

## LAI determination in dune vegetation: a comparison of different techniques

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### Abstract

Research was conducted in the nature reserve De Westhoek (De Panne, Belgium) in order to determine leaf-area-index (LAI) in different dune vegetation types by both direct (destructively) and indirect optical measurements. The destructive LAI determination was conducted in herbaceous and shrub vegetation types. It was found that the LAI of herbaceous vegetation ranges between 0.87 and 4.60 and the LAI of shrub vegetation between 2.25 and 3.58. Ground-based optical determination of LAI was only conducted in the shrub vegetation, by means of the SunScan (Delta-T Devices Ltd, Cambridge, UK). This indirect LAI method systematically overestimated direct LAI. Another applied optical method is the hemispherical photography (Nikon Coolpix 5000 camera). Airborne remote sensing data are used to establish a relationship between direct LAI and some vegetation indices. Based on the above established relationship a map of the horizontal LAI distribution in the nature reserve De Westhoek will be produced.

Keywords: Dune vegetation; Destructive sampling; SunScan; Hemispherical photography;  
Airborne remote sensing.

### Introduction

To be able to scale up transpiration at the leaf level to species- and stand-level, leaf-area-index (LAI) is used as a scaling factor. Leaf-area-index is defined as the single sided surface of leaves per square metre of soil ( $m^2.m^{-2}$ ). Former research (Sevenant *et al.*, 2003) showed a low LAI for dune vegetation and a large overestimation of the LAI measured by optical methods compared to those measured by destructive sampling. The main objectives of this paper are (i) to directly determine the leaf-area-index (LAI) in different vegetation types destructively, (ii) and indirectly by different non-destructive optical methods (including airborne remote sensing), (iii) to compare the applied

methods to estimate LAI, and (iv) to produce a map of the horizontal LAI distribution in the research area.

## Material and methods

Research was conducted in the nature reserve De Westhoek (De Panne, Belgium) during the 2004 growing season. The destructive LAI determination was conducted in ten plots representing herbaceous vegetation and in three types of shrub vegetation (*Salix repens* L., *Hippophae rhamnoides* L. and *Ligustrum vulgare* L.). The leaf area of the destructively sampled plots was measured using a planimeter (Li-3000, Li-Cor, Nebraska, USA). The ground-based optical determination was only conducted in the shrub vegetation, by means of the SunScan (Delta-T Devices Ltd., Cambridge, UK) and hemispherical photography (Nikon Coolpix 5000 camera). The software used to analyze the hemispherical photographs is CAN\_EYE (INRA-Avignon, France). Airborne remote sensing data are used to establish a relationship between direct LAI and some vegetation indices such as the Normalized Difference Vegetation Index (NDVI). Both a false colour digital orthophoto and hyperspectral (32 bands) data are used.

## Results

It was found that the LAI of herbaceous vegetation is low and ranges between 0.87 and 4.60, with a mean LAI value of  $2.11 \pm 0.34$ . The destructive LAI of shrub vegetation ranges between 2.25 and 3.58, with a mean LAI value of  $3.03 \pm 0.19$ . The indirect LAI determination (SunScan), with a mean value of  $5.67 \pm 0.50$ , systematically overestimated the direct LAI. The first results of the analysis of hemispherical photographs also indicate a systematic overestimation. Probably, the most important reason for this overestimation is that besides the leaf area, also woody area is measured, so the plant-area-index (PAI) instead of the LAI is measured. Preliminary results indicate that the woody area can contribute up to 64% in the PAI. First results of the analysis of the remote sensing data revealed a (quasi) log linear relationship between direct LAI and NDVI derived from false colour orthophotos ( $R^2 = 0.77$ ).

## Conclusions

The LAI of both herbaceous and shrub dune vegetation is rather low. The indirect LAI determination overestimated the direct LAI determination. Probably, the reason for this overestimation is that the plant-area-index (PAI) instead of the LAI is measured.

## References

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