The detection and characterization of broad-leaved forest canopy gaps: a regeneration perspective

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Abstract

Canopy gaps are areas of high regeneration potential and, in uneven-aged forest, gaps are therefore places of particular care for the forest manager. Nevertheless the cartography and characterization of canopy gaps are complex issues. This paper addresses the fundamental question of the canopy gap definition: what is the minimal area, the maximal height of vegetation, type of regeneration, etc? From a regeneration point of view, canopy gaps can be defined as holes in the forest cover where light conditions are suitable for recruitment. As an active sensor, LiDAR has made it possible to tackle the problems of shadows and penetration into the canopy, typical of aerial images. This study investigates the cartography and characterization of forest canopy gaps as areas of natural regeneration.

Remote sensing data are composed of leaf-off and leaf-on LiDAR high density datasets (13 points per m²) with intensity information and a point classification. Very high resolution (25cm) multispectral (r,g,b and ir) aerial images were also captured for the summer dataset. The methodology follows a number of steps: the detection of the canopy gap, the correction of this first cartography and the resultant characterization. Results are compared between leaf-off (winter) and leaf-on (summer) conditions.

The detection of gaps is based not only on height criteria but also on “canopy porosity” metrics (e.g. the penetration rate of pulses to the ground). Thresholding and OBIA approaches are then used from these height and porosity metrics. Following this first cartography, a filtering and cleaning limits step (based on several criteria including dimension and shape) was crucial. The canopy gap description comprises two parts; first, the gap is described with dimensions, shape and vegetation cover information. Secondly, the structure and stratification of the gap and the surrounding forest is characterized within an extended area delineated around the gap. This “extended” forest canopy gap can also be described with ancillary data extracted from LiDAR, image or vector database, including altitude, slope, aspect, soil, etc.

In conclusion, the development of a “regeneration potential index” based on the delineation and characterization of the canopy gaps would be extremely useful from a forest planning perspective. Mapping gaps would also enable analysis at a landscape level with regard to the stand scale successful regeneration, biodiversity and wildlife management. Furthermore, the exploitation of hemispherical photographs would be an interesting complementary issue to link regeneration and light needs.