Forest Industries Research Centre

MCPlan – a roundwood and biomass supply chain optimisation tool

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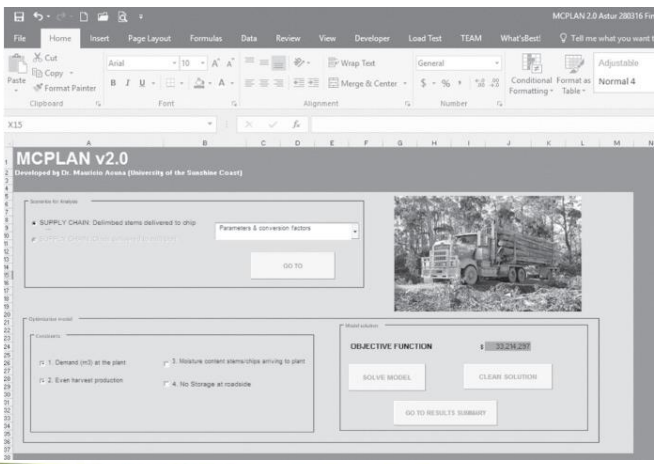
Background

Infield drying of logs and logging residue can reduce transport costs through weight reduction and, in the case of biofuels, also increase net calorific value. Drying models have recently been developed for a range of Australian plantation species. These drying models can be applied directly to planning decisions but to gain the most return from infield drying, application of a planning tool is essential. This bulletin describes the MCPlan planning tool developed at the University of the Sunshine Coast.

Overview

MCPLAN is a planning tool developed to optimize roundwood and biomass supply chains. It provides spatial and temporal solutions, which include harvest volumes per period and supply point, drying times for roundwood and biomass, and flows from supply to demand points. MCPLAN runs a linear programming model implemented in MS Excel. MCPLAN uses moisture content (MC) curves as the driving factor for the optimization of supply chain costs. It can be used to investigate the effect of MC on storage, chipping and transportation costs of roundwood and biomass delivered to mills and energy plants under different MC, operational, and drying scenarios. Geographical Information Systems (GIS) are used to get some of the inputs of MCPLAN, including the availability of roundwood and biomass per supply area, the geographical location of supply and demand points, and the average transportation distances from supply areas to demand points. Centroids from supply areas are used to calculate the distance between supply and demand points.

A basic formulation of the optimisation model implemented in MCPLAN considers two products (roundwood and biomass), multiple supply points and demand destinations for both products (pulp mill and energy plant in the same location). Decisions on the volume of roundwood and residues to be harvested and collected are made on a monthly basis (24 periods). Roundwood and residues are stacked at the roadside to reduce their transportation costs to the pulp mill and energy plant through reduction in their MC. In MCPLAN, storage of these materials at the roadside is allowed for up to 24 months, but the user can modify this nominal period that best suits the problem under consideration. The optimal drying period is provided by the optimal solution of the linear programming model and cannot exceed the maximum nominal drying period established in the model's formulation. MCPlan can also be used to optimise roundwood and residue flows without storage at roadside, which can be used as a "base case" to determine the potential gains from infield drying.



MCPLAN can be easily extended to include roundwood for sawmills, as well as dry matter content and volumetric losses, and losses resulting from fire, pests, etc. Residues can be stacked at the roadside for an equal or shorter period than the roundwood. After the storage period, the roundwood is transported to the pulp mill where it is chipped using a static chipper, whereas the residues are chipped at the roadside with a mobile chipper and then transported to the energy plant. Both roundwood and chips from residues are consumed during the same month in which they arrive at the pulp mill or energy plant and, therefore, there are no costs associated with roundwood or residue storage at the pulp mill or energy plant. Also, it is assumed that the pulp mill and energy plant demand a monthly volume of roundwood and chips from residues during the production year (Year 2 for modelling purposes). However, both roundwood and residues may be harvested and stacked at the roadside for drying from period 1 of Year 1. Thus, the optimal solution specifies for each supply area, when and how much volume of roundwood to harvest, and for how long to stack the roundwood before being delivered to the pulp mill. Likewise, it specifies how much volume of residues to collect and stack for later chipping at the roadside and delivery to the energy plant. The model displays the results in a series of matrices including:

- solid volume and tonnes of roundwood to be harvested and residues to be collected in each supply area and period
- drying times for roundwood and residues in each supply area. These are generated from drying models that include season, geographical location, local conditions, tree species, and tree dimensions, among others
- loose volume of chips from roundwood produced at the pulp mill
- loose volume of chips from residues produced at the roadside in each supply area and period
- volume of roundwood and chips from residues delivered to the pulp mill and energy plant from each supply area
- number of truckloads delivered to the pulp mill and energy plant
- energy content of chips produced from residues arriving at the energy plant
- harvesting, forwarding, chipping, storage, and transportation costs.

MORE INFORMATION

To obtain a copy of MCPlan and to find out more about its use, contact:

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More information about the mathematical formulation of MCPlan can be found at:

Acuna, M. (2017). Timber and Biomass Transport Optimization: A Review of Planning Issues, Solution Techniques and Decision Support Tools. *Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering, 38*(2), 279-290. https://hrcak.srce.hr/file/281504

Examples of the application of MCPlan:

Acuna, M. and Strandgard, M., 2017. Impact of climate change on Australian forest operations. *Australian Forestry*, *80*(5), pp.299-308.

SOSA A., ACUNA M., MACDONELL K., DEVLIN G. 2015. Controlling moisture content and truck configuration to optimise biomass supply chains in Ireland. Applied Energy 137 (215):338-351.

ACUNA M., ANTTILA P., SIKANEN L., PRINZ R., ASIKAINEN A. 2012. Predicting and controlling moisture content to optimise forest biomass logistics. Croatian Journal of Forest Engineering 33(2):225-238.