EFORWOOD

Sustainability Impact Assessment of the Forestry - Wood Chain

Project no. 518128

EFORWOOD

Tools for Sustainability Impact Assessment

Instrument: IP

Thematic Priority: 6.3 Global Change and Ecosystems

Deliverable PD3.2.5
Prototype development of stratified partial models for harvesting on case study levels

Due date of deliverable: Month 32
Actual submission date: Month 41

Start date of project: 011105
Duration: 4 years

Organisation name of lead contractor for this deliverable: Skogforsk, Sweden

Final version

Project co-funded by the European Commission within the Sixth Framework Programme (2002–2006)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	X
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Organisation of lead contractor for this draft report: Skogforsk

Partners involved: ALUFR, FCBA, FR, FVA, Skogforsk.

Researchers involved:	**Staffan Berg (Skogforsk)**
	Janine Fischbach (ALUFR) **Torsten Bensemann (FVA)** **Stefania Pizzirani (FR)** **Mikaël Poissonnet (FCBA)**

Contents

Concepts 2

Background, why partial modelling in EFORWOOD 2

Why models 2

Objectives of the report 3

Method 3

Results 4

References 11

Concepts

A general definition of **model** is "a miniature presentation of something" (Anon, 1966). In a technical and scientific context a **model** is a pattern, plan, representation (especially in miniature), or description designed to show the main object or workings of an object, system, or concept (Wikipedia, 2008). A model can in this perspective be abstract interpretations of a process (business or technical) or a physical representation of an object e.g. a log of timber. Models can be developed and used in many orders of scale as from a higher societal order to a small detail of a technological process. In EFORWOOD a complete industrial sector is modelled, which reflects business processes in The Forest Wood Chain (FWC) from forest to end consumer. This modeling has to adjust to a fairly high order of magnitude that is deemed to be relevant for the nature of the problem. In order to show detailed interdependence between input and output in the FWC chain **partial modeling** has been chosen as an appropriate tool.

Background, why partial modelling in EFORWOOD

The EFORWOOD Project develops the tool ToSIA, which model European forestry on a general level that take into consideration Economic, Social and Environmental perspectives. In this model it is not possible, with assigned resources, to make detailed assessments of parts of the chain. Nevertheless such partial modelling of parts of the chain is deemed necessary in order to penetrate different issues, as in the case of logging, timber with correct properties to the relevant industry use and favourable price or cost bracket, or to reflect the efficient use of resources.

Why models

HOW

Models provide computer aided decision support for the timber and marketing sectors by allowing the user to perform both preliminary and final costing analysis of harvesting operations. While derivation of stumpage value figures are important, also information as time use, labour costs and material costs and use is important to assess. Models might have many approaches and may stress several and certain aspects, deemed to be important to the very application it is intended for. Factors such assortment and harvest selection, quality classification, timber price and operational costs, salary rates, harvesting methods and workflow steps can all be parts hereof.

APPLICATIONS

There are several issues that can be solved by partial modelling as;

- To prognosis output from a given forest stand.
- Allocation of wood with certain properties to favourable market places.
- Allocate unexpected quantities (by Storm fellings e.g.) of wood to relevant storage or use.

- To serve as a mean for facilitating good agreements between seller and buyer.
- To aid users to select loggings system for a specific operation as well as for machine acquiring purpose.
- Planning yearly harvesting activities and use of timber assortments.
- Forest enterprise business analysis.
- Deriving standard costs for accounting purpose.
- Calculating the costs and time allocation of motor manual harvesting methods.
- Creation of regional harvest assortment and stand assortment tables.
- Harvest valuation.
- Sales of standing trees.

Objectives of the report

The title of this Project Deliverable implies there should been a ”prototype development of partial models”. As have been shown in earlier Deliverable D3.2.3. Many models are already at hand at the contributing bodies. Module and WP coordinators envisaged thus it to be more effective, with the limited resources available, to test and adapt existing models. The objective of this report is thus to describe and evaluate to which purpose models at are used or can be used for partial modelling of harvesting (logging) within Module 3.

Method

The understanding that many models at the partners can contribute to the EFORWOOD effort was common to many partners. In order to elucidate this, it was commissioned to Module 3 to make a compilation of all models used in EFORWOOD. This compilation (Fischbach, 2008) was made during early spring 2008 for the EFORWOOD week in May 2008 and covered all models used in Eforwood. The models at the participating institutes are in this report described according to their basic structures considering input, output, software.

Criteria for the compilation are as such:

- Usage in M3
- Purpose
- Type
- Input
- Output
- Where to find the model
- Link to ToSIA

Results

The compilation is demonstrated in Table 1 below.

Table 1.
Models used for partial modelling in Module 3. (1:1 -4).

Overview Table 1:1			
Model	**Institute**	**Used in Module 3 Eforwood by**	**Purpose**
ASORT	Forest Research	Robert Matthews	ASORT is a computer based model for estimating volumes of stem wood potentially available for different product specifications.
CONTQ_SS (Conifer Timber Quality for Sitka Spruce)	Forest Research, UK	Barry Gardiner	Calculation of key timber properties for Sitka spruce growing in United Kingdom and Ireland.
Holzernte – Kalkulationsprogramm für Holzernte und Holzvermarktung, Version: 7.1	FVA, Germany	Torsten Bensemann	HOLZERNTE provides computer-aided decision support for the timber harvesting and marketing sectors by allowing the user to perform both preliminary and final costing analysis of harvesting operations.
Transam V2 2006 – transam sv2.xls	Forest Research Institute of Sweden (Skogforsk), Sweden	Staffan Berg	The model calculates costs for road vehicles. The present version has common vehicles used in Sweden as default types. There is no handbook.
FlowOpt (used in Forest Research Institute of Sweden, developed by Mikael Frisk)	Forest Research Institute of Sweden (Skogforsk), Sweden	Mikael Frisk	FlowOpt is a computerized decision support tool that has been designed specifically for simplifying and optimizing planning and analysis of the wood flow. It enables enterprises, large or small, to find the lowest possible haulage costs.

Transport cost function by road	FCBA, France	Elisabeth Le-Net	Establishing the cost function (€/t per km) of road equipment dedicated to chips, roundwood and long logs depending on general conditions: mountainous vs. normal ones.
PROCOU	FCBA	Arnauld Villette Mikaël Poissonnet	Assessing the operational cost of different harvesting equipments (lumberjack, harvester, and forwarder). This software allows getting the operational cost based on the machine productivity. These costs can be presented with different units cubic meter over bark, loose cubic meter, ton depending on time measurement (productive machine hour, machine hour, work day…)
Tim-An bucking simulator (used in Skogforsk)	Forest Research Institute of Sweden (Skogforsk), Sweden	Lars Wilhelmsson	It is for predicting stem wood and fibre properties.
Skogforsks R&D tools (used in Skogforsk)	Forest Research Institute of Sweden (Skogforsk), Sweden	Lars Wilhelmsson	It is a simulation software, describing the wood properties and potential wood value, that with could be interpreted into environmental load and energy consumption unities by limited resources.
Kalkylverktyg, Cost Calculations.xls	Forest Research Institute of Sweden (Skogforsk), Sweden	Torbjörn Brunberg, Staffan Berg	Calculates cost of logging, labour, capital, fuel and maintenance.
Overview table 1:2			
Model	**Type**		**Input**
ASORT	Analytical model		Mean dbh, numbers of stems per ha, estimate volume per ha; other inputs could be derived from using stand and stock tables and other relationships to infer distributions of numbers, volume and heights with respect to dbh classes.

CONTQ_SS	Statistical model. Simple linear and non-linear model formula.	Inputs are tree height, diameter at breast height and age. These come from yield models for British grown Sitka spruce (M2).
Holzernte 7.1	It is a program package with several modules. It is based on the volume predictions using the BDAT model developed by the department of biometry and computer science at FVA. It also implements certain grading rules, based on the German standard HKS.	1. Volume Calculation • DBH distribution • Height curve models • Stem form curves • Form classes • Functions for subtracting bark volume • Functions for calculating timber volume within the crown 2. Rates for Cost Calculations • EST (Estimated Standard Time) • Performance rates • Piece rates • Premium wages • Hourly rates 3. Tree species • all economic relevant tree species in Germany 4. Quality
Transam V2 2006	Linear computations in Excel spread sheets.	Input data are investment, interest, depreciation, service and repair, taxes, speed, load distance and fuel use.
FlowOpt	It is a GIS-based user interface with an Access database and an optimization module consisting of a suite of models and methods.	• Supply and demand (company specific) • Costs for transportation (truck, train, ship) • Capacity constraints Distances (is calculated from the Swedish National Road Database.
Transport cost function by road	Type: Spreadsheet. This model aims to provide input data for cost indicator concerning transport process.	The input data are indicators like gasoil price or taxes and come from national data. Those input data give the general context of the transport movement.

PROCOU	Cost estimation based on spreadsheets.	• Fixed costs Investment (€) End value (€) Administration grant (€) Depreciation time (yr) Financial cost (equal to the interest rate) (% per yr) Insurance cost (% of investment) Other cost (€) • Working costs Fuel consumption (l / machine h) Fuel price (€) Oil consumption (l / machine h) Oil price (€) Tyre cost (€ per yr) Maintenance cost (€ per yr) Transportation cost (€ per yr) Other cost (€) • Operator costs Number of operator (per machine) Wages and charges (€) • Other costs Number of labour day (per yr) Travel advantage for operator (€) Daily maintenance car (km per yr) Cost of daily maintenance car (€ / km) Various costs (hotel, restaurant, phone,…) • Technical data Number of working days (per year) Number of service hour for the machine (h) Utilization machine rate (%) Harvester / lumberjack => Mean stem volume (cubic meter) Machine hour productivity (stem per machine hour) Forwarder => Payload (cubic meter or tons) Time per cycle (machine hour)

Tim-An bucking simulator	Simulation software	This planning tool requires input data that can be gathered from the Swedish National. Forest Survey (SLU) (over 100 000 temporary plots distributed over Sweden), the common forestry inventory standard ”Indelningspaketet” or specific inventories before harvesting. Generally the model is a "tree model”, predicting and/or simulating individual tree properties. Input data needed is generally tree diameter, tree age (at bh), tree height, latitude and altitude.
Skogforsks R&D tools	It is a computer program designed for planning stage or production control at harvesting.	This simulation software requires input data that can be gathered from the Swedish National Forest Survey (SLU) (over 100 000 temporary plots distributed over Sweden), the common forestry inventory standard ”Indelningspaketet” or specific inventories before harvesting. Generally the model is a ”tree model”, predicting and/or simulating individual tree properties. Input data needed is generally tree diameter, tree age (at bh), tree height, latitude and altitude.
Kalkylverktyg, Cost Calculations.xls	Cost estimation based on spreadsheets	Capital costs, fuel cost, depreciation, interest, productive and scheduled machine hours. Production.
Overview table 1:3		
Model	**Output**	**Where to find the model**
ASORT	The ASORT model allows additional flexibility to the user in terms of outputs that could be generated: volume up to a specified top diameter, or between two specified top diameters; estimates derived on an overbark or underbark basis; complex specifications for particular products they were interested in producing (eg--logs of fixed length with diameters constrained with certain ranges, logs of random length, or logs varying in length by fixed increments); average stump height when felling timber; detailed list of every single log cut in terms of log lengths and end diameters; estimation of volumes and dimensions of the product; estimation of quantities of offcuts and sawdust generated by conversion.	Matthews, R. W. and Duckworth, R. R. (2005) BSORT: A model of tree and stand biomass development and production in Great Britain. In: Imbabi, M.S. and Mitchell, C.P. (eds.) Proceedings of World Renewable Energy Congress (WREC, 2005), 22–27 May, 2005, Aberdeen, UK. Elsevier: Oxford, 404–409. Matthews, R.W. & Mackie, E.D. (2006) Forest Mensuration: A handbook for practitioners. Forestry Commission: Edinburgh. Rollinson, T.J.D. & Gay, J.M. (1983) Assortment forecasting service. Forestry Commission Research Information Note 77/83 MENS. Forestry Commission Research and Development Division: Farnham.

CONTQ_SS	Sawlog Density (kg/m^3), pallet log density (kg/m^3), pulp log density (kg/m^3), sawlog knot area ratio (%), pallet log knot area ratio (%), pulp log knot area ratio (%), grain angle at 1.3m height on outside of log and height at which all wood is juvenile wood. Data are output in Excel format.	Gardiner, B., Achim, A., Leban, J-M. & Bathgate, S. (2005). Predicting the Timber Properties and Performance of Sitka Spruce through the Use of Simulation Software. IUFRO 5.01 5th Workshop, Auckland, New Zealand, November 2005. The Forest Research owns the model. It is freely available in Mathcad or Java. There are no property rights. There's a source code available.
Holzernte 7.1	Volumes (m³ u.b., m³ o.b.), costs (total, per m³, per assortment, per process) in €.	Holzernte – Kalkulationsprogramm für Holzernte und Holzvermarktung, Version: 7.1 Forest Research Station (FVA) Baden-Württemberg; State forest administration use for free. There's no source code available.
Transam V2 2006	Costs per km and load, sensitivity assessment. Results can be saved as Excel files.	The model is open and free to use. Ref. Skogforsk claes.lofroth@skogforsk.se
FlowOpt	Optimized wood flow pattern, catchments areas, costs etc	Open for members of Skogforsk. Skogforsk The source code is available for members of Skogforsk.
Transport cost function by road	Cost function by equipment systems and context for chips, roundwood and long logs	The input data are own by feeders. Comparisons between countries (France, Germany, Sweden, UK): this information is in PD332. Excel file and general framework can be provide to EFORWOOD colleagues. FCBA would like to look at the results elaborated from this Excel files before publication.
PROCOU	Economic results per machine hour, per day. Share between fixed, working and operator cost. Process cost per cubic meter, ton, loose cubic meter	Description: There's an internal description (developed by AFOCEL). FCBA owns the model. There's no source code available.
Tim-An bucking simulator	It is a planning tool and with the output you can do calculations/ predictions of all properties mentioned before.	At Skogforsk.
Skogforsks R&D tools	Wood properties and potential wood value that could be interpreted into environmental load and energy consumption unities by limited resources.	At Skogforsk.
Kalkylverktyg, Cost Calculations.xls	Costs per time and production unit	At Skogforsk (Hallonborg, U. & Nordén, B., 2000. Räkna med drivare i slutavverkning. Resultat 21, 2000: von Hofsten, H. et al. 2005. Skogforsk FLIS. 2005-05-02.

Overview table 1:4	
Model	**Link of model to ToSIA framework**
ASORT	ASORT is used to determine percentage of product within each log, production forecasting, economic analysis and stand management.
CONTQ_SS ()	The model is being linked to ToSIA in order to calculate percentages of different logs going to different primary processors (M4). It is an existing model that the Forest Research is improving as part of EFORWOOD.
Holzernte 7.1–	FVA can imagine linking the model/ the results of the model to ToSIA. FVA could create an interface between Holzernte and the output of results at the moment possible as csv-file format. It is not a new model, but a model which you can use without making changes in EFORWOOD.
Transam V2 2006	The possibility to link the model/ the results of the model directly with ToSIA exists. This link could be established by transformation of excelfiles into ToSIA. It has been used for partial modelling of indicator input. As such you could use it without making changes in EFORWOOD.
FlowOpt)	The possibility to link the model/ the results of the model directly with ToSIA exists.
Transport cost function by road	No direct link is foreseeing with ToSIA. This model has been established for EFORWOOD. It could be improve for M4-M5 transport process. EFORWOOD gives the opportunity to put down existing work.
PROCOU	There's no plan or possibility to link the model/ the results of the model directly with ToSIA. It is an existing model which was adapted/ improved in the framework of EFORWOOD.
Tim-An bucking simulator	No comment.
Skogforsks R&D tools	No comment.
Kalkylverktyg, Cost Calculations.xls	No direct Link.

References

Anon. 1966 .Webster's Seventh New Collegiate Dictionary. Thomas Allen & Sons Limited, Toronto, Ontario.

EFORWOOD. 2006. D3.2.3 SI-data for harvesting operations based on 3.2.1 and 3.2.2.

Fischbach, J. 2008. Summary of all models. 2008.04.29.

Wikipedia. 2008. http://en.wikipedia.org/wiki/Models Sept 16th 2008