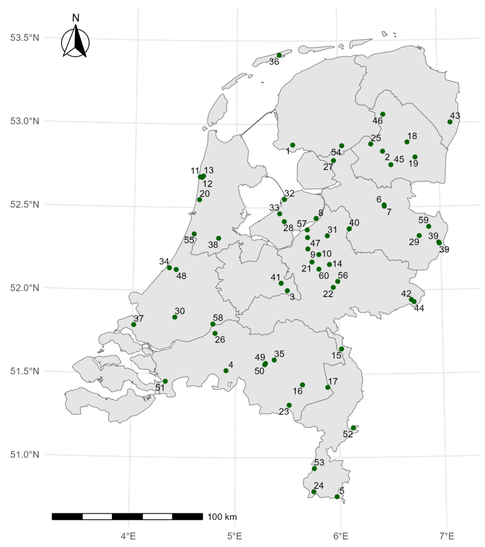

Figure 1 - The 60 Dutch forest reserves are distributed throughout the Netherlands, only Zeeland has no reserves.

Online map of forest reserves

Objective

To explore the potential and suitability of the Dutch national ALS data source (AHN) for the monitoring of forest reserve characteristics, to support the forest reserve monitoring programme. Three Specific Research Objectives (SROs) have been formulated to achieve this: (1) Identifying and evaluating potential methodologies for forest reserve characteristics. (2) Exploring the potential of the found methodologies. (3) Comparing the explored methodologies against field-collected data.

Methodology

SRO1 was achieved through a single-round backward snowballing literature review. Seed articles were selected based on predefined criteria, and the abstracts of referenced studies were screened against four selection criteria. Studies meeting all criteria were further evaluated to identify potential methodologies using a second set of selection criteria. The selected methodologies will be applied to a subset of pre-processed AHN data, divided into smaller units using Geotiles.

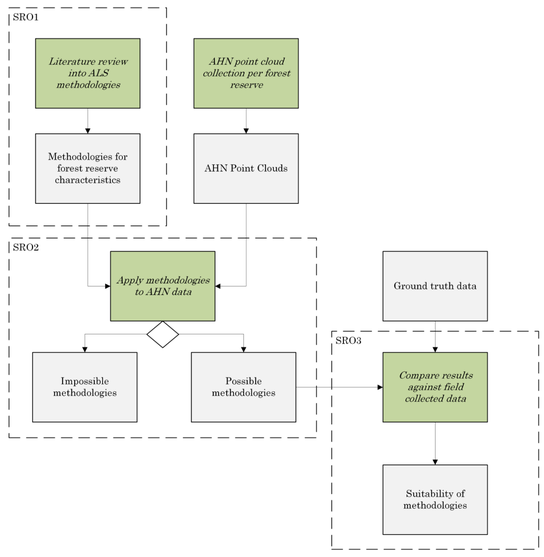

Figure 2 - Graphical overview of the methodology (to be) applied

After application, the initial suitability of each methodology for AHN data will be evaluated through expert consultation (in collaboration with WENR), visual assessment, and limited field visits (**SRO2**). Unsuitable methodologies will be discarded, while those deemed suitable will undergo further statistical assessment using recent fieldwork data from Limburg and Gelderland (**SRO3**).

AHN2/3/4/5 data will be used as needed, with a preference for AHN4/5 for single-temporal analyses due to their higher point densities. Fieldwork data is available in a DANS database, with additional reports provided by WENR.

Results SRO1

During the literature review, three seed articles were selected based on their relevance to a predefined Scopus search query. From these, 248 unique and accessible references were identified and assessed against four selection criteria. Of these, 82 articles met all criteria and were further examined to identify potential methodologies using two additional selection criteria. Nine articles met both criteria, providing methodologies for seven of the 14 forest reserve characteristics: Individual Tree Detection, tree height, tree diameter at breast height, snag (standing dead tree) detection, tree crown projection, tree structural characteristics, and coarse woody debris (lying dead trees). These methodologies demonstrated high accuracy in their respective test sets and appear promising for use with AHN data, as their required point densities closely align with those of the AHN dataset.

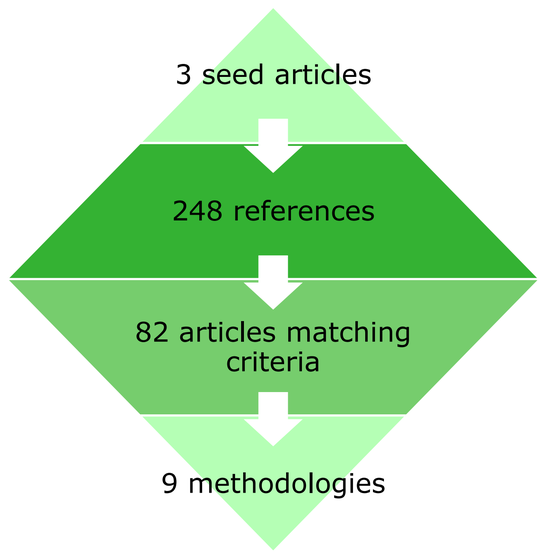

Figure 3 – Graphical representation of results for SRO1

Next steps

After the literature review, the next steps include preprocessing and subsetting the AHN data, followed by developing R scripts for analysis. **SRO2** will then be addressed by applying the resulting methodologies from **SRO1** to the AHN data and evaluating their suitability. Next, **SRO3** will be completed through statistical comparisons of model results with field data. Finally, the thesis report will be written to summarize the findings and conclusions.

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