An imputation/copula approach to benchmarking stand and individual tree growth and yield models

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When dealing with multiple species across multiple data sources collected over different points in time, traditional statistical methods are pushed to their limit. Linear and nonlinear modeling techniques were once the norm for analyzing and build prediction systems. These have largely been replaced my nonlinear mixed effects and Bayesian approaches. However, even these newer techniques have limitations, and require validation and/or benchmarking. We propose an alternative approach to modeling stand and tree dynamics using an iterative approach of imputation selection and copula sampling. In the first step, multiple imputation is used to identify a set of nearest neighbors based on tree and stand attributes. These data are used to build a copula and the copula is repeatedly sampled to obtain dynamics steps. Because the copula can be repeatedly sampled, uncertainties can be address across time and prediction envelops developed. We propose to use these prediction envelops as a benchmarking tool to assess how well statistical models are capturing forest and tree dynamics. Both short-term and long-term simulations for a variety of stand conditions in northeastern North America are compared with predictions from two statistically driven models of forest dynamics.

CalcMadeira - Validation of sawn timber calculation by the Circumscript square (Block) and Longitudinal Methods

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CalcMadeira is a software with eight modules, which estimates sawed lumbers, based diameter and height measured of trees or diameters and length of the log. The logic uses trigonometric rules that differ from optimization techniques, applied in others algorithmics. The goal of this work was to validate Circumscript Square (Block) and Longitudinal Methods. Experiments were performed with *Corymbia citriodora* trees from seeds and Urograndis Clone GG100, which were cubed and sawed. The results were compared to three softwares, CalcMadeira, SawModel/SigmaE and CutLog, which use different logics for the calculation of the sawn wood. In the 1st test, 32 pieces of lumber were sawed by Circumscript Square (Block) method and 33 pieces of lumber were calculated by CalcMadeira. In the 2nd test (operational), the sawed lumber was 136 pieces and 121 pieces were calculated. In the 3rd test (Longitudinal Method), CalcMadeira calculated 91 pieces of lumber and 93 pieces of lumber were sawed.

Could the production of extracts contribute to the resilience of the wood-based industry?

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Due to the large number of low-quality stems harvested from the hardwood forests of eastern Canada, the forest industry has been facing a decline in profit margins. One solution to this profitability problem would be to add value to the coproducts from sawmills by producing extracts such as betulin. The objective of this work was to estimate to what extent the inclusion of betulin in the traditional wood products portfolio could extend the profitability of the hardwood value chain. The profitability of a selection cut was evaluated from the sawmill perspective, followed by the evaluation of the potential financial gain of producing betulin. Finally, the potential inclusion of betulin in the value chain was assessed. Results showed that the profitability of selection cuts was very low in some forest stands. The sensitivity analysis demonstrated that, among selected costs and revenues, profit was more sensitive to variations in the value of coproducts and residues. If a fraction of coproducts volume was used for betulin extraction, it would generate enough revenue to offset the total costs. However, a major constraint for this integration would be the small size of the current betulin market. Despite that, our results demonstrate the potentially strong contribution of high value-added extracts to the profitability of the wood value chain.

Trade war in the wood pulp global market: winners and losers

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The global wood pulp market is composed by a complex web of multiple consumers and producers. Driven by economic growth, the demand for wood pulp tends to increase in the upcoming decades. However, the alarming expansion of protectionism through tariffs, quotas and other barriers to trade might change the flux of wood pulp products and impact global welfare in the long run. For instance, during the last months of 2018 the United States and China have bilaterally imposed up to 25% duty on imports of wood pulp products. We use the Global Forest Production Model (GFPM) to simulate the impact of tariffs enforced by the United State and China on international trade of wood pulp products, then we compared to a scenario without tariffs. Our hypothesis is since China and United States are among the largest importers and exporters; the trade war between them will increase global prices of wood pulp products, and therefore create opportunities for other countries to expand their markets. We discuss in detail the effect of this dynamics in key countries like Brazil, Canada, and Germany.

Contribution to modelling the growth of *Pinus radiata* with Yield-SAFE, a parameter sparse process based model

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Radiata pine (*Pinus radiata* D. Don), is one of the most important commercial conifer species in the world supporting a robust industrial production of pulp and paper, sawnwood, plywood, fiberboards, oriented strand boards, medium density fiberboards, and secondary industry products. Intensive silviculture and the genetic breeding programs of the species have improved considerably the productivity of the species. While deterministic modeling approach has been historically the way to give support to the productive forest system, changes in environmental conditions already experienced in different areas covered with *P. radiata* plantations are determining new site productivities risking scenarios for forest plantations. Modeling strategies need to include the new environmental