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New Methods to Demonstrate Wood Property Variation

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Deterministic prediction of lumber stability requires an ability to predict high-resolution, three-dimensional patterns of wood property variation within individual tree stems. Traditional methods are time-consuming and labour-intensive, so new approaches are required for efficient data collection by empirical means, along with suitable mathematical and analytical tools. Four wood quality variables key to stability prediction have been identified: chemical composition, microfibril orientation, wood density and grain orientation.

Equipment for rapidly measuring and mapping these properties in two dimensions using 30mm thick discs is under development, along with a methodology for economically serially-sectioning stems at the required intervals. To date this methodology has been used to map 50 radiata pine stems - 24 seven-year old stems (2 ramets each of 12 clones); 5 XX year old from a single family???; 20 seventeen year old ramets of a single clone. In this paper, the rationale for method development will be covered and results of the most recent set of 20 stems (all ramets of a single clone), presented and discussed in terms of within and between tree variation and implications for product performance.

Keywords: Sampling methods; product stability; wood material science

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A new process-based model of wood formation in Pinus

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New modelling developments now allow us to simulate wood formation in plantation species. In the past, tree growth models based on our understanding of tree biology have been used in commercial forestry to predict volume. Many underlying processes invoked in these models are those that also regulate wood variability. We report here on a process-based model ("Cambium") that interfaces with existing processed based models in a hierarchical modelling approach, and that is designed to predict variation in wood properties of commercial importance, and ultimately log quality, in radiata pine. The model has been written as software, and is flexible with regard to input data types, temporal resolution and stand spatial variability. Using the outputs of existing, well tested stand-level process-based growth models (including CABALA), radial pith-to-bark profiles of wood density variation and cell size are predicted at a daily time step. These profiles are then converted to a sampling interval similar to that produced by the SilviScan wood analysis system. Comparisons between actual and predicted SilviScan data allow the model to be thoroughly validated and refined over a wide range of growing conditions. Preliminary analysis of model performance is promising. Examples of how the model can be used to assess wood properties outcomes of different silvicultural scenarios, or climate futures, are presented, showing its potential to more precisely quantify levels of carbon storage in woody biomass than is currently practical, and contribute to forest management strategies.

Keywords: Cambium, CABALA model, xylem, Pinus radiata, climate change, carbon sequestration

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Decorative Wood – Properties and Quality Model

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Quality criteria can only be applied for the specific purpose for which the wood is used. The diversification of customers' demands for specific wood properties leads to a gain of sawed or cut wood surfaces which supply the fine or decorative appearance of wood products. While foresters think of tree size and form, and lumber manufacturers see large, straight and clear logs, customers associate wood quality with aesthetic characteristics. Special figures in wood have been defined as unusual grain or abnormal grain pattern that adds value to solid wood products. In Ukraine, a variety of sycamore (Acer pseudoplatonus L.), European beech (Fagus sylvatica L.) and ash (Fraxinus excelsior L.) represented by special wood anomalies like birdseye and wave grain are typical.

These valuable broadleaves tree species deliver high-value decorative wood and also special acoustical wood for the music instruments production. While traditional decorative wood surfaces face big challenges and veneer manufacturer complain about difficult markets and declining market shares, digital printing technology for wood and wood based panels with improved reproductions of natural wood surfaces show a rapid growing market share. There are evidences as well as that the final consumers are ready to pay a higher price for individual and customized wood products (e.g. furniture, interior design, floors with highly decorative wood surfaces). Additionally, from a socio-economic viewpoint sycamore, European beech and ash possessing decorative features have higher economic value for the forestry and wood technology. The research objective is focused on properties and the development of the quality model of decorative wood.

Keywords: Wood anatomy; birdseye; wave grain; wood selection; quality model

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Exploring the diversity in wood (dynamic) mechanical properties: What can we learn on affecting factors and on potential utilisations?

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A better knowledge on the diversity of wood would have implications in several domains of pure and applied research. Large databases of wood physical-mechanical properties are the pre-requisite for applying material selection method, which could allow more efficient, diversified and potentially sustainable utilisation of wood materials. They can also provide insights into the physical understanding of traditional preferences for specific woods in various cultural uses. In addition, wood diversity is increasingly taken into account by research into biomechanics and functional ecology, as properties and their microstructural / chemical affecting factors can reflect growth strategies related to taxonomy and/or biogeography.

Exploring the diversity of wood properties requires obtaining very large datasets. However, if a significant number or species have been characterised for some properties (such as density or modulus of elasticity along the grain), information is still scarce on other important aspects of wood behaviour (such as viscoelasticity and anisotropy).

The present work aims at contributing to overcome this lack of knowledge. Experimental characterisations of dynamic modulus of elasticity and of damping coefficient of many lesser-known wood species are combined with an extensive compilation of data scattered in the literature. This new "viscoelastic vibrational properties of wood" database, which covers 450 species, is linked to the CIRAD database of technological properties of tropical woods which covers 1000 species. The global dataset covers 1310 species.

Observed correlations between properties are discussed in connexion to affecting factors such as porosity, orientation of wood elements, presence of extractives. Properties distributions are compared between softwoods, temperate or tropical hardwoods, and between botanical families. The new dataset on vibrational properties could be used to select appropriate species for applications requiring specific ranges of damping.

Keywords: Biogegraphical origin; Databases; Diversity of wood; Mechanical properties; Structure-properties relationships; Viscoelastic damping

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Effect of growth rate and radial position on the natural durability of Douglas-fir

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In terms of natural durability, Douglas fir (Pseudotsuga menziesii) fame owns to the favourable characteristics of centuries-old trees harvested in old-growth North American forests. The properties of such material are susceptible to be different from those of wood coming from plantations harvested between 50 and 100 years-old. In such stands, plantation density and thinning intensity may vary: these silvicultural choices critically influence the trees growth rate. Since this parameter is known to affect some properties of the wood, it was decided to assess to what extent an increase in Douglas fir growth rate affects the natural durability of its wood. This issue is indeed poorly documented in the scientific literature.

This parameter was evaluated on standardized heartwood specimens taken from 66 trees originating from 11 stands in Wallonia (Belgium). In all these stands, the average girth of the trees ranged between 140 and 160 cm, whilst their age (from plantation) ranged from 38 to 66 years old: These stands are thus representative of very contrasted sylvicultural management practices. In the most dynamic stand, Mean Annual Girth Increment exceeds 4cm/year, whereas it is lower than 2.5cm/year in the stand with the most conservative management. In terms of tree growth, the Mean Ring Width ranges between ca 3 and 7mm. The mass losses caused by the wood decaying fungus Poria placenta were assessed according to Cen/ts 15083-1 (2005). Globally, 624 tests specimens were taken from two radial positions in each tree. Half of the specimens were taken close to sapwood; the other half enclosing the 20 years old ring, counting from the pith. The natural durability of the wood is discussed as affected by growth rate, sites, trees and radial positions in tree.

Keywords: Douglas-fir, natural durability, growth rate, radial position

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Wood Property Variations of Indian Teak Provenances

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The Indian teak provenances were clearly differentiated from the rest of the world populations by several studies. Wood property variations of Indian teak provenances from 23 geographic locations were studied with references to growth rate, heartwood proportion, wood colour, density, extractive content, lignin and anatomical variations in order to utilise the provenance variations for future tree improvement programmes. A total of 150 samples from 82 trees of various ages were collected from the natural teak populations of the moist and dry deciduous forests of 10 Indian states, viz., Madhya Pradesh, Maharashtra, Tamil Nadu, Karnataka, Adhra Pradesh, Kerala, Gujarat, Orissa, Chhattisgarh and Rajasthan. The distinct age group of the collected samples were: Age group I (upto 24 yrs); II (25-34 yrs); III (35-44 yrs); IV (45-54 yrs) and V (>55 yrs) for studying various wood properties. The analysis of variance (ANOVA) revealed that there was significant difference between provenances with respect to diameter of trees at breast height (dbh), heartwood percentage, ring width and basic density for all the age classes taken separately and together. Tree diameter at dbh of all the trees showed a positive relationship with age and heartwood percentage. Higher growth rate with mean ring width of above 4.7 mm and greater heartwood content (>90%) were recorded in trees grown in the southern Indian states like Kerala, Tamil Nadu and Karnataka. The Teli variety teak from Karnataka showed highest percentage of heartwood (about 93%) in age class II and III despite small log size. Nilambur provenance from Kerala produced large diameter logs (72.5 cm) having high proportion of heartwood (94.8%) with wider growth rings indicating high growth rate at the rotation age above 55 years. Teak from drier areas of Central India produced 10-15% less heartwood with narrow rings and darker coloured wood than teak from high rainfall (2000-3500 mm/year) areas as evident from this study. However, for a given age

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