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Microdensitometry of tropical wood using helical X-ray tomography: a proxy for dendroclimatology and forest management

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Nanowood is the latest multi-resolution X-ray tomography setup developed at UGCT, the Ghent University Centre for X-ray Tomography. It consists of an 8-axis motorized stage combined with two X-ray tubes and two X-ray detectors, specifically designed to obtain very high resolution scans as well as scans of larger objects. The system offers a large range of operation freedom, all combined in versatile acquisition routines (standard or fast scanning, tiling, helix, etc). It has a generic in-house developed CT scanner control software platform (Dierick et al. 2010) that allows full control of the scanner hardware. Reconstruction of the scans is performed with Octopus, a tomography reconstruction package for parallel and cone-beam geometry (Vlassenbroeck et al. 2007). The latest development includes GPU-based helix reconstruction, as such the scanner is suited for scanning elongated objects such as small sticks and drill cores in order to obtain 3D information on the growth rings and density from pith to bark. Since some time 2D microdensitometry is a known methodology, yet its 3D equivalent has only recently been explored. Especially in the field of tropical dendrochronology, with often difficult growth ring demarcation, the concept of microdensitometry in 3D can contribute to the study of growth cycles and the influence of the climate on wood formation. This approach can also assist in improved demarcation of growth rings for temperate wood species and visualization / quantification of wood anatomical traits such as vessels. The technique enables to compile and archive dendrochronological series, microdensitometrical profiles and in some cases vessel chronologies. Examples on limba (Terminalia superba), teak (Tectona grandis) and afrormosia (Pericopsis elata) illustrate the potential of the microdensitmetrical profiling while oak (Quercus spp.) is used to illustrate the potential of vessel quantification.

Keywords: Tropical wood; helical X-ray tomography; microdensitometry; dendrochronology; vessel quantification

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A dendroecological approach for evaluating growth and production models in Stone pine in the south of Spain

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The impacts of climatic conditions in Stone pine growth rate in drought-prone areas and their relationship with cone production have not been properly evaluated in the rear edge taking into account the differential responses to climate change of local sites, time, stands and tree conditions. In this work these responses are evaluated assessing the changes in radial growth and production of plantations of Stone pine (Pinus pinea) in Sierra Morena (Andalusia).

Dendrochronological methods and General Linear Models (GLM) of basal area increment are used to study the responses of trees to site, stand and climatic conditions. In the study area, a minimum temperature rise and a decrease in spring and fall precipitation have led to drier conditions during the late twentieth century which culminated with a sequence of severe droughts (1994, 1995, 1999 and 2005) affecting directly to Stone pine growth and production. The Principal Compound Analysis (PCA) and Pearson Correlation showed three main components in order of importance (climate, structure and physiography) related with growth and production, respectively. Comparisons with the climatic records showed that the radial growth and cone production were influenced positively by spring precipitation in the current year and the previous autumnal precipitation; and negatively by winter minimum temperature in the current year.

High growth rate was associated with tree size (dbh), competition (low density), site conditions (north aspect) and climatic conditions (high fall precipitation and winter minimum temperature). The production model showed positive relationship with crown diameter, fall-winter precipitation, and minimum winter temperature; and negative with stand density, north aspect and slope. The annual variation in production could be explained largely by the climatic conditions during the three previous years before of the collected year. The relationship between growth and climate in the three previous years could be implicated in the mature process of cones.

The growth rate and cone production of Stone pine plantations in Sierra Morena could improve their future knowledge with the study of moving correlation between climate, stand structure and fixed factors like physiographic conditions

Keywords: basal area increment, dendrochronology, Mediterranean climate, mixed models, Pinus pinea, plantation, production.

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