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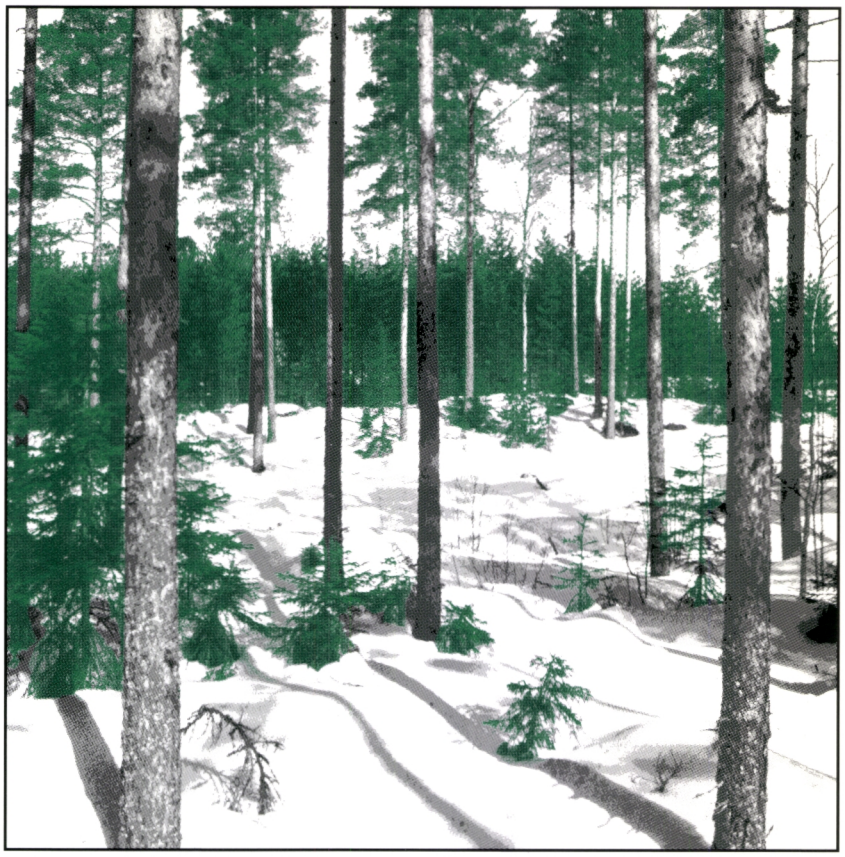

MELA Handbook
1996 Edition

Markku Siitonen, Kari Härkönen, Hannu Hirvelä,
Jari Jämsä, Harri Kilpeläinen, Olli Salminen and Maarit Teuri

HELSINGIN TUTKIMUSKESKUS - HELSINKI RESEARCH CENTRE

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Siitonen, M., Härkönen, K., Hirvelä, H., Jämsä, J., Kilpeläinen, H., Salminen, O., and Teuri, M. 1996. MELA Handbook 1996 Edition. Metsäntutkimuslaitoksen tiedonantoja 622. The Finnish Forest Research Institute, Research Papers 622. 452 p. ISBN 951-40-1543-6, ISSN 0358-4283.

The MELA Handbook describes the MELA System and its use. MELA is a forestry model and an operational decision support tool for integrated forest production and management planning designed for the Finnish conditions. The first versions of the system date back to the late 1970s and to the analysis of long term timber production possibilities at the regional and national level on the basis of sample plot and sample tree data of the Finnish National Forest Inventory. Now the system integrates into the same synthesis (or optimization problem) both the forest level production planning and the management planning of individual stands in forestry units of different size and of a large number of multilevel domains. The system can be applied stand-alone or as a forest management planning module in the forest information system. In the Handbook, the background of the system is first reviewed (Part 1, Introduction to the MELA System). First Touch (Part 2) helps with hands-on examples to get started in a short tutorial how to use MELA. Part 3, MELA User's Guide, is a reference manual. MELA Cookbook (Part 4) shows how to solve various practical forest management problems. The Appendices contain detailed instructions for experienced users, such as the descriptions of MELA system files, records and parameters, besides a collection of examples.

Keywords: forest management planning, forestry analysis, decision support, stand and tree simulation, forest and stand level optimization, linear programming
Authors' address: The Finnish Forest Research Institute, Unioninkatu 40 A, FIN-00170 Helsinki, Finland.
Publisher: The Finnish Forest Research Institute; Project 3002. Accepted by Matti Kärkkäinen, Research Director, on 5 December 1996.
Distributor: The Finnish Forest Research Institute, Unioninkatu 40 A, FIN-00170 Helsinki, Finland. Tel. +358 9 857051, Fax +358 9 625308.

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Hakapaino Oy, Helsinki 1996

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Preface

The MELA System is the realization of our attempts to provide a holistic paradigm and the corresponding tool for forest management planning in Finnish conditions. The initial versions of MELA were developed in the research projects of the late Dr. Pekka Kilkki in the 1970s. The development from a research instrument towards the end user product, including the MELA Handbook, was started in the early 1990s. Today, the planning approach aiming at the effective production and management of forests by means of alternatives, objectives and the multiple level synthesis seems most actual - and not only in Finland.

The key pages of the MELA Handbook date back to the discussions and experiments with the Lithuanian and German colleagues in 1994. Those explorations and the international seminar and summer school "Large-scale Forestry Scenario Models: Experiences and Requirements" at the European Forest Institute in 1995 revealed the interest and the potential viability of MELA applications outside of Finland. The MELA Team prepared the Handbook in 1995-1996. I wish that this documentation in English would be useful for our clients in Finland and make our methods and experiences known abroad.

The MELA Version 1996 may not be the finished end user product making forestry analysis everyman's right as we thought in the 1970s - nor the Handbook short, comprehensive and free from errors. Today's forest data and models do not justify all the detailed analyses the software as such would do. Data availability and future uncertainties put the ultimate limits to the analyzable problems and the reasonable regulation of forest resources. On the other hand, the current MELA and the Handbook will comprise a firm basis for forestry analysis and forest management planning. MELA is a powerful tool for practical forestry, forest research and education. Potential applications range from the everyday decision support to the learning of the general relationships of forest resource dynamics and the multiple dimensions of forestry far beyond the driving forces of everyday forest management. MELA will, as well, serve as an operational framework for further and deeper efforts and advances in data, models, methods and technologies for future forestry analysis.

Further on, we should see various natural, economic and social circumstances in different countries and regions, the apparent scarcity of the forest resources with respect to their multiple benefits, and the resulting analysis needs as driving forces toward still more general methods and comprehensive analyses in forestry. By the mutual sharing of our experiences we could grow stronger in the analysis capabilities and consequently be able to help our clients to do a better job - deeper understanding of the potentials and making better decisions in the management of the forest resources. The conditionally open and regulable future of managed forests is a promise and a challenge for forestry modeling and analysis.

MELA is the result of collaboration, besides the endeavours and efforts of the MELA Team during the last two decades. Forest management planning experts and scientists in Finland have offered their expertise and help in the different stages of our work. I want to mention especially the integral role of Dr. Juha Lappi, Dr. Tuula Nuutinen and Dr. Risto Ojansuu for the development of MELA. Dr. Lauri Valsta read the manuscript and made important comments. Our chiefs at the University of Helsinki and in the Finnish Forest Research Institute gave us a chance and they had patience to wait for the result.

I extend my sincere thanks to all concerned.

Helsinki, 2 December 1996

Markku Siitonen

MELA Handbook User's Guide

MELA Version 1996

The MELA Handbook 1996 Edition describes the MELA System in December 1996. The Handbook covers several individual subjects in one package dealing with MELA and how to apply it.

The MELA Version 1996 is not compatible with earlier MELA versions. The users of the earlier versions should notice the changes, for example, in the file formats, in the names of MELA programs, commands and parameters, in the definitions of variables, and make relevant changes in their own applications.

In the next major release of MELA, changes in forest models, model interfaces, forest management operations, decision variables and in the details of several individual routines and system functions should come true.

We would appreciate your feedback very much. Your experiences in the use of the MELA System and your opinions and suggestions concerning the MELA Handbook will help us to improve our methods and products in the future. See the MELA customer response sheet at the end of the publication.

How to Use the MELA Handbook

The MELA Handbook is the general documentation of the MELA System and its use for forest management planning and forestry analysis. It is intended for end users and application designers - a tutorial for the potential ones and a manual for those with more experience. The tutorial, the reference manual, the user's guide and a collection of deep technical details packed into one book - the public notebook of the MELA Team - is a compromise. The multitude of contents reflects the fact that the paradigms, the problems being solved and the solution technologies are deeply interdependent in forestry analysis and forest management planning, from backgrounds, theories, methods and their implementations to the analysis process itself in practice.

In spite of all the complexity in details, the reader should never forget the simple and clear basic principle applied here, the generation of alternatives and the selection of the fittest ones, and its operationality, even if many tricks and details are needed to make it come true. The generally defined details just create the versatility of the system.

The readers of the MELA Handbook are assumed to be a heterogeneous group of persons with different backgrounds and interests, from end users (forest managers, forest owners) to teachers, application developers (researchers, analysts) and system developers (including the MELA Team itself). Their applications vary from the management of the individual stands of a forest holding to the strategic forest policy questions at the national or multinational level. By solving various problems, the users require information about distinct details. Indeed, a

dedicated manual would be needed for every single application, besides this general introduction. The Handbook as such will never make anyone an expert. It can at best lead to the first steps of practical exercises in forestry analysis and forest management planning with the MELA System.

The MELA Handbook consists of the compact main text and the appendices.

- Introduction to the MELA System (**Part 1**) is a review about the backgrounds of MELA.
- First Touch (**Part 2**) helps to get started in a short tutorial how to use MELA.
- MELA User's Guide (**Part 3**) is a reference manual.
- MELA Cookbook (**Part 4**) shows how to solve various practical forest management planning problems.
- The **Appendices** contain detailed information and instructions for experienced users, such as the descriptions of the system files, records and parameters. Appendix H provides a comprehensive set of **examples** in the order of the calculation steps.
- **Text references**, **a glossary** and **an index** complement the documentation.

Some details are intentionally repeated in various contexts.

Novices and end users, at least, should begin from First Touch (Part 2). The hands-on instructions and exercises there should - following a basic course in forestry analysis - satisfy the needs of most end users, who use MELA in well defined environments and who are not yet interested in deeper details or backgrounds. First Touch should also prepare the readers to the other parts of the Handbook and for the generation of their own, more ambitious applications. Part 1, Introduction to the MELA System, explains the backgrounds. Users should then select the details relevant for their own needs from Parts 3 and 4 and the Appendices.

In the Handbook, MELA is presented as a stand-alone system. The MELA programs (MELASIM, for stand level simulation, and MELAOPT, for integrated forest and stand level optimization) are here used directly via the MELA interface. As well, MELA users can build their own interfaces or embed MELA programs as a part of their own information systems where MELA serves as a forestry analysis and forest management planning module. The MELA Handbook should support also those MELA application designers, who write their own user instructions.

The number of potential issues and details worth of being touched in the Handbook proved wider than possible in practice. The **interest and feedback of the readers** will probably be the only way to select the relevant materials for the future versions of the MELA documentation. Do not hesitate to contact the MELA Team if you need further information or if otherwise unresolvable problems occur. There are also plenty of details in the Handbook that are mentioned just reminding their existence in the MELA System; further information in such cases will be delivered by the MELA Team.

It is assumed that the readers of the MELA Handbook have the JLP User's Guide (Lappi 1992) always at hand.

Document conventions

Following typographic conventions are used in this book:

Example	Description
MELASET.PAR	The uppercase, bold text indicates file names.
SIMULATE	The uppercase, plain text indicates MELA commands, parameter names, and symbol definitions.

```
SIMULATE application forestry_unit[,forestry_unit] problem
```

The general syntax of commands, parameters and symbol definitions is shown in boxes in Courier.
The bold text shows the obligatory parts of syntax, while the plain text refers to the optional parts.
Items shown inside the square brackets might be repeated (notice that the brackets must not appear in the actual commands and definitions).

```
* A parameter definition on one input line
YEARS 1 11 21
```

Examples are in intended boxes in Courier.

In the examples of the Handbook, short and unillustrative parameter values are only for the compatibility with the operating systems that are not capable of processing longer file names than 8 characters.

Notice also the specific exponential expressions in MELA solution and summary reports. Bigger values than 7 digits are expressed by the notation $a*n$ where a is a numerical value and n is 3 to 9 referring to the number of zeros to be added to the value a. For example, 12345*4 should be interpreted as 123 450 000.

Part 1

Introduction to the MELA System

What is MELA? Why is it like it is? Why the forest level synthesis on the basis of management options of stands - and why the details up to the individual trees in stand simulation? How will MELA be developed in the future? Part 1 is simultaneously a short introduction to forestry analysis and to the MELA System.

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Part 1

Introduction to the MELA System

1.1 Background

1.1.1 Forestry Analysis and Forest Management Planning

The key problems when deciding the use of forest resources are:

- what are the expected production potentials of forests over time and how they depend on human activities and external factors, and
- how to manage forests in order to meet the multiple needs of people and societies now and in the future.

When considering any given activity, one should be aware of the factors and consequences affecting the decision in question. In forestry, when deciding the national forest policy or the management of an individual forest stand, attention needs to be paid to the forest resources and their growth potentials, the goals of forest owners, the demand for forest products, the costs of operations, the general exploitation rate of forests and the intensity of silviculture, the goals for national forestry, and the whole physical, economic and social environment of the forestry unit over time.

Planning means here the analysis of future potentials, decisions and operations taking into account the pertinent factors and their interactions. Planning is needed, for example, in complex decision situations and in regulating such decision objects as national or enterprise's forest production over time, by charting the production and decision potentials, by selecting effective solutions, and by resolving conflicting demands. Even if the principal interests in forest management decisions have a short time horizon, more far-reaching studies have to be carried out to ascertain the sustainability of forestry. In forestry, the interest horizon may reach one century in timber production or even more for other products because of the long production cycles. Therefore decisions can be based only on uncertain assumptions on future needs and potentials.

When using computational methods, knowledge describing discovered or supposed dependencies is utilized in the form of models. The variety of models needed in forest management planning reaches from natural processes to human activities and economy.

Advances in data processing have allowed the development of powerful synthesis methods and tools, such as the MELA System (Kilkki & Siitonen 1976, Kilkki 1987, Siitonen 1983, 1993, 1994a and 1994b) discussed here, and consequently the increasingly versatile and detailed analyses of forest production in the broad sense.

1.1.2 Development of MELA

The first attempts to apply mathematical programming to forest management problems in Finland date back to the 1960s, when the integration of physical production and economic aspects, computer-based methods, simulation and linear programming (Kilkki 1968, see also Kilkki 1987), and dynamic programming (Kilkki & Väisänen 1969) were introduced inspired by the American models of that time. The detailed data of the Finnish National Forest Inventory (e.g. Tomppo & Siitonen 1991), and the regular estimation of the regional allowable cut gave a basis for the Finnish development of planning methods.

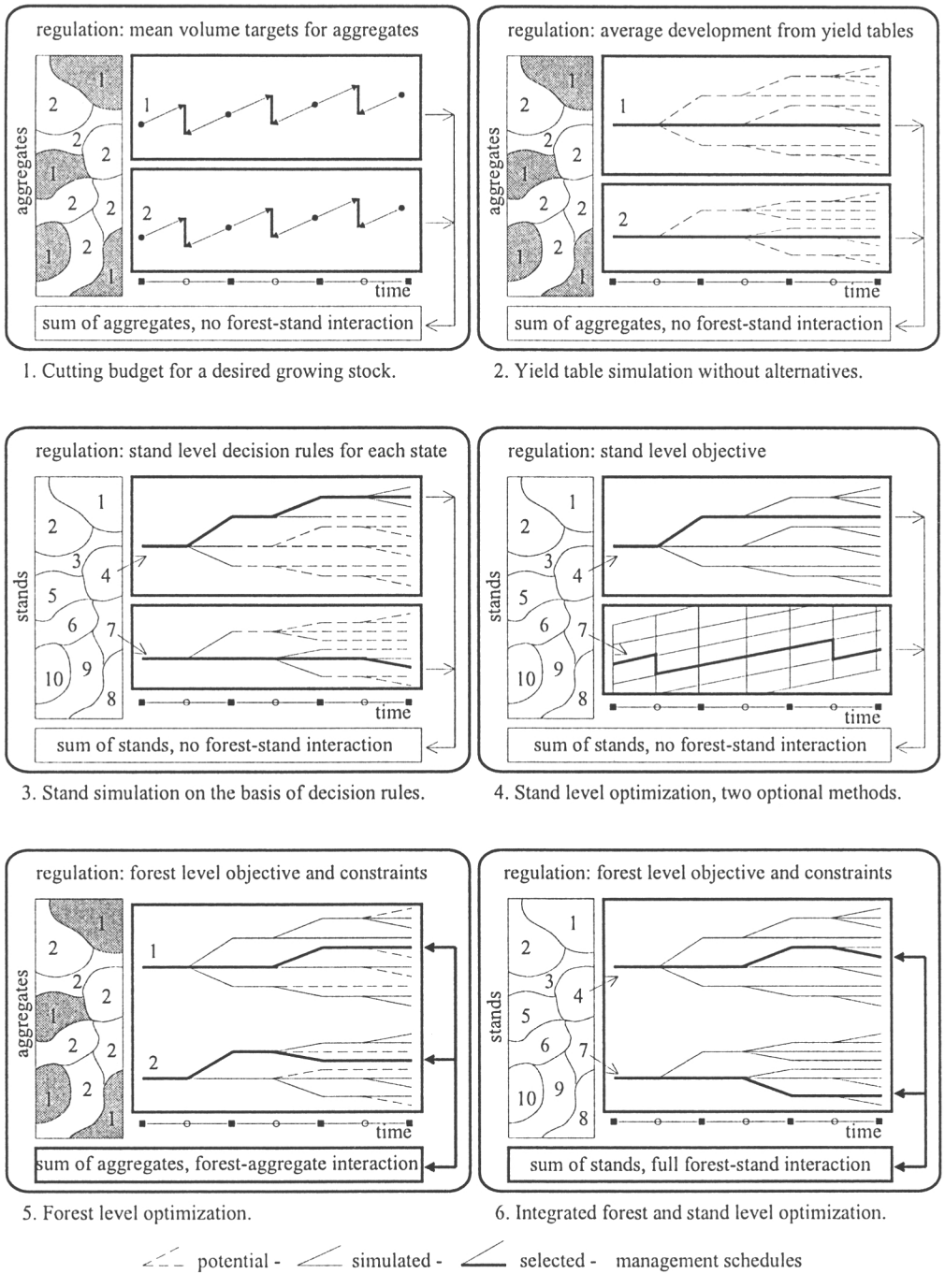
The experiences showed the way from the traditional forest level cutting budget (e.g. Kuusela & Nyyssönen 1962) to a broader and deeper view on forest management planning and forestry analysis:

- **Integration of forest level production planning and stand management optimization into multiple objective synthesis**. In spite of all the traditions, analyzing the interdependent parts of forestry separately, for example, stand level optimization without forest level aspects (e.g. Siitonen 1972) has less relevance as a planning method in decision situations where strategic aspects at the forest level are also important. Forest level analysis based on sole stand level simulations turns out to be difficult (or usually impossible) to control, if more than one forest level constraint should be simultaneously obeyed (Kilkki & Pökälä 1975). Forest level optimization based on the management options of stands (Kilkki & Siitonen 1976), and an open (or user-defined) decision problem supported by a large choice of optional decision variables (Kilkki et al. 1977) offer an universal way to manage the various and multiple objectives occurring in forestry. See Figure 1.1 for a schematic comparison of some forest management planning methods.

- **Stand management options as an endogenous factor subject to forest level objectives.** The simulation of alternative management schedules for individual stands provides a relevant way to describe the variation and the future development potentials of forests (Kilkki & Siitonen 1976). All the stand management options in the form of the stand management schedules become endogenous factors subject to the forest level objectives in the integrated forest and stand level optimization.

- **Individual trees in stand simulation.** Individual trees are needed to describe the details and discontinuities of forest processes, for example, the effects of treatments on the tree distribution in different types of thinnings, or the dependence of timber prices on stem characteristics.

- **Automated simulation.** The simulation of management schedules has to be automated due to the large number of stands in practical analysis (Siitonen 1983).



1. Cutting budget for a desired growing stock.
2. Yield table simulation without alternatives.
3. Stand simulation on the basis of decision rules.
4. Stand level optimization, two optional methods.
5. Forest level optimization.
6. Integrated forest and stand level optimization.

Figure 1.1. A schematic comparison of some model-based forest management planning methods with regard to data aggregation, management options and stand-forest interactions over time.

- **Optimization as a synthesis tool.** Rather than just finding true optima, optimization should be primarily understood in forestry analysis as a powerful tool to select effective solutions with several simultaneous conditions (or performing the synthesis over forest resources, goals, physical production, economic aspects, efficiency, etc., over time). In fact, true optima over time seem irrelevant in forestry due to the multiple uncertainties of natural processes and the changing social and economic situations, for example.

- **Hierarchical forestry units and integration of decision levels.** There are often several decision levels and their members (ecological zones, administrative regions, forest management categories, etc.) in practical decision situations to be included in the synthesis (Lappi 1992, Nuutinen 1994, Lappi et al. 1994). Mutual dependencies and synergies in forest production call for the integration of the separate analyses and the conventional decision levels into the same synthesis, such as strategic and operational, or stand and forest levels.

- **Conceptual level and automation.** The conceptual level of planning and analysis can be raised, for example, by an automation of repeated trivial steps (where human interaction is less crucial), by a powerful user interface, and by analysis designs. If the parameters of the utility function are not completely known in advance, the iterative use of linear programming (LP) proves to be a versatile and computationally feasible method in solving large-scale hierarchical multiple objective decision problems (Lappi 1992). In the automation of the planning procedure, one should also be aware of the learning process character of analysis and planning. One computationally optimal solution may be far from all the information actually needed for the decision under consideration.

- **Platform for applications and development.** The selection of upper level solutions (or performing forest level synthesis) from the lower level options (or the management options of stands over time) on the basis of decision makers' actual preferences, is a universal and simple paradigm for planning. Several strategic and operational forest management problems can be solved as variations of this basic theme. The modifications may appear, for example, in the scope of the problem, in the variables of the actual utility function, in the length of the planning horizon and the resulted calculation periods in different decision situations, and in the size and complexity of the hierarchical structure of the forestry unit. An existing planning system, on the other hand, provides an operational platform for additional aspects of synthesis and for further development efforts and advances in data, models, methods and technologies.

- **Production planning paradigm.** If we call "products" all what we have in or get from the forests over time, for example timber and conserved forests, then several forest management problems can be understood and solved by means of production planning just taking into account resources, human needs, and characteristic production cycles. The universality requirement for the synthesis tools implies getting beyond the everyday driving forces or philosophies of forest management.

- **The role of computing.** Computers and software engineering play a key role in the development of forest management planning methods. They have made synthesis (or optimization) methods feasible for solving larger, more detailed and also new problems. Today we can solve 1 000 times larger problems with workstation computers than the hundreds of management schedules two decades ago. The trends in computing capacity

promise to make today's heavy experimental systems computationally and economically feasible before their future implementation in forestry practice.

For textbooks about the international state-of-the-art in forestry modeling and the use of linear programming in forestry, see Chapter 4.8.

1.2 MELA System

1.2.1 Introduction

MELA is a forestry model and an operational decision support system for solving problems related how to manage forest stands in order to achieve the overall (usually forest level) goals for forestry in each particular decision situation. Generally speaking, MELA is the realization of our attempts to provide a holistic approach and the corresponding tool for forest management planning in Finnish conditions. MELA stands for the Finnish word "metsälaskelma" meaning broadly "forestry analysis tool", instead of the traditional "cutting budget" for just deciding the allowable cut. The Finnish word "MELA" literally refers to "the hand-held steering paddle of a row-boat".

The first experimental versions of MELA appeared in the middle of the 1970s. The system was developed to integrate forest level production planning and the management planning of individual stands into the same optimization problem. The analysis of long term timber production potentials at the regional and national level was based on the sample plot and sample tree data of the Finnish National Forest Inventory (Kilkki et al. 1977). Now the system is capable, besides the conventional forest and stand level analyses, to manage also hierarchical forestry units, see Figures 1.3 and 1.4.

The MELA System can be regarded as an upper level decision model consisting of lower level models describing forests, natural processes, forest production and its economy with the details of individual trees and forest stands. The MELA System should be considered as a framework for gathering and managing relevant information for forest management planning (e.g. forest resources, forest models, and goals for forestry) from the stand and tree levels to decisions concerning the whole forestry unit.

1.2.2 Methods

1.2.2.1 Principles

The methods applied in MELA (see Figure 1.2) are

- to simulate automatically a finite number of feasible (e.g. biologically, technically, ecologically, economically, socially etc. sound and acceptable) management schedules for the stands over time, and

- to select from these options simultaneously both a production program for the whole forestry unit and the management for the stands based on the actual (or hypothetical) goals of the decision maker.

The available management schedules define the search space of the optimization for each individual decision problem (see Figure 1.3).

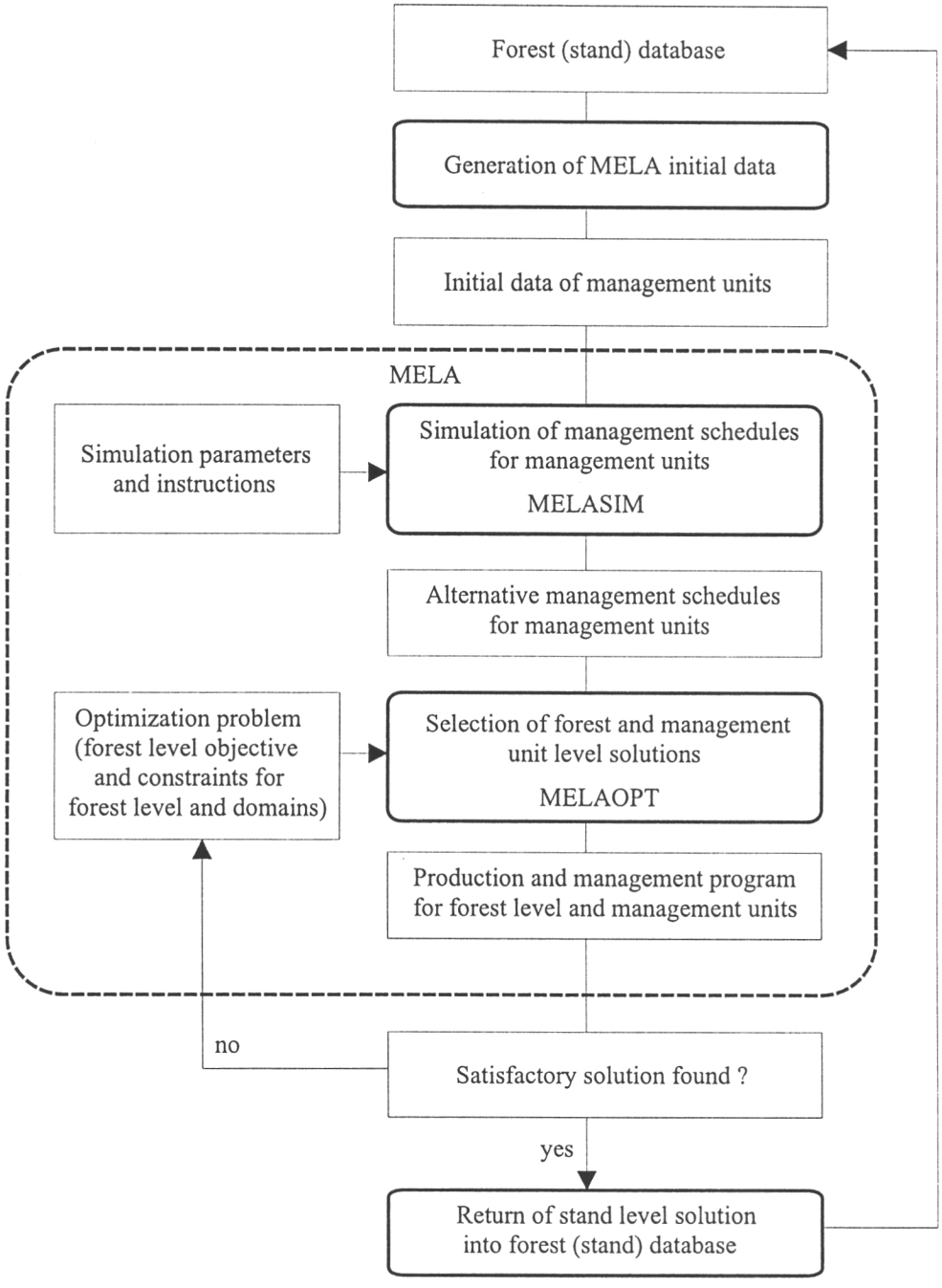


Figure 1.2. The iterative use of the MELA tools in the search of a production and management program for a forestry unit.

The methods are based on the general assumption, that the natural processes in forest stands - and consequently the development of forest resources - can be predicted, and the limited number of management schedules describes the future potentials of forests with sufficient accuracy and relevance concerning the decisions under consideration. Relevant forest resource data and forest development, forest management and forest economy models are also required to accomplish any analyses.

Forest data and models have a great influence on the planning results and their relevance. In the interpretation of the results and in the evaluation of the methods, one should make the difference between the actual data and models and the general simulation-optimization principle being applied in MELA.

1.2.2.2 Simulation of stand management options

The aim of the simulation phase is to produce a finite number of management schedules (or optional "yield tables") for each stand in order to predict the future development possibilities of a single forest stand. All the management schedules of the stands represent the management and production possibilities of the whole forestry unit. See also Chapter 3.4.

Forest resources are described in MELA by all the stands or by a representative sample of stands, depending on the size of the forestry unit, the problem being solved, and the computing capacity available. The stands may be grouped in advance into management units in order to reduce the size of the optimization problem. A management unit consists of one stand or a set of homogeneous stands with regard to the present stand characteristics and the expected future management and development. A management unit is described in the simulation by one or more sample plots and the growing stock on the sample plots by sample trees. The number of sample trees may vary from one to the whole tree population of the management unit. The sample plots represent the spatial, tree species etc. variation within the management unit or the actual stand. In the simulator, the management units (sample plots and sample trees) are described by a three-level data structure (see Figures 1.4 and D.3).

Sample plots and sample trees have to be furnished with the site and tree variables necessary for further calculations. The main simulation variables for trees in the current simulator version are number of stems/ha (that each tree represents), tree species, diameter, height and age. These simulation variables are transformed into volumes, timber assortments and values etc. using respective general models. See Appendix D.3.

The simulation of management schedules for each management unit consists of states and events. Events are natural processes (e.g. ingrowth, growth and mortality of the trees) and human activities (e.g. cuttings, silvicultural treatments, drainage of peatland, fertilization, and changes in land use). For details, see the EVENT parameter in Appendix B.2. Branching of the simulation (see Figure 1.3) is caused by several optional events in the same state.

The development of the growing stock is predicted using the sample trees of the sample plots. A set of detailed models based on individual trees describing natural processes, human activities (or treatments), timber prices, costs, management instructions etc. is utilized. For example, the growth of the trees is predicted by using stem diameter and height increment models. The current statistical models are based on the 5-year increment measurements of

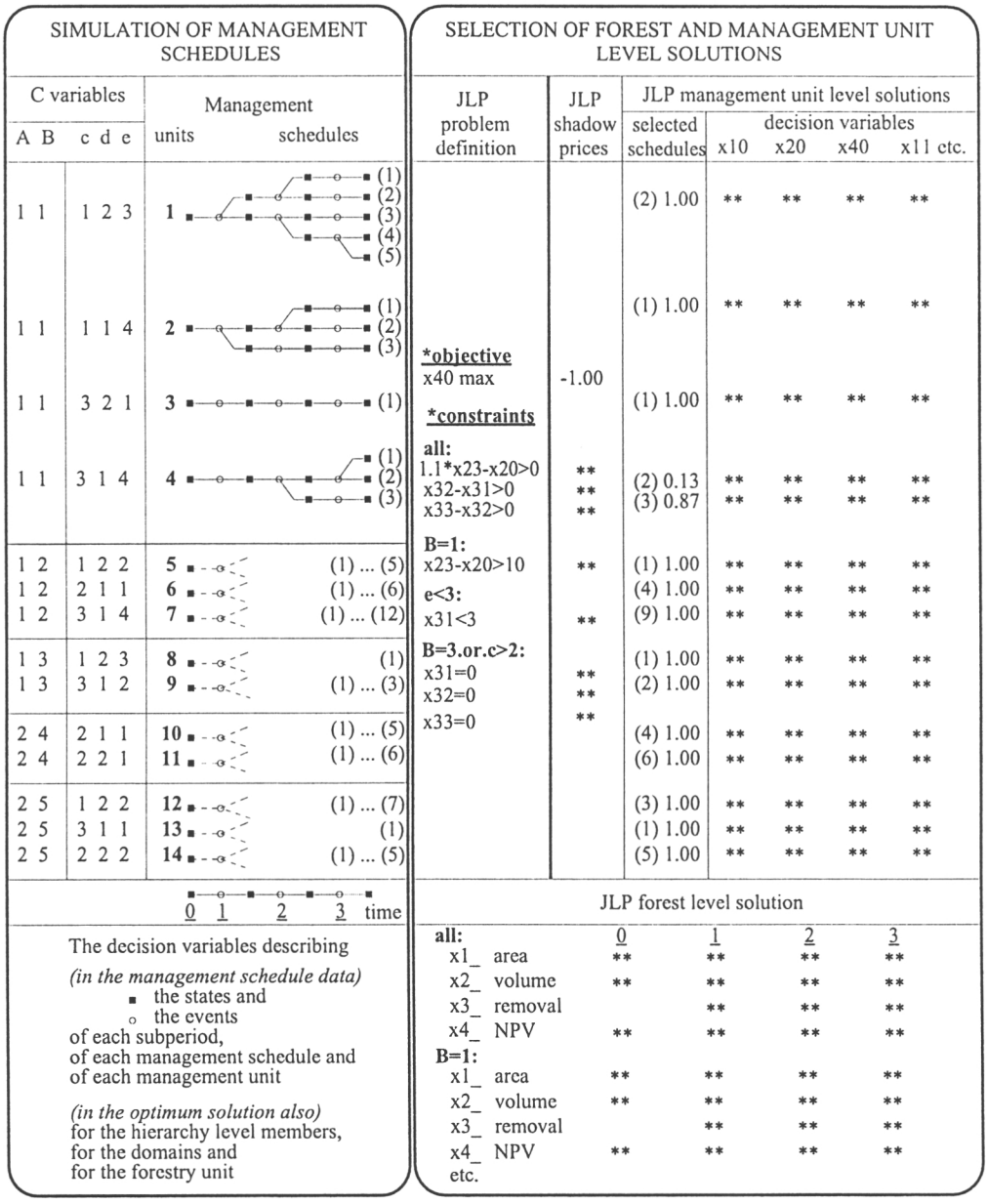


Figure 1.3. An overall scheme of the MELA analysis in a hierarchical forestry unit.

the sample trees of the National Forest Inventory in the 1970s. Increment of diameter, for example, is a function of tree species, diameter and height of the tree, basal area of the stand, site type, geographical location, etc. (Ojansuu et al. 1991). Tables for volume and timber assortments are obtained from stem curve models as a function of tree species, diameter and height (Laasasenaho 1982). The value of the stems is calculated from timber assortments and unit prices. The total figures of the sample plots and further of the management units are obtained as sums of the trees.

The development of the trees is predicted on the basis of the characteristics of each tree and the sample plot. The feasible treatments are selected on the basis of the average characteristics of the management units, but the simulation is carried out on each individual sample plot.

Only the expected values of the models are used in the simulation. The stochastic variation in natural processes, for example in the growth of the trees, has not been taken into account. However, the detailed and accurate initial description of the simulation objects and the processes and avoidance of improper aggregation are supposed to diminish possible biases.

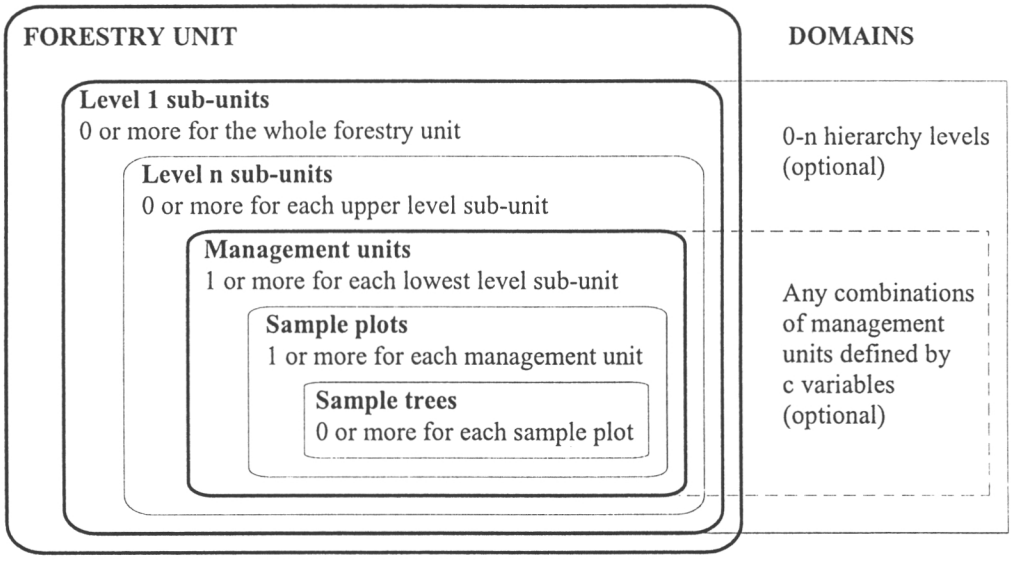


Figure 1.4. The hierarchical structure of a forestry unit with optional domains.

The automated branching of the simulation is controlled by general decision rules and dedicated simulation instructions for each management unit. There are available a large number of parameters to define application dependent options, for example, the length of the calculation period and the sub-periods, and the unit prices for each timber assortment (see Appendix B.2). The choice of events for each application is provided by user-supplied event definitions. Besides the simulation of ordinary management schedules, the pre-simulation option updates the growth of trees in the input data and the re-simulation option repeats the simulation of the management schedules selected in a forest level solution. For the calculation of the net present value, the simulation of each management schedule continues after the calculation period until the end of the current rotation period.

A selection of user-defined simulation variables and aggregated decision variables at the management unit level, and the simulation instructions of the management schedules are stored in files for the selection phase and further analyses. There are available for storing approximately 1 000 decision variables for each sub-period in the current version, for example, volume, increment, drain and cutting removal by tree species and timber assortments, value, areas of different treatments and land categories, gross income, costs, net income, net present value discounted with different interest rates, etc., see also Example 2.2 and Appendix D.4.

Sampling of stands over forest area and using moderate calculation periods reduce effectively computing by decreasing the number of management schedules and by minimizing the size of optimization problems. User-programmable event definitions and the simulation of only feasible management schedules have the same effects besides facilitating the generation of different applications.

1.2.2.3 Integrated forest and stand level optimization

In the current version of MELA, linear programming is applied to select simultaneously forest (production program) and stand level (management option) solutions. For the details of the dedicated linear programming software (JLP) and the optimization problem, see Lappi (1992). A LP solution gives one efficient management policy from the management schedules. Multiple objective problems without explicit utility function are solved through the iterative use of LP, analysis of the primal and dual solutions and regulation of the constraints for the forestry unit and the stands. See also Chapter 3.5.

The "built-in" constraints of JLP, for example the area constraints and the domains, reduce the memory needs of the actual LP problems compared with general LP packages. Constraints for domains, easy constraint definitions, a control language, subroutine access allowing automated matrix and report generation directly to and from the JLP memory, pre-compiler for flexible generation of versions, etc. are available in JLP in addition to the large problems and the computational efficiency. The marginal analysis of the JLP solution (shadow prices, cost of increase, cost of decrease, etc., see Lappi 1992) gives useful information about the solution.

The optimization problem is open in MELA. Actual JLP problems are given in user-supplied problem definition files. Any of the stored decision variables over the calculation period (hundreds in total) and their linear combinations are available as optional decision criteria (objective or constraints of the optimization) both for the whole forestry unit and for the domains (any combinations of stands, overlapping if required, defined by the JLP c variables of the management units, see Appendix D.2). The decision variables describe the state and the development of the forests, as well as forest production and its economy and efficiency over the whole calculation period. The optional decision variables make it possible to solve various planning problems depending on the needs of the decision makers. However, surprisingly small number of effective decision variables may be enough for actual syntheses.

The size of the JLP problem is minimized by taking into the JLP memory only the variables referred in the optimization problem. The JLP solution as such comprises, for example the summary of the decision variables for the domains referred in the problem definitions, the list

of the management schedules selected in the JLP solution, and the shadow prices for the constraints. In the MELA report, a summary of all stored decision variables is generated from the selected management schedules for monitoring the solution in details. A selection of results including the simulation instructions and a summary of stand level information from the selected management schedules are stored for further analysis and transfer to other programs.

The JLP software is embedded in the MELA optimization module as a subroutine and controlled by MELA commands and MELA parameters. In the optional JLP mode, JLP commands are available for interactive use.

1.2.3 MELA User Interface

The MELA programs are controlled using commands and parameter definitions given on input lines. MELA user interface routines take care of the interpretation of input lines, run-time parameter management, different language versions, hierarchically nested parameter files, file management and file naming based on command arguments, generation of loops from command arguments, and the management of hierarchical forestry units (see Figure 1.5 and Chapter 3.2).

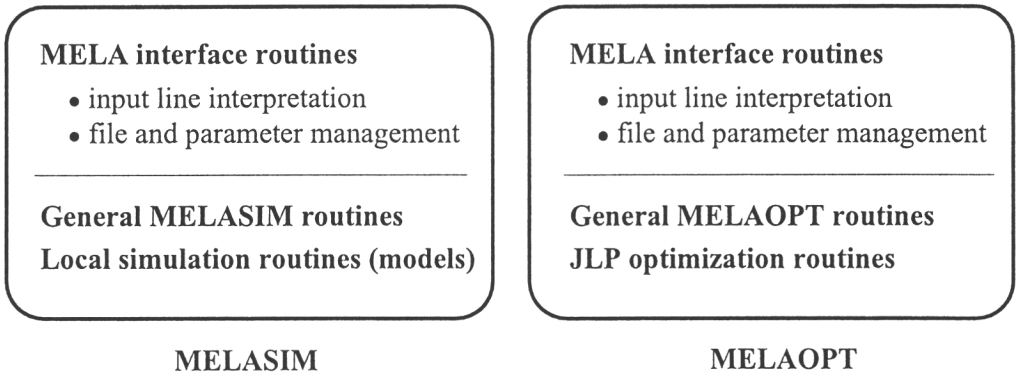


Figure 1.5. The general structure of the MELA programs.

1.2.4 Computational Aspects

Simulation is the most time consuming step in the calculations while computer memory sets size limits to optimization tasks. The idle computer time outside the working hours suits well for larger simulations. The size of optimization tasks depends on the number of management schedules and the number of decision variables in the JLP problem. The latter one is due to the number of sub-periods and constraints. The scarce computing resources need to be allocated in accordance with the problem being solved.

Minimum capacity requirements for small strategic analyses (less than 1 000 management units) are, for example, an Intel 80486 family processor with an 8 Mb memory and a 100-200 Mb disk. Workstation computers with a 32 Mb or larger memory and several Gb disks are used in national level analyses in the Forest Research Institute, and for stand level analyses in forest enterprises. - Software written in FORTRAN 77 has proved to be portable to MS Windows, OS/2, VAX/VMS, and several UNIX environments.

The trends in computer capacity and prices seem favorable still further. The maximum size of test problems solved today are illustrated by the materials of more than 100 000 management units, 2-3 millions of management schedules in total with ten or so decision variables in one optimization problem (a 64-bit Digital Alpha AXP3000/600S server, 128 Mb). The computer memory appears to be clearly the limiting resource in larger optimization problems. The increasing computing capacity can be allocated to broader and deeper syntheses, larger data, more complex structure of forestry units, faster runs, etc. depending on the problem being solved.

1.2.5 Application Types

The applications of MELA fall into four overlapping categories: research projects, strategic analyses, integrated stand and forest level analyses, and updating of forest resource data. Besides the regular determination of the regional cutting possibilities, the large scale applications of MELA include two rounds of national timber production analysis in Finland since the middle of the 1980s (The Forest 2000 Program in 1986, The Presentation of the Revised Forest 2000 Program in 1992). The national level calculations of the third generation are carried out in 1996-1997. MELA is installed by clients in state, company and private forestry as the forest management planning module of their own forest (stand) information systems in Finland. The first international pilot projects, in Baltic countries, were started in 1994-1995. See also Part 4.

1.2.6 Further Developments

The experiences up to now reveal that the current MELA version may finally be reaching the critical mass in substance, versatility and applications. The contributory factors include production planning paradigm, simultaneous forest and stand level synthesis, detailed and automated simulation of forest processes, open hierarchical decision problem, integration of conventional decision levels as well as physical production and economy, and sufficient capacity for practical analysis and planning tasks.

In the on-going regional and national analysis we intend to include transportation costs from forests to the mills (in addition to the costs of logging and extraction), other uses of forests than timber, land use allocation questions, etc. into the synthesis. For example, we shall calculate the regional trade-off curves between timber production and other uses of forests assuming different production technologies (such as the prohibition of clear cuttings and the protection of old forests). The calculations will be based on the data of the eighth Finnish National Forest Inventory (FNFI) finished in 1994 (Salminen 1993). The multi-source information of the FNFI on pixel level (interpreted from Landsat information, digital maps and

the FNFI field measurements, see Tomppo & Siitonen 1991) should be useful, for example, when planning results are presented on large-scale maps over the whole country.

The next steps of the system development will comprise the finish of the prototype like character of the current system towards a true product. Besides the project tasks mentioned above, supplements to synthesis (such as the indicators of ecosystem state and dynamics), new or improved forest models (natural processes including timber quality, stand management, production, and economy), preparing for international applications by separating general (simulator and optimization framework) and local (actual data and models) system components, and publishing the module and interface definitions, need to be accomplished. In fact, the MELA programs should be put together with the decision support system components (graphical user interface, GIS and maps, economic short term analyses, for example) to constitute a forest manager's toolbox (see e.g. Nuutinen 1994).

1.3 Conclusions and Visions

The detailed forest level syntheses are suggesting more options and a more dynamic way of thinking in forest management than restrictions and formal regulations traditionally applied in Finland. There seems to be more alternatives and freedom of choice at reasonable costs in organized forest management compared with the concepts based on more narrow-minded analyses. Learning to avoid inappropriate or unnecessary measures may also raise the efficiency of forestry, for example, by setting the ignorantly bounded forest resources available for other uses. These conclusions are, of course, highly dependent on the local resource and ownership conditions.

Lately, during the last decades, other forest products than timber have emerged among the explicitly expressed goals for forestry, turning emphasis from timber to the other benefits of forests. For example, how much land (and forests) should be reserved completely out of human activities? What kind of human activities and effects can nature stand? These claims manifest the scarcity of nature as a resource and the need of more effective forest management in the sense of the overall utility. They may also suggest a re-thinking in the management of forests and a new allocation of timberlands. No equilibrium has been reached so far.

The stand level applications of the MELA System in the 1990s seem to prove a breakthrough of the multiple objective synthesis paradigm also in practical forestry, besides large-scale strategic analyses in Finland. The local case-by-case methods of forest management planning are being replaced by more universal tools making deeper and broader syntheses possible in each particular decision situation based on more detailed information. Besides the usual problem solving, the planning system also transfers research results to practical forestry as well serves as a platform for new aspects in synthesis and for further development efforts and advances in data, models, methods and technologies. The universality requirement for the synthesis tools implies also getting beyond the everyday driving forces or philosophies of forest management.

Tens or soon hundreds of thousands management units, actual stands or items of a sample, are fitted in a single optimization problem, to say nothing of the decomposition of problems, the sampling and the aggregation of data, and trends in computing capacity. The lack of synthesis tools and computing power is no more a valid excuse to refuse from strengthening the information infrastructure for forest management, such as reliable data and relevant models, and from solving practical forest management planning problems. For example, the quantitative facts about the existing lands and forest resources with their future potentials, the estimates of human needs, and the syntheses covering the forest production as a whole should constitute a basis for resolving today's conflicting demands in forest management.

Strategic forest policy questions as well as individual stand management decisions have a common basis in the management of forest resources in a satisfactory way, even though there are differences in such details as the scale and the time horizon. The selection of the upper level solutions (or performing forest level synthesis) from the lower level options (or the management schedules of stands over time) based on decision makers actual preferences, is a universal and simple paradigm for planning. Several strategic and operational forest management problems can be solved as variations of this basic process.

The future of managed forests is conditionally open and controllable by human activities and numerous uncertainties have to be taken into account in decisions concerning forestry. The upper level synthesis from the optional lower level "management schedules" furnished with standard variables, or the simultaneous regulation of the whole and the details, gives a more comprehensive characterization of the future of forests than the conventional predictions or scenarios of the "probable" development. If applied in multinational scale, local information in this framework may originate from any source or software just able to produce relevant future options. The level of aggregation and the number of hierarchical levels may vary region by region from one or few prepared scenarios for each region to the management schedules of all the sample stands, depending on the available information and computing resources, and the ambitions of the analysis in question.

According to our experiences, the methods applied in MELA constitute a valid and operational paradigm for the analyses on potentials, operations, options and trends in forest production and management from forest holdings to national level, and also larger scale if local information production (data and models) can be organized.

The multiple future uncertainties and the unpredictably changing human needs may challenge the simple interpretation of sustainability in forestry and make the search of optima for long periods and for eternal management regimes irrelevant. Instead, the iterative process of forest resource, growth and drain monitoring and forest management planning supported by forest research and modeling seems to provide an operational framework and a dynamic information base for the practical forest resource management also in changing conditions and under uncertainty. This means that at any given time or in each new decision situation an effective combination of regulation (or production, management and preparation) and adaptation is searched for the foreseeable needs of people and societies, within the framework of the existing forest resources, their predictable future potentials and the decision criteria considered important.

Part 2
First Touch

First Touch is a beginner's guide introducing the basic steps of MELA analyses and the integrated forest and stand level synthesis paradigm. Everyone should study First Touch and do the exercises. For further examples, sample runs and results, see Part 4 and Appendix H.

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Part 2

First Touch

2.1 MELA in Short

MELA is a forestry model and an operational decision support system for solving problems related to how to manage forest stands in order to achieve the overall (usually forest level) goals for forestry in each particular decision situation. MELA integrates forest level production planning, stand management optimization and goals for forestry over time into a hierarchical multiple objective optimization problem.

The MELA System consists of two main parts (see Figures 1.5 and 3.1):

- an automated stand simulator based on individual trees in Finnish conditions, and
- an optimizer including the JLP optimization software with hierarchical constraints,

both wrapped into an interface module.

A typical MELA task consists of some or all of the following (iterative) steps (see Figures 1.2 and 4.1):

- generation of stand and individual tree level input data,
- generation of application dependent parameters and instructions for simulator,
- simulation of feasible management schedules for stands over a desired calculation period,
- formulation of the optimization problem at the forest level on the basis of the user-supplied goals,
- selection of the forest level solution and the management of the stands based on the optimization problem (synthesis),
- re-simulation of the management schedules of the forest level solution (if non-stored details are required),
- return of stand level results into stand database (in stand level applications), and
- interpretation of results.

Several strategic forest policy and forest production planning questions as well as individual stand management problems can be solved as variations of this basic process. The modifications may appear, for example, in the scope of the problem, in the variables of the actual utility function, in the length of the planning horizon and the resulted calculation periods in different situations, and in the size and complexity of the (user-defined) hierarchical

structure of forestry units. These modifications are largely facilitated by the variety of optional decision variables combining the state of forests, physical production and economy over time.

Besides the regular determination of the regional cutting possibilities, the large scale applications of MELA include two rounds of national timber production analysis in Finland since the middle of the 1980s. According to the results, the Finnish forest resources as such allow a remarkable increase of cuttings besides other uses of the forests, if the silvicultural intensity of the 1980s is kept. The national level analysis of the third generation is being carried out in 1994-1997. New analysis products include regional production possibility frontiers between timber production and set-aside areas under different management strategies.

Computerized models and methods implemented in the information systems make the operational use of research results possible in practical forestry. MELA is used by clients in state, company and private forestry as a forest management planning module in their forest (stand level) information systems.

The MELA System (and the software) consists of a general framework and local (e.g. land-dependent data and models) components (see Figure 1.5) facilitating the porting of the system outside Finland. The software written in FORTRAN 77 is portable to MS Windows, OS/2, VAX/VMS, and several UNIX environments. With software modifications the methods are applicable also for multinational forestry analysis of inter-regional problems, if relevant and compatible local forest information is available.

2.2 Getting Started by Solving a Sample Problem

2.2.1 Introduction to the Sample Problem

This chapter demonstrates the commands needed to perform the steps of a typical MELA task (or solving the MELA basic problem, a timber production program for a forestry unit and the relevant management of the stands), i.e.:

- simulation of management schedules for the stands,
- selection of a production program for the forestry unit and stands on the basis of the user-supplied goals for forestry, and
- re-simulation and detailed printout of the selected management schedules of the stands.

The details of the calculations (phases, commands, arguments etc.) are explained in Part 3. The list of the MELA files needed in solving the sample problems is found in Example A.1. Instead of these files, users can provide (and they usually do) their own task-specific data and parameter files. For further information about the MELA files, see Appendix C.

> NOTE: MELA text files can be read, printed or edited by the user, when necessary. Binary MELA system files cannot be edited and should not be tampered by the user.

2.2.2 Solving the Sample Problem for a Simple Forestry Unit

2.2.2.1 Simulation of management schedules for the stands

EXERCISE: The reader is encouraged to run the following computing steps and sample problems on the computer in order to get familiar with the MELA software, MELA commands, parameters, files and reports, and the fundamental phases of practical MELA applications.

The MELA programs are started according to the starting convention of the actual operating system, see Appendix A.

> NOTE: If you are using a multi-processing (such as OS/2 or X family) window system, it is recommended to run MELASIM, MELAOPT and system editor sessions each in separate windows. MELA program sessions can be started simultaneously if memory allows. If so, you must not start a new MELA step in one window (for example, SOLVE in MELAOPT) before the successful completion of the previous one in another window (for example, SIMULATE in MELASIM). When running MELA programs each in a separate window the EXIT command is needed only at the end of each session.

NOTE: The instructions (and the EXIT command) below refer to the running of the MELA programs one by one in one window. The prompt of the MELA System (MELASIM> or MELAOPT>) is also shown in the examples of the First Touch.

```
>MELASIM
```

Start a MELASIM (MELA simulator) session on the operating system level.

```
MELASIM>SIMULATE MS F2
```

Simulate management schedules for the stands of the forestry unit F2 (initial stand data come from the **F2.RSD** file) according to the simulation parameters in the **MS.PAR** file (and included parameter files, see the **MS.PAR** file in Example H.5). The optional events are given in the **MS_EVENT.PAR** file, see the MELA command INCLUDE in the **MS.PAR** file. The management schedules are stored in the **F2.MSC** (descriptions of the management schedule data) and **F2.MSD** (management schedule data) files.

NOTE: F2 is a tiny and hypothetical forestry unit in Southern Finland, see Appendix H.2.

```
MELASIM>EXIT
```

Finish the MELASIM session and return to the operating system level.

2.2.2.2 Selection of the production program

```
>MELAOPT
```

Start a MELAOPT (MELA optimizer) session on the operating system level.

```
MELAOPT>SOLVE S4 F2
```

Solve the optimization problem given in the **S4.MDL** file (see Example H.19) and using the management schedule data simulated for the forestry unit F2 (the management schedule data were stored in the **F2.MSC** and **F2.MSD** files), see Example 2.1. In the problem S4, the net present value (4 % interest rate) is maximized subject to non-declining flow of cutting removal, saw log removal and net incomes. For a discussion on sustainability, see Chapter 4.2.2.2. For the current formulation of the MELA optimization problem, see Lappi (1992).

Example 2.1. The MELAOPT solution of the problem S4 for the forestry unit F2.

```
================================================================
 <>MELA<>   F2  - all:
            S4-MAXIMUM SUSTAINED YIELD,4%   solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %              468743                          562491
 537 Forestry land area     24.1
 700 Volume, m3           2829.4  2846.0  2681.1  2574.1  2603.9
 697 -saw log             1224.6  1236.6  1324.7  1346.8  1167.3
 090 Increment, m3/a          115.7   104.5   110.3   122.5
 195 Cutting removal, m3/a    107.6   115.0   115.0   115.0
 193 -saw log                  67.4    67.4    67.4    72.1
 370 Net revenues, FIM/a    16667.0 17698.7 18436.2 18609.2
 800 Roadside value,FIM   525340                          500949
----------------------------------------------------------------
```

Numbers on the left refer to the decision variables, see Appendix D.4.

```
MELAOPT>REPORT SUMMARY
```

Generate MELAOPT reports, including the **F2_F2_S4_O.SUM** file (MELA summary report in a text file).

After the REPORT SUMMARY command, print (or type on the display) the contents of the MELA summary report file **F2_F2_S4_O.SUM** using the standard commands on your operating system. See Example 2.2.

NOTE: On some operating systems, at most eight characters can be used in file names.

```
MELAOPT>EXIT
```

Finish the MELAOPT session and return to the operating system level.

EXERCISE: Should the S4 solution be considered sustainable in terms of timber production? If not, how would you modify the optimization problem?

Example 2.2. The MELAOPT summary report of the problem S4 for the forestry unit F2.

F2 - S4-MAXIMUM SUSTAINED YIELD,4% - all:

	1996	2006	2016	2026	2036
FORESTRY LAND AREA, ha	24.1	24.1	24.1	24.1	24.1
TOTAL VOLUME, m3	2829.4	2846.0	2681.1	2574.1	2603.9
Pine	1790.9	2310.2	1803.2	1400.3	1424.0
Spruce	969.6	414.1	645.2	783.4	656.8
Birch	53.6	94.2	180.3	306.2	399.0
Other deciduous	15.3	27.4	52.4	84.2	124.2
Saw log	1224.6	1236.6	1324.7	1346.8	1167.3
Pulpwood	1472.8	1509.9	1267.3	1123.5	1214.5
VALUE (roadside prices), FIM	525340	535141	523144	509442	500949
NET PRESENT VALUE (NPV) 3%	634510	659511	681151	701683	727272

	1996	2006	2016	2026	2036
INCREMENT, m3/a	115.7	104.5	110.3	122.5	
Pine	74.5	67.5	50.9	53.2	
Spruce	33.2	25.1	33.7	36.8	
Birch	6.1	9.4	20.3	23.9	
Other deciduous	1.8	2.5	5.4	8.6	
TOTAL DRAIN, m3/a	114.0	120.9	121.0	119.6	
Mortality	2.6	3.3	4.1	3.1	
Cutting drain	111.4	117.7	117.0	116.4	
CUTTING REMOVAL, m3/a	107.6	115.0	115.0	115.0	
Shelterwood cuttings	20.2	7.9	29.8	16.0	
Thinnings	34.9	0.0	26.6	47.3	
Regeneration cuttings	52.4	107.1	58.6	51.7	
Pine	20.1	115.0	88.4	49.2	
Spruce	86.5	0.0	18.9	48.4	
Birch	0.6	0.0	5.7	13.0	
Other deciduous	0.4	0.0	2.0	4.4	
Saw log	67.4	67.4	67.4	72.1	
Pulpwood	40.2	47.6	47.6	42.9	
TOTAL CUTTING AREA, ha/a	1.1	0.8	1.2	1.1	
Thinnings	0.7	0.0	0.3	0.5	
Clear cuttings	0.2	0.0	0.0	0.0	
Over story cuttings	0.1	0.2	0.7	0.3	
Seed tree cuttings	0.1	0.7	0.3	0.1	
Shelterwood cuttings	0.0	0.0	0.0	0.1	
REGENERATION AREA, ha/a	0.2	0.7	0.3	0.2	
Artificial regeneration	0.2	0.0	0.0	0.0	
Natural regeneration	0.1	0.7	0.3	0.2	
TENDING YOUNG STANDS, ha/a	0.3	0.2	0.7	0.3	
GROSS REVENUES, FIM/a	23258.4	23674.1	25153.2	24413.9	
TOTAL COSTS, FIM/a	6591.4	5975.3	6717.0	5804.8	
NET REVENUES, FIM/a	16667.0	17698.7	18436.2	18609.2	

2.2.2.3 Re-simulation of the selected management schedules for the stands

```
>MELASIM
```

Start a MELASIM (MELA simulator) session on the operating system level.

```
MELASIM>SIMULATE MSR F2 S4
```

For detailed stand level results, re-simulate the management schedules of the solution S4 for the stands of the forestry unit F2 (in the **F2.RSD** file). Use simulation parameters given in the **MSR.PAR** and **MS_EVENT.PAR** files, see Examples H.45 and H.6.

```
MELASIM>EXIT
```

Finish the MELASIM session and return to the operating system level.

2.2.2.4 Some variations of the sample problem: analysis designs

In most cases, one MELA solution is not enough for comprehending a decision problem or for demonstrating the relationships between interesting variables (for example, alternative production and development potentials of forests). More versatile analysis designs may be needed to enlighten complicated decision problems.

In the next variations of the sample problem, the effects of different discount rates and the effects of sustainability constraints on timber production besides the pure economic efficiency are examined. The discount rates used in the next exercise are 1, 2, 3, 4, and 5 %.

EXERCISE: Solve the following MELAOPT problems and compare the solutions of the P type (**P*.MDL**) runs and then the solutions of the S type (**S*.MDL**) runs. These results will illustrate the effects of the discount rate in net present values and the consequent forest management decisions. Look first at the dynamics of the cutting removal and the volume of the growing stock, preferably in graphical form. Then compare P type and S type solutions with each others (P1 and S1, ..., P5 and S5).

```
>MELAOPT
```

Start a MELAOPT (MELA optimizer) session on the operating system level.

```
MELAOPT>SOLVE P1 F2
MELAOPT>SOLVE P2 F2
MELAOPT>SOLVE P3 F2
MELAOPT>SOLVE P4 F2
MELAOPT>SOLVE P5 F2

MELAOPT>SOLVE S1 F2
MELAOPT>SOLVE S2 F2
MELAOPT>SOLVE S3 F2
MELAOPT>SOLVE S4 F2
MELAOPT>SOLVE S5 F2
MELAOPT>EXIT
```

Solve, one by one, optimization problems given in the **P1.MDL**, ..., **P5.MDL** and **S1.MDL**, ..., **S5.MDL** files using the management schedule data simulated for the forestry unit F2 (and stored in the **F2.MSC** and **F2.MSD** files).

In the P type solutions, the net present value is maximized without forest level constraints (stand level optimization). In the S type solutions, the net present value is maximized subject to non-declining cutting removals and net incomes at the forest level. Constraints in the S type problems indicate sustainable timber production in addition to the economic efficiency of the P type solutions. Should the S type problem formulations guarantee sustainable timber production after the calculation period? Adjust the optimization problem, if necessary.

If possible, draw the development of the cutting removals into one figure and the development of the growing stock into another one - solutions P1, ..., P5 and solutions S1, ..., S5 separately, four figures in total - in order to see the differences between different solutions. You can draw the figures manually or by using some business graphics software, such as MS EXCEL, see Figures 2.1 and 2.2.

EXERCISE: How are sustainability and effectivity aspects fulfilled in S type solutions?

2.2.2.5 Feasible (or final) production program

None of the tutorial sample problems above is intended to be the final timber production program for the forestry unit F2. Some of them may serve as a starting point for further analysis, but probably additional considerations are needed to find an acceptable solution.

EXERCISE: Try to iteratively (by adding new constraints and solving these new problems one by one) formulate a MELAOPT problem for the forestry unit F2 suitable for your preferences and your newly acquainted knowledge on this forestry unit (as if you were the owner of F2). Perhaps you can use one of problem files above as a starting point when designing your own problem definitions?

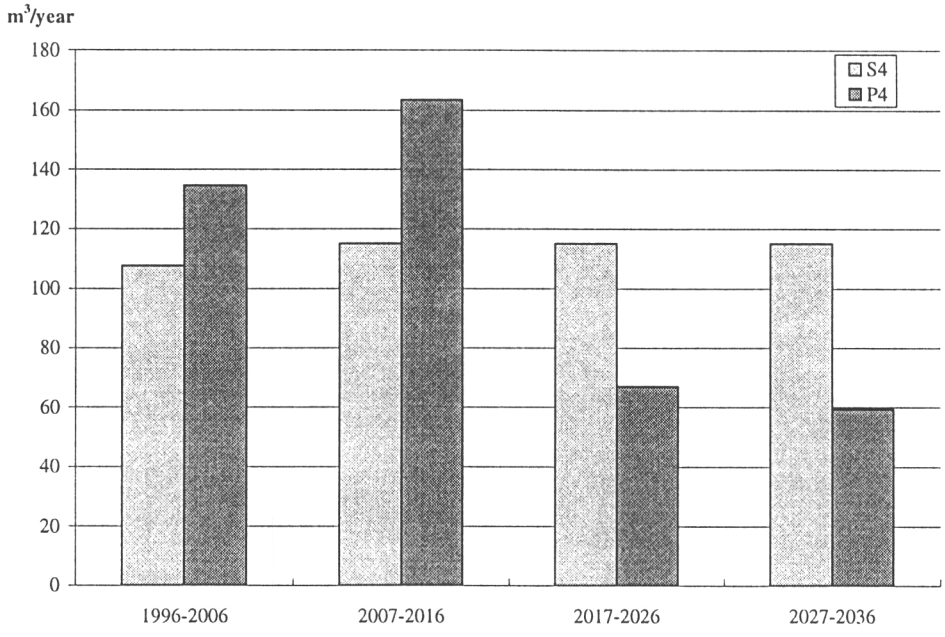

Figure 2.1. The development of the cutting removals in the solutions S4 and P4.

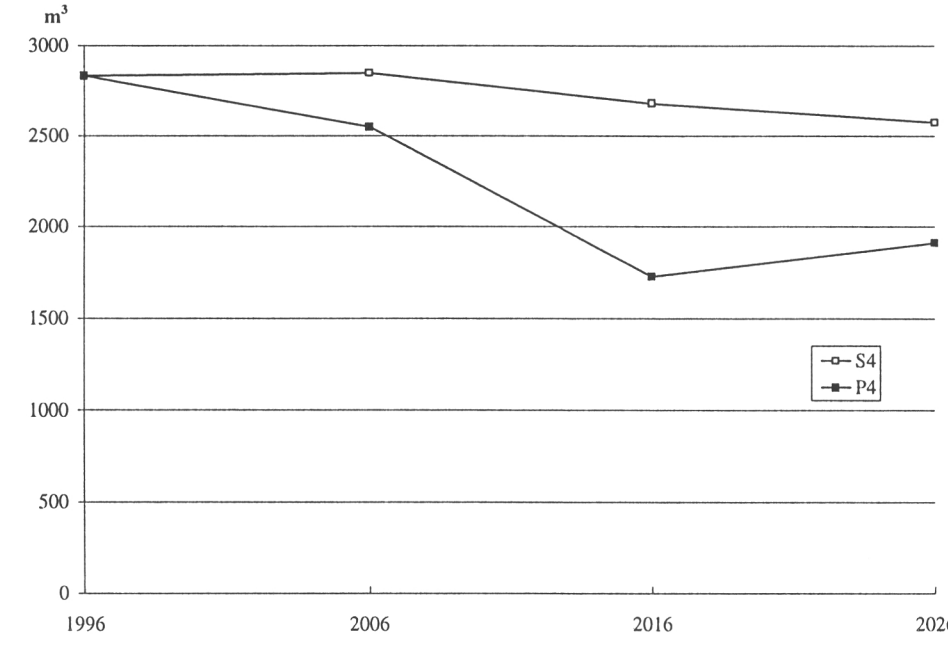

Figure 2.2. The development of the growing stock in the solutions S4 and P4.

NOTE: When using this kind of interactive iteration to search the final production program, it is assumed, that the forest owner doesn't thoroughly know their utility function, neither variables nor coefficients. An interactive iteration, however, makes it possible to find a satisfactory solution in a simple and illustrative way. In general, sophisticated solution methods should be considered for the cases, in which the decision maker knows the utility function exactly in advance.

You may find the following steps applicable in your MELAOPT iteration:

- Generate your own MELAOPT problem definition (**mdl** type) file:

  - either, copy the most relevant sample **mdl** file to **Z0.MDL** and edit your changes,
  - or edit a completely new problem definition file (**Z0.MDL**).

  NOTE: In a **mdl** type file you must completely define JLP's 'xvar' and 'prob' sections. A 'xvar' section must contain at least all variables used in the 'prob' definitions. For syntax and details, see **mdl** type files in Appendix C.2 and optional decision variables in Appendix D.4.

- Solve your own MELAOPT problem (**Z0.MDL**) for the forestry unit F2.

```
>MELAOPT
```

```
MELAOPT>SOLVE Z0 F2
MELAOPT>REPORT SUMMARY
MELAOPT>EXIT
```

- Print the contents of the MELA summary report file **F2_F2_Z0_O.SUM**.

- If the MELAOPT solution is not satisfactory, modify your MELAOPT problem definition and then solve the problem again.

- If necessary, re-simulate the selected management schedules of the stands for stand or forest level details.

```
>MELASIM
```

```
MELASIM>SIMULATE MSR F2 Z0
MELASIM>EXIT
```

- Simulate and print relevant final results, see the OUTPUT parameter in **MSR.PAR** (see Example H.45 and Appendix B.2).

2.2.3 Solving the Sample Problem for a Hierarchical Forestry Unit

2.2.3.1 Simulation of management schedules for the members of a decision hierarchy

In this exercise, the forestry unit FX consists of several lower level members. The hierarchical structure of forestry unit FX and some examples of JLP domains are illustrated in Figure 2.3. A JLP domain can be defined as any subset of management units (see Chapter 3.3.3).

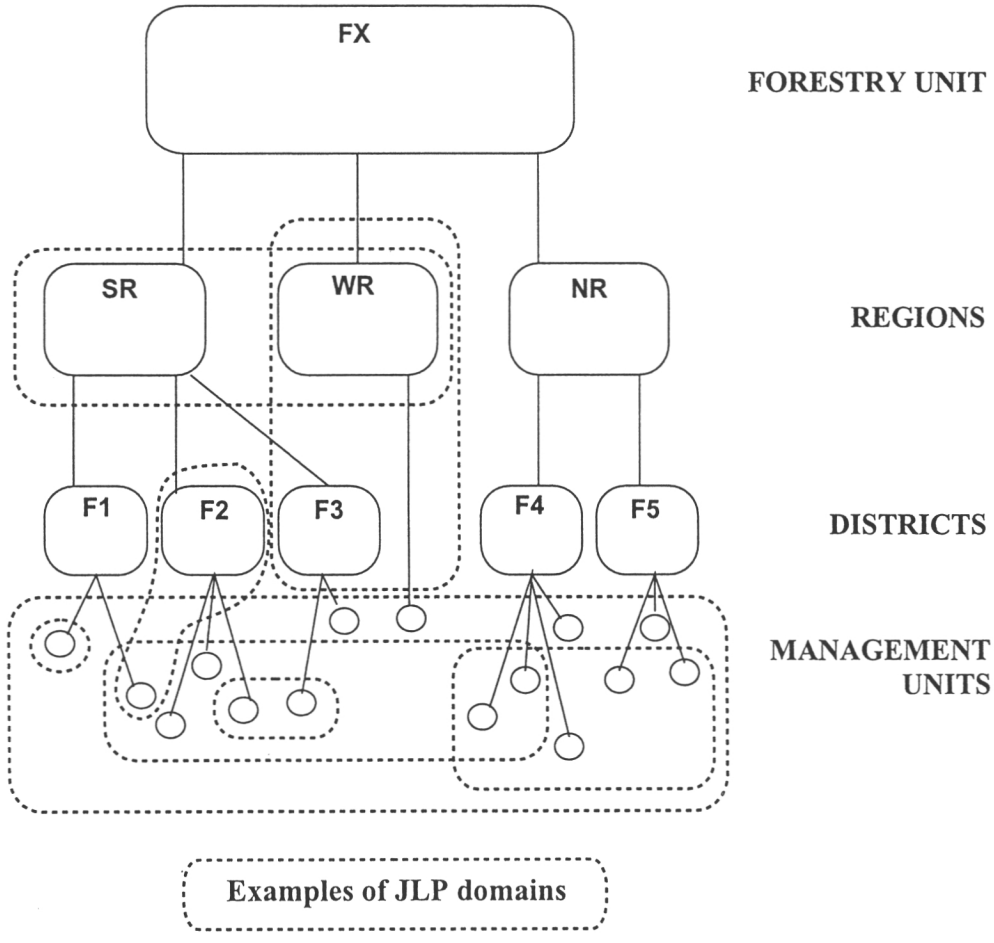

Figure 2.3. The hierarchical structure of the forestry unit FX and examples of JLP domains.

```
>MELASIM
```

Start on the operating system level a MELASIM (MELA simulator) session.

```
MELASIM>FORESTRY_UNIT#FX
MELASIM>SIMULATE MS FX
```

Simulate management schedules for the stands of the forestry unit FX. Initial stand data come from the **F1.RSD**, ..., **F5.RSD** and **WR.RSD** files according to the decision hierarchy definitions in the **FX.PAR** file, the simulation parameters in the **MS.PAR** file and included parameter files (see **MS.PAR** in Example H.5). See Chapter 3.4.2.1 for the arguments of the SIMULATE command. See Figure 2.3 and Example 3.11 for the illustration and contents of the **FX.PAR** file.

```
MELASIM>EXIT
```

Finish the MELASIM session and return to the operating system level.

2.2.3.2 Selection of the production program for the forestry unit and its decision hierarchy members

```
>MELAOPT
```

Start MELAOPT (MELA optimizer) on the operating system level session.

```
MELAOPT>FORESTRY_UNIT#FX
MELAOPT>SOLVE S4 FX
```

Solve the MELAOPT optimization problem given in the **S4.MDL** file for the whole forestry unit FX using the management schedule data simulated for its members (F1, ..., F5 and WR).

```
MELAOPT>REPORT SOLUTION REGION=SR:
MELAOPT>REPORT SOLUTION REGION=NR:
MELAOPT>REPORT SOLUTION DISTRICT=F2:
MELAOPT>REPORT SOLUTION DISTRICT=F2.or.DISTRICT=F3:
MELAOPT>REPORT SUMMARY
```

Try different report options for domains. For the explanation of REPORT arguments, see Chapter 3.5.2.2. See also Examples H.28 to H.33 in Appendix H.

```
MELAOPT>SOLVE S4 SR
MELAOPT>REPORT SOLUTION DISTRICT=F2:
MELAOPT>SOLVE S4 F2
MELAOPT>REPORT SOLUTION DISTRICT=F2:
```

Solve the problem S4 for different domains separately.

Compare the sub-unit and forestry unit level solutions of S type problems for the same sub-unit. Notice that each new binding constraint (also same constraints for smaller forestry units) should diminish the value of the objective function.

```
MELAOPT>EXIT
```

Finish the MELAOPT session and return to the operating system level.

2.3 Summary of First Touch Experiences

Having made the exercises, you should now have hands-on experience on the following subjects:

- how to start the MELA software on your computer,
- how to use MELA for solving some common forest management planning tasks,
- how some basic relationships of timber production possibilities may look like,
- how to generate and solve your own MELAOPT problem definitions and analysis designs, and
- how to manage hierarchical forestry units with multiple members.

As well, you should now be better prepared to read other parts of the MELA Handbook and the details of the MELA User's Guide.

> NOTE: The database operations and generation of MELA initial data are omitted in the examples above. In practical applications, MELA modules are usually a part of the forest information system. In stand level applications, the stand information (selected management schedules and corresponding parameters) are usually returned to the stand database of the forest information system for further analysis and presentation of the results (lists, tables, graphs, maps) by standard means.

Synthesis paradigm should have raised new views and questions concerning problems, requirements, potentials and practices of forest management planning and forestry analysis. You might consider useful the examples in Appendix H and the analyses in Part 4, too.

In spite of many details and tricks, the thread through the whole story is to **generate alternatives** on multiple levels and to **select the fittest** ones simultaneously on all levels.

Part 3

MELA User's Guide

MELA User's Guide is a reference manual. The components of the MELA System and their use are introduced in details.

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Part 3

MELA User's Guide

3.1 Components of the MELA System

At the moment, the MELA System consists of two individual program modules (see Figures 1.5 and 3.1):

- **MELASIM** for stand level simulation and re-simulation with built-in forest development, forest management and forest economy models, and
- **MELAOPT** for integrated stand and forest level optimization with the built-in JLP software (Lappi 1992).

The MELA standard package contains also the default MELA system files, the default MELA parameter files, and some examples of initial data files and problem definition files. Besides these default files, users can generate their own task-specific files instead. For the components of the MELA System, see also the MELA system delivery material in Appendix A. Detailed information on the parameters and files is found in Appendices B and C.

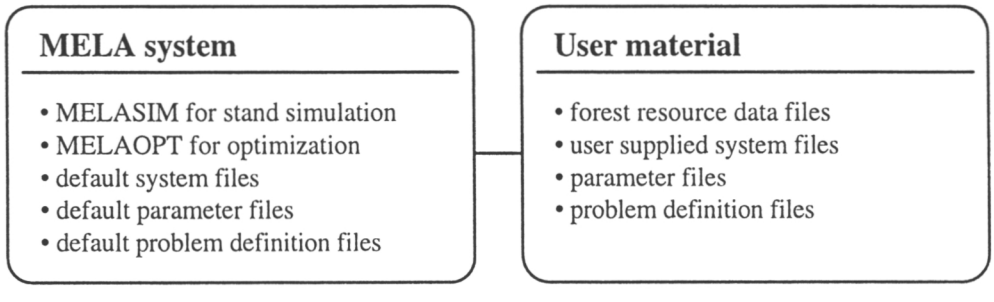
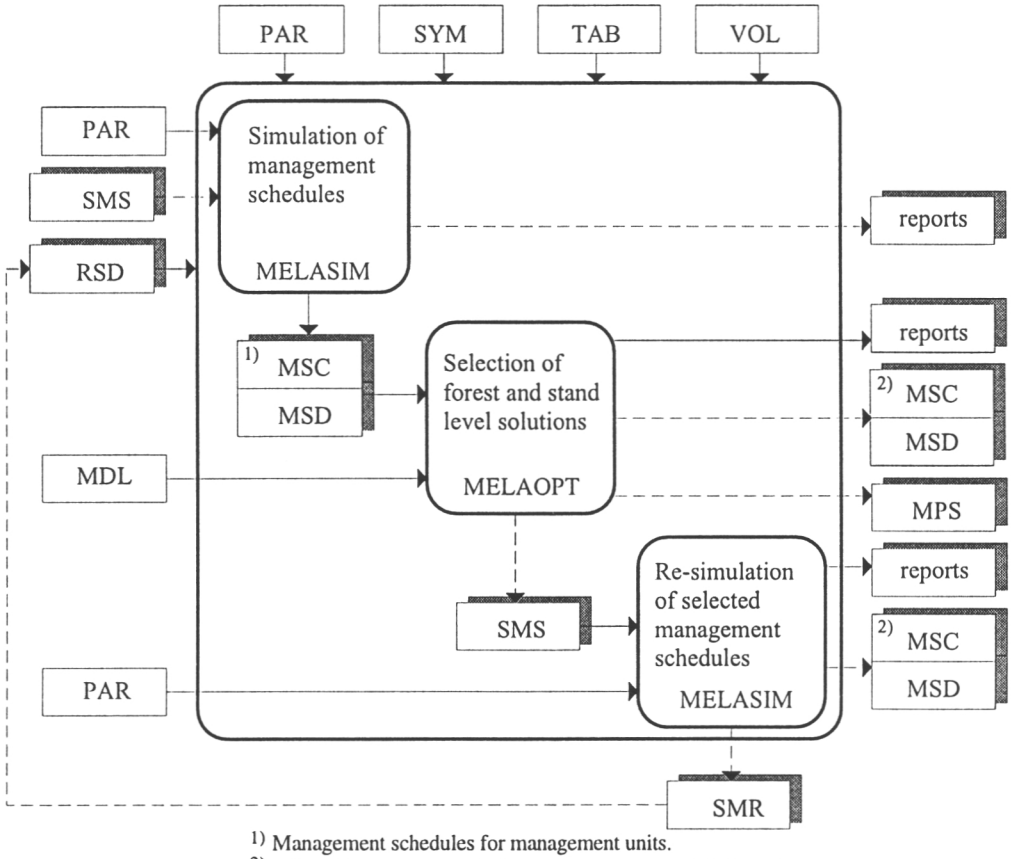


Figure 3.1. The components of the MELA System.

User-supplied initial data files (forest resource information) have to be compatible with the MELA System. There are currently no universal MELA routines in the MELA standard package to preprocess forest resource data and to postprocess results, except the re-simulation.

The MELA programs (MELASIM and MELAOPT) are separate program modules communicating with each others via MELA system files (for example, **msc** and **msd** type files). MELA parameters define the optional details of the MELA programs making it possible to use the same program modules for different applications. For example, users can create their own MELA applications in addition to the standard ones.

Figure 3.2 provides a schematic illustration of the roles and the use of the MELA programs and files during analysis.



1) Management schedules for management units.
2) A forest level summary in the management schedule format.

Figure 3.2. A schematic illustration of the MELA programs and file types in analysis.

3.2 Using MELA

3.2.1 MELA User Interface

3.2.1.1 Input lines

All MELA programs have the same character based user interface. The MELA programs are controlled via input lines. There are four types of input lines:

- comments,
- commands,
- parameter definitions and their continuation lines, and
- symbol definitions.

One input line

- contains one command, comment, parameter definition or symbol definition, or
- starts a multiple line parameter definition, or
- is a continuation line of the preceding parameter definition line.

Comments and empty lines may appear anywhere among the input lines, including the continuation lines. Comments and empty lines are omitted in the interpretation of input lines. See Example 3.1.

The maximum length of an input line is 131 characters. Comments, commands, parameter names and symbol definitions begin at column 1 on an input line (except user defined parameters beginning at column 2, see Chapter 3.2.1.4). Parameter and symbol names begin with a character (A - Z). Characters (0 - 9) are valid components of the parameter and symbol names after the leading letter. National characters (such as Scandinavian Å, Ä and Ö) should not be used in commands and definitions. Commands, parameter and symbol names are given in upper case letters. Comments, commands, parameter names and symbol definitions must not contain extra spaces (character ' ') and tabs in the beginning of the input line.

Comments, commands and symbol definitions occupy one input line each. Parameter definitions may have an unlimited number of continuation lines. There is no explicit continuation line sign. All input lines (excluding comments and empty lines) from a valid parameter name to the next valid command, parameter name or symbol definition are continuation lines of the current parameter definition. Continuation lines cannot begin with a character (A-Z) at column 1 or 2 in order to separate continuation lines from commands and definitions (for further information, see Chapters 3.2.1.2 - 3.2.1.5).

Example 3.1. Continuation lines of parameter definitions and comments.

```
* A parameter definition on one input line
YEARS 1 11 21
* The same parameter definition on two input lines
YEARS
* Empty lines and comments may appear among continuation lines
 1 11 21
```

MELA commands are executed one by one in the order provided (see also Chapter 3.2.1.6). Parameter and symbol definitions must always precede the MELA command in question. Parameter and symbol definitions are stored temporarily in the internal databases for retrieving during a MELA session. The use of the same parameter files in different MELA sessions (see the INCLUDE command in Chapter 3.2.2.2) makes it possible to share the common parameter definitions.

MELA user interface routines take care of the interpretation of input lines, the management of run-time parameters, hierarchically nested parameter files, file management and file naming based on command arguments, generation of loops from command arguments, and the management of hierarchical forestry units.

3.2.1.2 Comments

Input lines beginning with the character '*' at column 1 are comments. Comments are omitted in the interpretation of the input lines. Comments may appear in parameter files or anywhere during a MELA session. The number of comment lines is not restricted. Comments may contain any characters. See Examples 3.1 and 3.2.

Example 3.2. Comments in MELA parameter files.

```
* This is a comment.
* Empty lines (above) are interpreted as comments.
```

3.2.1.3 Commands

The general syntax of the MELA commands

MELA commands are used to perform desired actions during MELA sessions. Commands can be used in a free order. The two types of MELA commands are

- general commands which are common to all MELA programs, and
- program specific MELA commands.

The general MELA commands are introduced in Chapter 3.2.2. The program specific MELA commands are introduced in Chapters 3.4 and 3.5.

The general syntax of a MELA command is

```
command/option=option_value[/option=option_value]
                            argument_value[ argument_value]
```

command	A valid MELA command name.
option	An option name. An option is a parameter with one value only.
option_value	A relevant numeric or character value depending on the option (parameter) type, see Chapter 3.2.1.4.
argument_value	A character string separated by spaces from the command name and the other arguments. Each argument has a position dependent interpretation.

NOTE: In principle, there is no difference in the processing of options and parameters except the syntax and the maximum number of values. Options are stored during a MELA session in the internal parameter database with other parameters.

MELA command argument loops

Some MELA command arguments may have several members each referring to the individual objects that are processed in the same way (for example, using the same parameter values). The MELA programs generate automatically the required loops during the program execution.

There are two types of argument definitions and loops:

- loops generated from the argument members, and
- loops generated via the interpretation of the decision hierarchy members appearing as argument members. In this case each argument member refers to all the members of the decision hierarchy in question (see Chapter 3.3).

For further information of the argument loops, see the MELASIM command SIMULATE in Chapter 3.4 and the MELAOPT command SOLVE in Chapter 3.5.

3.2.1.4 Parameters

Parameter definitions

Parameters are used to transmit user-supplied optional information to the MELA programs. Built-in default parameter values are used when no relevant parameter value exists in the internal parameter database.

Parameter definitions may appear in a free order during a MELA session. However, the parameter definitions must precede the MELA command in question. Parameters belonging to the same context should be stored in the same parameter file. The MELA command INCLUDE allows the nesting and the hierarchical organization of MELA parameter files.

All parameter definitions are stored in the internal parameter database to be retrieved by the MELA programs. Same parameter name may appear in the internal parameter database several times with different values. The MELA programs select the relevant appearances of the parameter (the first, the last, or all) depending on the parameter and the program in question.

To avoid conflicts of the parameter definitions in one session, old parameter definitions are automatically removed from the internal parameter database before the execution the next SIMULATE (see Chapter 3.4), SOLVE or JLP command (see Chapter 3.5). Only parameter definitions provided after the preceding (if any) SIMULATE, SOLVE or JLP commands are available in the internal parameter database (see Examples 3.3 and 3.4). Individual parameters can be removed also by the MELA command REMOVE (see Chapter 3.2.2).

Example 3.3. The availability of parameter values in the execution of the consecutive MELA commands.

```
* A parameter definition.
MELA_TABLE#USER.TAB

* The MELA_TABLE parameter definition is valid with
* the first occurrence of the SIMULATE command.
SIMULATE MS F1

* Old parameter definitions are removed from internal
* parameter database before the next SIMULATE command.
* The default values of parameters are used instead.

SIMULATE MS F2

* The MELA_TABLE parameter should be defined again
* after the first SIMULATE command in order to make it
* available for the second SIMULATE command.
```

Parameters are divided into two categories by their origin:

- general parameters of the MELA System (system parameters), and
- specific parameters declared by the user (user parameters).

Most of the MELA parameters are system parameters and their names are constants defined in the MELA programs. At the moment, user parameters are applied only in defining hierarchical forestry units (see Chapter 3.3). For a complete list of parameters, see Appendix B.

> NOTE: User-supplied substitutes can be given to parameter names using symbol definitions (see Chapter 3.2.1.5). Symbols are used, for example, in the different language versions of MELA.

Parameter values belonging to the same parameter definition may appear on one or several adjacent input lines. The continuation lines cannot begin with a character (A - Z) at column 1 or 2 in order to separate the continuation lines from commands and definitions.

An individual parameter value must be given on one input line. The maximum length of an individual parameter value is 131 characters.

The general syntax of MELA parameters

MELA parameters are either numerical or character type.

The general syntax of a **numerical type** parameter is

```
PARAMETER_NAME numerical_value[ numerical_value]
```

PARAMETER_NAME A valid MELA parameter name.

numerical_value An integer or a floating point value.

NOTE: The delimiter between values of numerical type parameters is the character ' ' (space).

Example 3.4. Numerical parameter definitions.

```
* The name of the system parameter begins at column 1.
YEARS 1 3 7 17 27
* or equivalently
YEARS
* After the parameter name there can be extra spaces or comments.
      1 3 7 17 27
```

The general syntax of a **character type** parameter is

```
PARAMETER_NAME#character_value[#character_value]
```

PARAMETER_NAME A valid MELA parameter name.

character_value A character string.

NOTE: The delimiter between values of character type parameters is the character '#'.

Example 3.5. Character parameter definitions.

```
* The name of system parameters begins at column 1.

FORESTRY_UNIT#FX

* The name of user parameters begins at column 2.

 FX#SR#NR

*or equivalently

 FX
#SR
#NR
```

NOTE: To separate visually system parameters, user parameters and continuation lines, it is recommended to begin the continuation lines of character type parameters with the delimiter '#' at column 1 (see Example 3.5).

The syntaxes of system and user parameters are slightly different. The name of the system parameter begins with an upper case letter at column 1 on an input line, while user parameters begin at column 2 preceded by a space (character ' '). The reason for this is the validation of the parameter names. If the parameter name begins at column 1, its validity is automatically checked by the MELA programs. If the parameter name begins at column 2, its validity is not checked because the validity of names of user parameters cannot be controlled by the MELA programs.

NOTE: If the name of the user parameter begins at column 1, a warning message will be printed (see Chapters 3.4.7.2 and 3.5.7.2). However, the definition of the parameter is accepted.

3.2.1.5 Symbols

Symbols are used in the translation of MELA commands and parameters in the different language versions. Symbols may also be used to substitute long character strings with shorter synonyms.

Symbols can be applied to MELA commands and parameters only. Nested symbol definitions are not allowed.

All symbol definitions are provided in the **SYMBOL.SYM** file. Symbol values are stored during a MELA session in the internal symbol database to be retrieved by the MELA programs.

The general syntax of a MELA symbol definition is

```
ORIGINAL_STRING=SYMBOL_VALUE
```

ORIGINAL_STRING A character string that can be substituted by SYMBOL_VALUE, for example, a generic name of the command or the parameter in Finnish (see Chapters 3.2.2, 3.4.2 and 3.5.2).

SYMBOL_VALUE A (short and illustrative) substitute for ORIGINAL_STRING.

After the respective symbol definition, ORIGINAL_STRING cannot be used, except the generic MELA commands in Finnish.

3.2.1.6 Running MELA programs

The MELA programs are started according to the starting convention of the actual operating system.

The MELA programs can be run interactively or in batch mode. Contact your system manager to find out if batch jobs are supported by your operating system and to get detailed instructions for using batch jobs.

In interactive use, input lines are typed one by one. The MELA command INCLUDE (see Chapter 3.2.2.2) makes it possible to include a set of input lines stored in a file, usually a **par** type file (see Appendix C.2). The included files may contain any types of input lines, also nested INCLUDE commands.

When working with batch jobs, operating system commands and relevant MELA input lines are stored in a command file. The command file is then submitted for execution using operating system commands. The MELA command INCLUDE can be used in the command file to include input lines from other MELA parameter files. The output of the batch job is directed into a operating system dependent log file. The use of the MELA programs in batch mode is comparable to interactive use. Command files containing MELA input lines can be run in interactive mode as well by using the MELA command INCLUDE.

MELA sessions requiring more than a few minutes of CPU time should be run as batch jobs (if you are using a one-window terminal or equivalent) or in a separate window (if your operating system allows several simultaneous windows and tolerably fast multi-processing).

3.2.2 General MELA Commands

3.2.2.1 EXIT command

Generic name in Finnish: LOPETA

Finish the MELA session and return to the operating system level.

The general syntax of the MELA command EXIT is

```
EXIT
```

3.2.2.2 INCLUDE command

Generic name in Finnish: LUE

Get and process input lines from a text file. The commands are executed one by one in the sequential order and the parameter and symbol definitions are stored in the internal databases.

The general syntax of the MELA command INCLUDE is

```
INCLUDE filename.ext
```

filename The name of the file containing input lines (usually a **par** type file). The file may contain any type of MELA input lines. Nested INCLUDE commands are supported up to 5 levels.

ext The extension of the file name if other than **PAR**.

NOTE: File names are provided in upper case letters (see Chapter 3.2.3.1 and Example 3.6).

Example 3.6. An INCLUDE command.

```
* Get and process input lines from the
* MS_EVENT.PAR file in the MELA session.

INCLUDE MS_EVENT
```

3.2.2.3 RECALL command

Generic name in Finnish: TOISTA

Show and execute the last MELA command.

The general syntax of the MELA command RECALL is

```
RECALL
```

3.2.2.4 REMOVE command

Generic name in Finnish: POISTA

Remove all appearances of the specified parameter from the internal parameter database in the current MELA program session.

The general syntax of the MELA command REMOVE is

```
REMOVE parameter_name
```

parameter_name The name of the parameter to be removed from the internal parameter database.

Example 3.7. A REMOVE command.

```
* Remove all appearances of the DISCOUNT_RATES parameter
* from the internal parameter database in the current session.

REMOVE DISCOUNT_RATES
```

3.2.2.5 SHOW command

Generic name in Finnish: NAYTA

Generate and show the requested information (available commands, parameter values or symbols) on the terminal.

The general syntax of the MELA command SHOW is

```
SHOW request_type
```

request_type The type of the information requested:

COMMANDS

Generic name in Finnish: KOMENNOT

Show all the MELA commands available in the session. Only the list of commands is provided without further explanations.

Example 3.8. A SHOW COMMANDS command.

```
* Show available commands.
SHOW COMMANDS
```

INTERPRETATION parameter_name

Generic name in Finnish: TULKINTA

Show the interpreted values of the parameter. This request type is used, for example, to show the lowest level members of any hierarchy structure or the members of command argument loops.

C_PARAMETER parameter_name

Generic name in Finnish: C_PARAMETRI

Show the values of a character type parameter.

N_PARAMETER parameter_name

Generic name in Finnish: N_PARAMETRI

Show the values of a numerical type parameter.

Example 3.9. A SHOW N_PARAMETER command.

```
* Show the values of the YEARS parameter.
SHOW N_PARAMETER YEARS
```

PARAMETERS

Generic name in Finnish: PARAMETRIT

Show all the parameters and their values in the internal parameter database of the current session.

SYMBOLS

Generic name in Finnish: SYMBOLIT

Show all the symbol definitions in the internal symbol database of the current session.

3.2.3 MELA Files

3.2.3.1 File naming

The MELA System generates automatically names as well as opens and closes the files needed by the MELA programs. File names are generated from the actual command arguments (see the MELASIM command SIMULATE in Chapter 3.4 and the MELAOPT command SOLVE in Chapter 3.5) and parameter values. Missing files result an error message and the current task will stop.

The general syntax of the MELA file name is

```
FILENAME.EXT
```

FILENAME A character string defining the file name.

EXT A string of three characters defining the extension of the file name.

NOTE: Operating systems often limit the length and valid characters of file names. Usually at least eight characters can be used in file names, but national characters (such as Scandinavian Å, Ä and Ö) are not allowed by all operating systems. For details, see instructions of your operating system. See also the MELA parameter MAX_LENGTH_OF_FILENAME in Appendix B.2.

Some MELA file names are constants (for example, **VOLUME.VOL**, where VOLUME is the file name and VOL is the extension). Most of the MELA file names are automatically generated from naming components typical to each file type. The naming components of the file names are

- values of command arguments,
- values of actual parameters,
- character constants, and
- delimiters.

Example 3.10. The components of the file name.

```
The automatically generated file name

      FX_F2_S4_S.SUM

consists of the following components:

      · 'FX', 'F2', 'S4'  values of command arguments
        'S'   character constant
      · 'SUM' extension
      · '_'   delimiter between file naming components
      · '.'   delimiter between file name and extension
in the case of the following file naming instructions:

      #65 SUM _ FORESTRY_UNIT SUB_UNIT PROBLEM S

denoting:

      <forestry_unit>_<sub_unit>_<problem>_S.SUM

(see also the naming instructions of sum type files in Appendix C.2)
```

The default values for the naming components, their order in the file names, and the file name extensions are automatically set by the MELA System (see Appendix C and the FILE_NAMING parameter in Appendix B.2).

The naming convention applied in the MELA System makes file names unique and illustrative, because natural language can be used in the file names. The file names are generated and interpreted automatically. In order to avoid too long file names it's recommended to use short command arguments and parameters values.

> NOTE: The MELA System deletes the old version of the output file when writing a new output file with the same name. Use the operating system commands for saving or renaming the old file version before the execution of the MELA programs, if necessary. Use also the operating system commands to delete unnecessary files.
>
> NOTE: For changing default file naming instructions, see the FILE_NAMING parameter in Appendix B.2.

3.2.3.2 Obligatory MELA files

Some MELA files are always required when using the MELA programs. If the necessary files do not exist, the current MELA session will stop. The obligatory files for all MELA programs are

- **MELA_SET.PAR**, and
- **SYMBOL.SYM**.

MELA_SET.PAR is a file for general parameter definitions and initial parameter settings. The MELA programs read this file by default. If required, the FILE_NAMING parameter should be defined in this file. See Example H.1.

MELA symbol definitions and default names of the decision variables are provided by the **SYMBOL.SYM** file (for further information, see Appendix C.2). See Example H.2.

There are also obligatory files specific to each MELA program (for further information, see Chapters 3.4 and 3.5).

3.2.4 Errors and Troubleshooting

Try always first to find out where the error message comes from (e.g. from your operating system or from a MELA program) in order to find proper instructions.

Notice that there are not messages for all potential errors in the MELA programs. In the case of an unexplained error, contact your system manager or directly the MELA Team.

The MELA Team needs such details as complete messages and a detailed description of the task, the data and the computer system for any investigations. See the MELA customer response sheet at the end of the publication.

See also Chapters 3.4.7 and 3.5.7.

3.2.4.1 Some common error conditions

- Conflicts with lower and upper case letters.

  The use of lower case letters in file names may lead to conflicts with the MELA programs. This occurs in the form of "Cannot find file ..." type error messages (see Chapters 3.2.4.2, 3.4.7.2 and 3.5.7.2).

  Use only upper case letters in file names.

- Not enough memory.

  There may appear three types of memory adequacy problems with the MELA programs:

  - The computer memory available and/or the operating system settings are less suitable for a MELA program. The details of the error messages vary on different operating systems. The MELA session terminates anyway.

    Consult your system manager first if the task cannot really be modified at all. The memory requirements for the programs can in some cases be changed by the MELA Team. See also Chapter 3.5.7.2.

  - The MELA program version is too small for the data or the task in question.

    Usually, a larger program version is required, if available. Consult your system manager or retailer first. The memory requirements for the programs can in some cases be changed by the MELA Team. See also Chapter 3.5.7.2.

  - Uncontrolled error exits with no or mysterious error messages may seldom result from program errors and an unsuitable memory allocation of the programs.

    Consult your system manager or the MELA Team.

- Disk is full.

  The details of the error message vary on different operating systems. The MELA session terminates anyway.

  The amount of disk space needed depends on data material. Delete unnecessary files to increase the amount of free disk space or get a larger disk, depending on your needs.

3.2.4.2 Some warnings and error messages

- `Cannot find file` **`SYMBOL.SYM`**`.`

  The execution of the MELA program terminates.

  Ensure that the **SYMBOL.SYM** file exists in the proper directory and that the file name is in upper case letters.

- `Cannot find file` **`MELA_SET.PAR`**`.`

  The execution of the MELA program terminates.

  Ensure that the **MELA_SET.PAR** file exists in the proper directory and that the file name is in upper case letters.

- `Writing over an existing file "filename".`

  The execution of the MELA program continues.

  MELA programs delete automatically the old versions of files before writing new ones.

  > NOTE: Before the execution of the MELA programs, the old versions of necessary MELA output files should be saved or renamed using operating system commands.

- `No interpretation.`

  A command or a parameter cannot be found from the symbol definition (**sym** type) file.

- `Error in number of parameter items: 'parameter_name'.`

  A warning message is printed if the number of parameter values is not correct. The values provided are omitted and the default values are used.

  Check the validity of the results carefully.

3.3 Hierarchical Forestry Units and JLP Domain Definitions

3.3.1 Functions

The MELA programs possess capabilities to process hierarchical forestry units. The management units may belong to several hierarchical and overlapping categories or domains. It is also possible, for example, to set constraints to members of hierarchical forestry units in MELAOPT problem definitions and to use short references to hierarchy members in MELA commands.

There are two complementary ways to refer to the parts of forestry units in the MELA programs:

- MELA decision hierarchies, and
- JLP domains.

Both MELA decision hierarchies and JLP domains may appear simultaneously.

> NOTE: A MELA decision hierarchy in MELAOPT is, in fact, a specific application of the JLP domains.

3.3.2 MELA Decision Hierarchy

The forestry units may comprise several sub-units on several (organisation or decision) hierarchy levels.

MELA decision hierarchy definitions are used, for example, for following purposes:

- to refer with a short name in MELA commands to the individual members or all the members of hierarchical forestry units,
- to define constraints for the individual members of hierarchical forestry units in MELAOPT (or JLP) problems being solved, and
- to select report categories in MELAOPT commands.

Actual MELA decision hierarchies are described in **par** type files (see Example 3.11). Each decision hierarchy definition must contain two types of parameters:

- names of the decision hierarchy levels (see the forestry_unit_LEVELS parameter) and
- members of each level in the decision hierarchy (see user parameters in Chapter 3.2.1.4).

> NOTE: The name of the **par** type file containing the decision hierarchy definitions must equal to the name of the forestry unit described in the file.

Example 3.11. A simple decision hierarchy definition.

```
* FX.PAR * (see also Figure 2.3)

* Decision hierarchy levels of the forestry unit FX

 FX_LEVELS
#FX
#REGION
#DISTRICT

* The names of the members of each level
* in the decision hierarchy.

* Region level sub-units of FX

 FX
#SR Southern Region
#NR Northern Region
#WR Western Region

* District level sub-units of SR

 SR
#F1 District F1
#F2 District F2
#F3 District F3

* District level sub-units of NR

 NR
#F4 District F4
#F5 District F5

* Notice that WR has no lower level members.
```

NOTE: The names of decision hierarchy parameters (FX_LEVELS, FX, SR and NR in the Example 3.11) must begin at column 2 on input lines (if not, error exit will occur). See user parameters in Chapter 3.2.1.4 and the MELA parameters FORESTRY_UNIT, forestry_unit_LEVELS and forestry_unit_members in Appendix B.2.

In principle, the number of hierarchy levels and their members in MELA is unlimited. However, the software and computing capacity may set limits to the number of hierarchy levels and members in practice.

NOTE: The stands belonging to the smallest logical and physical decision unit should belong to the same lowest level member of the decision hierarchy and consequently to the same initial data (**rsd** type) file.

NOTE: The names of the **rsd** type (and output) files belonging to the forestry unit are automatically generated from the lowest level members of the decision hierarchy described in the **forestry_unit.PAR** file, see Example 3.11.

For further instructions, see the **forestry_unit** argument of the SIMULATE command in Chapter 3.4.2.1 and initial data (**rsd** type) files in Appendix C.2.

The reference to the actual decision hierarchy is selected in a MELA program session using the FORESTRY_UNIT parameter (see Example B.20).

NOTE: The decision hierarchy selection may appear during the MELA program session (if several alternative hierarchies are used in the same session) or in the **MELA_SET.PAR** file (if only one hierarchy is going to be applied), for the convenience, the default hierarchy reference should always be found in the **MELA_SET.PAR** file.

3.3.3 JLP Domain Definitions

MELA management units can be grouped into categories or JLP domains. In principle, JLP domains are any subsets of management units.

JLP domains are used, for example, for the following purposes:

- to define constraints for groups of management units in MELAOPT (or JLP) problem definitions, and
- to select report categories in MELAOPT commands.

JLP domains are defined via logical statements in terms of the management unit variables (c variables, see Appendix D.2) and the actual decision hierarchy (see Chapter 3.3.2 and Examples 3.11, H.28 and H.31).

NOTE: JLP domains may well be (in fact they usually are) overlapping.

c variables are provided in MELA in initial data (**rsd** type) files (see initial data files in Appendix C.2 and management unit records in Appendix D.2). Additional c variables can also be generated using JLP 'ctran' transformations (see Lappi 1992).

Domain definitions may appear, for example, in MELAOPT (JLP) problem definitions (see problem definition (**mdl** type) files in Appendix C.2) and in report requests (see the REPORT command in Chapter 3.5.2.2.).

3.4 Program MELASIM

3.4.1 Functions

MELASIM is the stand management and development simulator of the MELA System.

The MELA simulation is based on user-supplied forest resource data, see Chapter 4.6.4 and **rsd** type files in Appendix C.2. The details of the simulation are controlled with MELASIM commands, user-supplied MELA parameter values and specific simulation instructions. The simulation control is

- either automatic on the basis of general event definitions (see the EVENT parameter in Appendix B.2) valid for all management units

- or user-supplied when specific prescriptions are provided for each management unit separately, for example re-simulation instructions (see Chapter 4.1.4) or management proposals, see **sms** type files in Appendix C.2.

Event definitions and other parameter values are customized for each simulation application.

The MELASIM program is used, for example, for the following tasks:

- simulation of optional management schedules for the management units (or equivalent),
- re-simulation of the management schedules selected in a MELAOPT solution, and
- updating of initial forest resource data.

The purpose of the simulation of optional management schedules is to generate feasible management alternatives of stands for the MELAOPT optimization phase. The simulated management schedules are stored in **msd** and **msc** type files (see Figure 3.2, management schedule (**msd** type) files in Appendix C.2 and the decision data record in Appendix D.4). Only necessary decision variables are usually stored. In larger applications, the number of management schedules may become high and consume a lot of disk memory.

The purpose of the re-simulation is to restore the management schedules selected in a MELAOPT solution with sufficient details for presenting and storing the results. Event definitions and other parameter values (the OUTPUT parameter excluded) must be equal to the original simulation of management schedules. Re-simulation requires a simulation instruction file (a **sms** type file) from the MELAOPT solution, see the MELAOPT command REPORT SUMMARY in Chapter 3.5.2.2.

Initial forest resource data can be updated as a separate task or as a part of the simulation of management schedules using the pre-simulation option of MELASIM (see the YEARS parameter in Appendix B and Examples H.13 and H.14).

A typical MELASIM task consists of the following steps:

- generation of application dependent parameters and instructions for simulation, and
- simulation of feasible management schedules for the management units over the calculation period.

3.4.2 MELASIM Commands

3.4.2.1 SIMULATE command

Generic name in Finnish: SIMULOI

Simulate feasible management schedules for the management units of the forestry unit(s).

The general syntax of the SIMULATE command is

```
SIMULATE application forestry_unit[,forestry_unit] instructions
```

or

```
SIMULATE application forestry_unit instructions sub_unit
```

application The name of the **par** type file containing application-dependent MELASIM parameters. For example, the **application** value 'MS' refers to the **MS.PAR** file.

forestry_unit A reference to the forest resource data (**rsd** type files) of the forestry unit.

The value of **forestry_unit** can be

- a reference to the decision hierarchy description for **forestry_unit** in a **par** type file (for details, see the description of **par** type files in Appendix C.2, the FORESTRY_UNIT and forestry_unit_LEVELS parameters in Appendix B.2 and the decision hierarchy in Chapter 3.3.2). The names of **rsd** type files belonging to **forestry_unit** are automatically generated from the lowest level members of the decision hierarchy described in the **forestry_unit.PAR** file.

  NOTE: The reference to the decision hierarchy description for each forestry unit should be provided in a separate **par** type file.

  NOTE: The actual decision hierarchy is given with the FORESTRY_UNIT parameter before the SIMULATE command. If only one decision hierarchy is used, the FORESTRY_UNIT parameter

should be given in the **MELA_SET.PAR** file. For example, if the parameter description FORESTRY_UNIT#FX is found in **MELA_SET.PAR**, the decision hierarchy definitions of the **FX.PAR** file are automatically made available for the MELA session.

- the name of the **rsd** type file containing forest resource data of the whole forestry unit. For example, if **FX.PAR** and decision hierarchy definitions are absent, the value FX refers directly to the **FX.RSD** file.

  NOTE: MELASIM output files are generated separately for each **rsd** type file of the forestry unit.

`instructions` A reference to the standwise simulation instructions (**sms** type files) of the forestry unit, see Appendix C.2.

The value of **instructions** can be

- the name of the MELAOPT optimization **problem** (a **mdl** type file), **only in the re-simulation** of the management schedules selected in a MELAOPT solution.

  NOTE: Re-simulation is possible only, if the standwise simulation instruction (**sms** type) file from the MELAOPT solution is available. For the generation of **sms** type files, see the MELAOPT command REPORT SUMMARY in Chapter 3.5.2.2.

- the value of the **proposals** component in the name of the **sms** type file (see Appendix C.2) containing user-supplied management proposals for individual management units, **only in the simulation of user-supplied management proposals**.

`sub_unit` The name of the individual member in the decision hierarchy of the forestry unit. A **sub-unit** argument is used **only in the case of re-simulation** of the management schedules selected in a MELAOPT solution **for one individual member** of the decision hierarchy, **instead of the whole forestry unit**.

Example 3.12. The simulation of alternative management schedules.

```
SIMULATE MS FX
```

Simulate forest management schedules for the stands according to the parameters given in the **MS.PAR** file. If **FX.PAR** exists, stand data come from **rsd** type files defined by the decision hierarchy in the **FX.PAR** file, otherwise from the **FX.RSD** file.

Example 3.13. The re-simulation of the selected management schedules

```
SIMULATE MSR FX S2
```

Re-simulate the selected management schedules for the management units of the forestry unit FX on the basis of the MELAOPT problem defined in the **S2.MDL** file and collect the information requested in the **MSR.PAR** file.

NOTE: In order to get consistent re-simulation results, the parameters in the **MSR.PAR** file have to be equal to the simulation of the original management schedules (except the OUTPUT parameter). Nevertheless, experiments with careful interpretation can be made by changing the re-simulation parameters.

NOTE: In the re-simulation, the item (1) of the OUTPUT parameter should be set to '0'. Otherwise originally simulated management schedules will be lost, see Chapter 3.2.3.1.

3.4.3 Simulation Parameters

Only some frequently used parameters are introduced here. For more information and additional parameters, see MELA parameters in Appendix B and examples in Appendix H.

NOTE: **The simulation of management schedules is sensitive to all parameters.** If exactly the same simulation results are required in different MELASIM applications, all simulation parameters **must** have exactly the same values.

3.4.3.1 General simulation instructions

YEARS

Generic name in Finnish: VUODET

The YEARS parameter defines the calculation period and its sub-periods. The time period is expressed either in relative (default) or absolute terms. For further details, see the YEARS parameter in Appendix B.2.

OUTPUT

Generic name in Finnish: TULOSTUS

A collection of instructions, for example, for storing management schedules, printing forestry unit and management unit level summaries, and collecting sample plot data into files. For details, see the OUTPUT parameter in Appendix B.2.

SIMULATION_CONTROL

Generic name in Finnish: SIMULOINNIN_OHJAUS

A collection of essential simulation control parameters. For details, see the SIMULATION_CONTROL parameter in Appendix B.2.

LAND_VALUES

Generic name in Finnish: MAAN_ARVOT

The LAND_VALUES parameter defines the land values for the calculation of the net present value of future revenues (NPV). Relevant land values should be defined for each application. For the determination of land values, see Chapter 4.5.1. For details, see the LAND_VALUES parameter in Appendix B.2.

3.4.3.2 Event definitions

EVENT

Generic name in Finnish: TAPAHTUMA

Event definitions describe the optional events available in the simulation of management schedules. Each occurrence of the EVENT parameter generates another alternative event for the automatic simulation. Specific (user-defined) event definitions are required for each different simulation application. For details, see the EVENT parameter in Appendix B.2.

EVENT_DEFAULTS

Generic name in Finnish: TAPAHTUMA_OLETUSARVOT

Default values for the optional items of the event definitions. Default values will be used instead of the missing event definition items. For details, see the EVENT_DEFAULTS parameter in Appendix B.2.

3.4.4 Input File Types

The input of MELASIM consists of materials such as initial forest resource data, different kinds of simulation instructions and auxiliary information. For details of files, see Appendix C. See also Figure 3.2.

Some common input files:

par type files — MELA parameter values (including event definitions) specific to each application.

rsd type files — User-supplied initial forest resource data.

sms type files — Standwise simulation instructions (for re-simulation or simulation of management proposals).

sym type files — Symbol definitions (see Chapter 3.2.1.5.).

tab type files — Instructions for the generation of forest level summary reports. For different report versions (language, variables), see the MELA_TABLE parameter in Appendix B.2.

vol type files — Stem volume and timber assortment tables.

3.4.5 Output File Types

The output files of MELASIM transfer simulation results directly to the user and for further processing in MELAOPT and in user programs. For details of files, see Appendix C. See also Figure 3.2.

Some common output files:

msc type files — A description of the management schedule data in the respective **msd** type file.

msd type files — Management schedule data.

NOTE: Management schedule (**msc** and **msd** type) files store and transfer selected decision variables from MELASIM to MELAOPT.

NOTE: In re-simulation, the item (1) of the OUTPUT parameter should be set to '0'. Otherwise originally simulated management schedules will be lost.

sum type files — Forest level summary (decision data) reports. In MELASIM, the generation of **sum** type files is controlled by the items (2) and (5) of the OUTPUT parameter (see Appendix B.2) and by instructions for the generation of summary reports (see **tab** type files).

NOTE: The default naming of **sum** type files is different in MELASIM and MELAOPT. For details, see forest level summary report (**sum** type) files.

3.4.6 Computing Capacity

The capacity of MELASIM depends on the program version being used, see actual delivery parameters. Some other limits and general recommendations are given here.

The maximum number of management units in one **rsd** type file is limited in each MELASIM version. If there are more management units, they can be organized into several **rsd** type files.

The maximum number of sample plots in each management unit can be controlled with the item (11) of the SIMULATION_CONTROL parameter. If the number of sample plots in the initial data exceeds the parameter value, extra sample plots constitute an additional management unit. However, confusions in further processing of results may occur.

The number of sample plots in one management unit should never exceed 100 sample plots assuming that the average number of sample trees for each sample plot is 10.

The maximum number of sample trees on a sample plot is limited to 500.

The maximum number of simulated management schedules for each management unit can be controlled with the item (8) of the SIMULATION_CONTROL parameter. If the maximum number is reached, the management schedule with natural processes is still simulated and the simulation is continued in the next management unit. However, confusions are likely to occur if limits of this kind are set. If there are plenty of simulation periods and optional events, the number of management schedules can rise high.

The overall computing capacity for a single management unit is restricted by memory available for a management unit and for a management schedule. The amount of memory required is a function of the number of sample plots and sample trees in a management unit, the number of sub-periods and the number of optional events. The capacity of simulation memory should become critical only in extreme cases.

In the case of thousands or more of management units and hundreds of thousands management schedules, the disk capacity can become critical.

3.4.7 Errors and Troubleshooting

For additional warnings and error messages, see Chapter 3.2.4.

3.4.7.1 Some common error conditions

- Disk is full.

  The details of the error message vary in different operating systems. MELASIM terminates anyway.

The amount of disk memory needed depends on data material and simulation parameters. Depending on your needs, delete unnecessary files in order to increase the amount of free disk memory or reconsider the relevance of the simulation parameters or get a larger disk.

- Output file is not found after a successful simulation.

  MELASIM may not have generated the file.

  The generation of output files is controlled with the OUTPUT parameter, see Appendix B.2. Edit the parameter values to get the required output.

- Unexpected function of MELASIM.

  Missing, faulty, inconsistent or unintended parameter values can generate unexpected or wrong results. Notice that the defects of the results may sometimes be difficult to detect.

  Check your parameters and parameter files. For example, alternative management schedules cannot be simulated without user-supplied event definitions.

3.4.7.2 Some warnings and error messages

NOTE: There are not messages for all potential errors.

- `Cannot find file: 'filename'`

  An error message is printed when MELASIM tries to open a file, which is not found. If **SYMBOL.SYM**, **MELA_SET.PAR**, **VOLUME.VOL** or the initial data (**rsd** type) file is not found, the simulation always terminates.

  > NOTE: MELASIM tries to open a simulation instruction (**sms** type) file in the beginning of the simulation. Depending on the type of simulation, this might be an expected or unintended situation; omit message in the first case.

- `Error in number of parameter items: 'parameter_name'`

  A warning message is printed if the number of parameter values is not correct. The given values will be omitted and the default values will be used.

  Check the validity of the results carefully.

3.5 Program MELAOPT

3.5.1 Functions

MELAOPT is the integrated forest production and stand management optimizer module of the MELA System. On the basis of the user-supplied LP problem (objective and constraints), both the forest and stand level solutions are searched from the stand level management schedules. The forestry unit in question may consist of several members on several decision hierarchy levels. Constraints can be given both for the whole forestry unit and for its subsets. JLP (Lappi 1992) is the LP solver module in MELAOPT. In fact, MELAOPT contains the entire JLP package as a subroutine.

MELAOPT performs the following tasks:

- solves JLP optimization problems,
- generates different kinds of reports from the solution, and
- generates re-simulation instructions of the selected management schedules.

MELAOPT consists of the MELAOPT routines and the embedded JLP routines. The MELAOPT routines read initial data and problem definitions, transmit them into the JLP routines and generate MELAOPT reports based on the JLP solutions.

The MELAOPT program can be run in two modes:

- MELAOPT mode (see the SOLVE command in Chapter 3.5.2.1), and
- JLP mode (see the JLP command in Chapter 3.5.2.3).

A typical MELAOPT task consists of the following steps:

- selection of relevant decision variables,
- formulation of the optimization problem at the forest level,
- selection of the forest and stand level solution (the SOLVE or JLP commands),
- generation of requested reports and files (the REPORT command), and
- analysis and evaluation of the results.

3.5.2 MELAOPT Commands

3.5.2.1 SOLVE command

Generic name in Finnish: RATKAISE

Find a production program for the forestry unit and relevant management schedules for the management units in accordance with the user-supplied objective and constraints over time (for the present formulation of the MELA optimization problem, see Lappi 1992). Print automatically a short forest level solution found for all the domains referred in the problem definition of the actual **mdl** type file (see the REPORT SOLUTION command in Chapter 3.5.2.2).

Notice that the simulated management schedules define the search space in the MELAOPT optimization. Solutions are found from the management schedules of the actual **msc** and **msd** files of the forestry unit only. It is necessary to define dedicated simulation instructions and to simulate management schedules for each different application type separately, see the MELASIM program in Chapter 3.4.

The general syntax of the SOLVE command is:

```
SOLVE problem forestry_unit[,forestry_unit]
```

or

```
SOLVE problem forestry_unit[&forestry_unit]
```

In the case of the comma (',') as a delimiter between forestry units, the problem is solved for each forestry unit separately.

The character ampersand ('&') as a delimiter between forestry units means that the problem is solved for all the forestry units together.

problem The name of the **mdl** type file containing the linear programming problem definition.

The linear programming problem is provided in the JLP problem definition language. JLP 'xvar' and 'prob' sections are needed at least. For further information about problem definitions, see JLP User's Guide in Lappi (1992) and the description of **mdl** type files in Appendix C.2.

For the available decision variables, see the MSD_VARIABLES parameter in Appendix B.2.

NOTE: It is recommended to design in advance a number of relevant problem definitions (**mdl** type files) for common forest management

problems. They can then be used as well to solve actual forest management problems as for mapping the feasible solution space (or the limits of the production potentials) in the first phase of planning. In the second phase of planning, some or one of these solutions can probably serve as the starting point for defining the final production program (see Chapters 2.2.2 and 4.2.1).

forestry_unit A reference to the initial data (**rsd** type) files and the management schedule data (**msc** and **msd** type) files of the forestry unit.

The value of **forestry_unit** can be

- either a reference to the decision hierarchy description file of the forestry unit,
- or the name of the **rsd** type file the containing initial data and the **msc** and **msd** type files containing the management schedule data.

For more information, see the **forestry_unit** argument in Chapter 3.4.2.1.

NOTE: A considerable time may be needed to read all the initial data (**rsd** type) and management schedule (**msc** and **msd** type) files of large forestry units.

Example 3.14. The selection of a production and management program for a single forestry unit.

```
SOLVE S2 FX
```

Solve the optimization problem given in the **S2.MDL** file using the management schedules for the forestry unit FX.

If **FX.PAR** exists, initial data are obtained from **rsd** type files and management schedule data from **msc** and **msd** type files defined by the decision hierarchy in the **FX.PAR** file, otherwise from the **FX.RSD**, **FX.MSC** and **FX.MSD** files.

Example 3.15. The selection of a production and management program for two forestry units in one.

```
SOLVE S2 F1&F2
```

Solve the optimization problem given in the **S2.MDL** file for the forestry units F1 and F2 together.

3.5.2.2 REPORT command

Generic name in Finnish: TULOSTA

Generate requested reports and files from the MELAOPT solution for the whole forestry unit as well as its sub-units and other domains. There are available both forestry unit level and management unit (stand) level results.

The general syntax of the REPORT command is

```
REPORT request_type [domain_definition:][,domain_definition:]
```

Generate the requested reports from the MELAOPT solution after the SOLVE command. For the report files, see Appendix C.2 and for the reports, see examples in Appendix H.

NOTE: Domain definitions are valid for the SOLUTION and SUMMARY requests only.

NOTE: A SOLUTION type report is automatically generated after each successful SOLVE command for all domains referred in the problem definition.

request_type A report type, that can have following values:

JLP_SOLUTION

Generic name in Finnish: JLP_RATKAISU

Print the last JLP solution on the terminal in the JLP style, see JLP User's Guide in Lappi (1992). See Example H.41.

MARGINALS

Generic name in Finnish: RAJAHINNAT

Store the costs of decrease and increase for x variables from the last JLP solution in a **mrg** type report file, see Example H.42.

For information about JLP marginal analysis, see Chapter 4.1.3.3 and JLP User's Guide in Lappi (1992).

NOTE: The costs of decrease and increase for x variables are not calculated as a part of the standard solution in MELAOPT. That is why the generation of a MARGINAL report will usually take much time. See also **mdl** type files in Appendix C.2.

SCHEDULES

Generic name in Finnish: VALITUT

Store a short list of the selected management schedules from the last JLP solution in a **sch** type report file. See Example H.43.

SHADOW_PRICES

Generic name in Finnish: VARJOHINNAT

Store shadow prices of the last JLP solution in a **shp** type report file.

For information about shadow prices, see Chapter 4.1.3.2 and JLP User's Guide in Lappi (1992). See Example H.44.

SOLUTION

Generic name in Finnish: RATKAISU

Store the last forest level solution for all the domains referred in the problem definition in a **sol** type report file directly from the JLP memory. The variables of the report are determined at the 'xvar' section in a **mdl** type file. See Examples 2.1 and H.30.

SUMMARY

Generic name in Finnish: TAULUKKO

Store the summary of the last forest level solution in a **sum** type report file. The summary report is generated on the basis of the selected management schedules from management schedule (**msc** and **msd** type) files and the actual instructions for the generation of summary reports (a **tab** type file). See Examples 2.2 and H.18.

The REPORT SUMMARY command also generates **mps**, **sms** and forest level **msc** and **msd** type files, see Appendix C.2.

`domain_definition:` A logical statement in terms of c variables with the character colon (':') at the end of the statement, see JLP User's Guide (Lappi 1992). Domain definitions are valid for the SOLUTION and SUMMARY requests only.

The specific domain definitions:

`all:` the whole forestry unit or all the management units in the current JLP optimization problem, and

`domains:` all the domain referred in the preceding SOLUTION requests and in the current JLP problem definition.

The 'all:' and 'domains:' definitions may not appear as the components of the logical statements.

> NOTE: Even if the 'domains:' definition may appear in the SOLUTION and SUMMARY requests, the domains from the SOLUTION requests are applied in both cases.

Logical statements consist of one or many relational expressions linked with logical operators:

Logical operator		Meaning
.and.	&	logical conjunction
.or.		logical disjunction
.not.		logical negation

Relational expressions consist of operands and values of operands separated with relational operators:

Relational operators		Meaning
.gt.	>	greater than
.lt.	<	less than
.ge.	>=	greater than or equal
.le.	<=	less than or equal
.eq.	=	equal
.ne.		not equal

Operands and values are linked in relational expressions in the following ways:

Operand	Value of operand
the name of the c variable in the last JLP problem solved	the valid value of the c variable
the name of the decision hierarchy level in the last JLP problem solved	the member of the decision hierarchy level
'data'	the value (or one of the values) of the argument **forestry_unit** in the last SOLVE command

See Examples 3.17 and 3.18.

Example 3.16. The generation of a MELAOPT solution report.

```
REPORT SOLUTION
```

Generate a SOLUTION type report for the whole forestry unit from the last JLP solution.

Example 3.17. The generation of a MELAOPT solution report for the domain defined by a simple relational expression.

```
SOLVE S2 F1&F2

* For the explanation of the expression 'F1&F2'
* as the value of the forestry_unit argument,
* see Chapter 3.5.2.1.

REPORT SOLUTION data=F1:
```

Generate a SOLUTION type report for the domain 'data=F1:' from the last JLP solution.

Example 3.18. The generation of a MELAOPT summary report for the domain defined by a logical statement consisting of relational expressions.

```
C_VARIABLES#UNIT#AREA#SITE#CATEGORY#OWNER
SOLVE S2 FX
REPORT SOLUTION DISTRICT=F1.and.OWNER>2:
REPORT SUMMARY
```

Generate a SUMMARY type report for the domain 'DISTRICT=F1.and.OWNER>2:' from the last JLP solution. Notice that F1 is here a valid DISTRICT level member of the forestry unit FX and OWNER is a valid and accessible c variable of the forest resource data (see **rsd** type files in Appendix C.2, management unit records in Appendix D.2 and the C_VARIABLES parameter in Appendix B.2).

3.5.2.3 JLP command

The MELAOPT command JLP without an argument turns the MELAOPT mode to the JLP mode (see Chapter 3.5.1), where all JLP commands and definitions are available, in addition to the management unit and management schedule data from MELA files. After the return from the JLP mode (the JLP command 'end'), the MELAOPT session continues.

If the MELAOPT command JLP is given with a JLP command as an argument, program control turns temporarily to the JLP mode. Program control automatically returns to the MELAOPT mode after the execution of the JLP command.

The JLP mode during a MELAOPT session makes it possible to utilize all JLP features with MELA data, for example, transformations ('ctran', 'dtran' and 'xtran' transformations) and additional domains for reporting (the JLP command 'show/domains'). For details, see Lappi (1992).

In the JLP mode, the same management unit data can be used (without reading the data for each problem again) for several subsequent JLP 'solve' commands and problems with the MELA decision variables introduced at the 'xvar' section of the last MELAOPT problem definition (**mdl** type) file.

NOTE: The JLP mode is recommended for users having previous experience in the use of JLP or needing JLP properties, that are not available in the MELAOPT mode.

```
JLP
```

Turn from the MELAOPT mode to the JLP mode. See Examples H.39 and H.40.

NOTE: Use the JLP command 'end' to return from the JLP mode to the MELAOPT mode.

NOTE: In the JLP mode, the JLP 'mrep' command is used for the generation of the MELAOPT type reports, for the command arguments see Chapter 3.5.2.2.

```
JLP jlp_command
```

Execute the JLP command in the JLP mode and return immediately to the MELAOPT mode.

jlp_command An individual JLP command to be executed in the JLP mode, see JLP User's Guide (Lappi 1992).

3.5.3 Optimization Parameters

Only some frequently used parameters are introduced here. For more information and additional parameters, see MELA parameters in Appendix B and examples in Appendix H.

C_VARIABLES

Generic name in Finnish: C_MUUTTUJAT

The names of the c variables of the management unit records (see Appendix D.2) stored in initial forest resource data (**rsd** type) files. For details, see the C_VARIABLES parameter in Appendix B.2 and Example H.1.

INTEGERAPPROXIMATION

Generic name in Finnish: KOKONAISLUKURATKAISU

The presentation of the JLP solution, true optimum or integer approximation. For details, see the INTEGERAPPROXIMATION parameter in Appendix B.2.

3.5.4 Input File Types

The input of MELAOPT consists of materials such as initial forest resource data, management schedule data, JLP problem definitions and auxiliary information. For details of files, see Appendix C. See also Figure 3.2.

Some common input files:

mdl type files — A JLP problem definition.

msc type files — The description of the management schedule data in the corresponding **msd** type file.

msd type files — Management schedule data.

NOTE: Management schedule (**msc** and **msd** type) files store and transfer the selected decision variables from MELASIM to MELAOPT.

par type files — MELA parameter values.

rsd type files — User-supplied initial forest resource data, including the c variables of the management units.

sym type files — Symbol definitions (see Chapter 3.2.1.5).

tab type files — Instructions for the generation of forest level (decision variable) summary reports. For different report versions (language, variables), see the MELA_TABLE parameter in Appendix B.2.

3.5.5 Output File Types

The output files of MELAOPT transfer optimization results directly to the user and for further processing with user programs and with MELASIM (re-simulation). For details of files and their generation, see Appendix C and the command REPORT in Chapter 3.5.2.2. See also Figure 3.2.

Some common output files:

mps type files — Selected simulation and decision variables for further processing (for example, for transmission to the user's forest database).

mrg type files — The cost of change reports.

msc type files — A description of the forest level summary data in the corresponding **msd** type file.

msd type files — Forest level summary data for further processing.

sch type files — Management schedule (stand level solution) reports.

shp type files — Shadow price reports.

sms type files — Standwise simulation instructions for the transmission of the re-simulation instructions of the selected management schedules from MELAOPT to MELASIM.

sol type files — Forest level solution reports.

sum type files — Forest level summary (decision data) reports. In MELAOPT, **sum** type files are generated by request using instructions for the generation of summary reports (a **tab** type file).

NOTE: The default naming of **sum** type files is different in MELASIM and MELAOPT. For details, see forest level summary report (**sum** type) files in Appendix C.2.

3.5.6 Computing Capacity

MELAOPT versions in different sizes are available for computers with different capacity and for different types of applications.

MELAOPT memory requirements depend on following factors:

- number of management units,
- number of management schedules in management units,
- number of decision variables defined at the JLP 'xvar' section,
- number of constrains in a problem definition, and
- number of c variables in initial data.

3.5.7 Errors and Troubleshooting

For additional warnings and error messages, see Chapter 3.2.4.

3.5.7.1 Some common error conditions

- Disk is full.

  The details of the error message vary in different operating systems. MELAOPT terminates anyway. - This is not a typical error message in MELAOPT. Sometimes

JLP can produce a big swap file during the problem execution and there might be a shortage of free disk space.

Delete unnecessary files to increase the amount of free disk space, reconsider the optimization task or get a larger disk, depending on your needs.

- Output file is not found after a successful optimization.

  MELAOPT may not have created the file yet.

  MELAOPT output files are generated by request only (see the REPORT command in Chapter 3.5.2.2), after a successful solution of the JLP problem. Try again.

- Unexpected function or results.

  Missing, faulty, inconsistent or unintended optimization problems and parameter values can generate unexpected or wrong results. Notice that the defects of the results may sometimes be difficult to detect.

  Check your optimization problems, parameters and parameter files. If necessary, check also the MELASIM session log for the simulation parameters and the management schedules generated.

- Conflicts with lower and upper case letters in problem definitions.

  The use of upper case letters in the JLP problem definition is not allowed.

  Check your problem definition (**mdl** type) file.

- Conflicts with 'xvar' and 'prob' sections in a problem definition file.

  The 'xvar' section must contain all the variables referred in the 'prob' section, at least, otherwise unexpected results without warnings will be obtained. See also the JLP z variables in JLP User's Guide in Lappi (1992).

  Check your definitions in the problem definition (**mdl** type) file.

- Undefined variables in JLP problem definitions.

  The JLP problem definition in a **mdl** type file must contain only existing and accessible variables, for example, faulty or infeasible results are obtained due to variables referring outside of the calculation period.

  Check your JLP problem definition in the **mdl** type file.

- Infeasible JLP problems.

  Linear programming problems can be solved in the case of feasible (nonconflicting) constraints only. Notice that the probability of infeasible solutions depends, for

example, on the problem formulation, the management schedules available and the number and the relationships of the constraints provided.

There is no universal way for treating infeasibilities. Try first to find out the reason for infeasibility. Get, for example, the JLP solution report in order to point out the infeasible constraint, see the REPORT JLP_SOLUTION command in Chapter 3.5.2.2. Check the relevance of the infeasible constraint as well as formal errors and misunderstandings in the problem definition. Study the shadow prices in order to learn the nature of the problem. Study the cost of change information of JLP for changing constraints.

Decrease the number of constraints in the case of numerous ones. Start from the simple problem and add new constraints one by one (see also Chapter 4.2.3.1). Change gradually the infeasible constraint and try to solve the problem again. Reconsider the importance of the infeasible constraint. Consider the interrelations of the constraints. Reconsider the problem formulation in general.

Notice that the infeasibilities may reveal inadequacies in the data and in the model as well as characteristics of the optimization problem and of the phenomenon being studied.

- JLP computation failures in optimization.

  In the case of large and complex problems, rare kinds of computation problems may occur. For a discussion about potential failures, see Chapter 5.3 in Lappi (1992).

3.5.7.2 Some warnings and error messages

NOTE: There are not messages for all potential errors.

- `Cannot find file: 'filename'`

  An error message is printed when MELAOPT tries to open a file, which is not found. If **SYMBOL.SYM**, **MELA_SET.PAR**, the management schedule (**msc** or **msd** type) file or the initial data (**rsd** type) file is not found, the optimization always terminates.

- JLP warnings and error messages.

  MELAOPT prints JLP warnings and error messages as such, see Chapter 5.2 in Lappi (1992).

  For example, JLP checks the ranges of arrays and character strings. If an overflow occurs, JLP prints a short error message telling the name of the memory item in error, and MELAOPT terminates. See Example 3.19.

  In the case of JLP capacity problems and failures, contact your system manager or the MELA Team.

Example 3.19. A JLP memory overflow message as an example of JLP messages.

```
*PAR* increase MAXML
```

An example of the JLP messages. Here, the maximum number of management units in the MELAOPT version was exceeded. For a discussion about the JLP syntax errors, see Chapter 5.1 in Lappi (1992).

Part 4

MELA Cookbook

MELA Cookbook deals with issues how to use MELA for solving practical forest management problems and how to interpret MELA results. The reader is assumed to be familiar with MELA and the basic concepts and steps of the MELA analysis introduced in Parts 1 - 3 of the MELA Handbook. The approach presented here is to provide some general hints and experiences rather than detailed instructions for all potential applications. For further sample runs and results, see Appendix H.

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Part 4

MELA Cookbook

4.1 MELA Results

4.1.1 MELA as an Analysis and Planning Tool

4.1.1.1 Interpretation and use of model-based results

MELA is a forestry model, an image of forests and forestry. Models are not complete images of reality because of inevitable simplifications and uncertainties, even of the lack of the underlying information. However, models provide a way to look at the potential consequences of forest production and management decisions by organizing the almost infinite number of decision possibilities.

Thus MELA, like any other model-based planning tool, should serve as an analytical tool for better understanding of the decision object, forests - and for better decisions.

The users are responsible for their data, analyses, results and interpretations. They are assumed to know the underlying methods and the potential errors in various steps of the analysis.

The precondition for good results is that the model users are aware what they are doing. The results of complex models should never be implemented in practice as such without human interpretation and validity checkings. For example, the quality, the details, the aggregation level and the biases of the underlying information in each specific analysis situation put the ultimate limits to the utilization of model-based calculation results.

MELA results are conditional with regard to the underlying assumptions. They depend on, for example, the following types of factors and their interactions:

- forest resource data,
- models of natural processes,
- models of costs and revenues,
- forest management models,
- optional events provided for simulation,
- optimization problems describing the goals for forestry,
- factors completely or explicitly missing from analysis,

- implicit assumptions in data, individual models and software, and
- errors and uncertainties in various steps of the analysis process.

Besides that, optimization results do apply with the forest management policy described by the optimization problem only, they should never be interpreted as general predictions. Furthermore, the results after the first sub-period are conditional also to the developments during each preceding sub-period. Due to the future uncertainties, the principal interest in MELA results should be laid on the first sub-period even if more far-reaching analyses were carried out, for example, to take into account the future sustainability aspects with the policy under study.

In the analyses of such uncertain, large-scale and long-term problems as in forestry, model based results should always be critically evaluated by forest production and management planners and decisions makers, taking into account the potential errors and risks. A planning tool never makes decisions. It just provides options for interpretation and consideration. Besides the professional skills of the modelers and the expertise of the model users, common sense is also required in order to realize when imaginary results or absurd decisions are due to defective analyses or poorly understood models.

The output of the MELA runs should by no means be understood as the only or ultimate result of forestry analysis. Instead, the optional scenarios should demonstrate the conditionally open and regulable future of managed forests as a basis for the utilization and management of forests. As well they should provide material for more ambitious analyses and new analyses designs. The decision problems may reach, for example, from the search for the attainable targets for forest production and product mix in the short and long term, taking into account also the need of reserve supplies and the consecutive losses in production, to the relevant level of reliability and details of information required for these analyses. The creative and critical mind of the user will play the key role in forestry analysis, creative in the design of the analyses and critical in the interpretation of the analysis results.

See also Part 1 of the MELA Handbook for some additional considerations in the review of the development of the model-based forest management planning methodology in Finland.

4.1.1.2 Further processing of MELA results

The policy in the current MELA software is to provide results both in the form of table type reports directly for users and in the form of files for further processing by user programs or commercial software for creating tables, graphics, maps, etc. The reports and the files currently available are shortly introduced in the following chapters of MELA Cookbook. For the details of the reports, the files and the available information, see Part 3 and Appendices B, C, D and H.

4.1.2 Introduction to MELA Results

MELA results fall into three categories:

- temporary run-time results for the control of the analysis process,
- intermediate calculation results and materials from one program module to another, and
- final analysis results directly to user or for further processing with other programs.

Most of the final MELA results come from the optimization phase (MELAOPT). The simulation phase just generates alternative management schedules, i.e. material for the optimization. The re-simulation of the selected management schedules after the optimization is sometimes needed to generate such forest, management unit, sample plot or sample tree level details that were not stored in the simulation of the alternative management schedules. For an overview on the steps and files of MELA analysis, see Chapter 2.1 and Figures 1.2, 3.2 and 4.1.

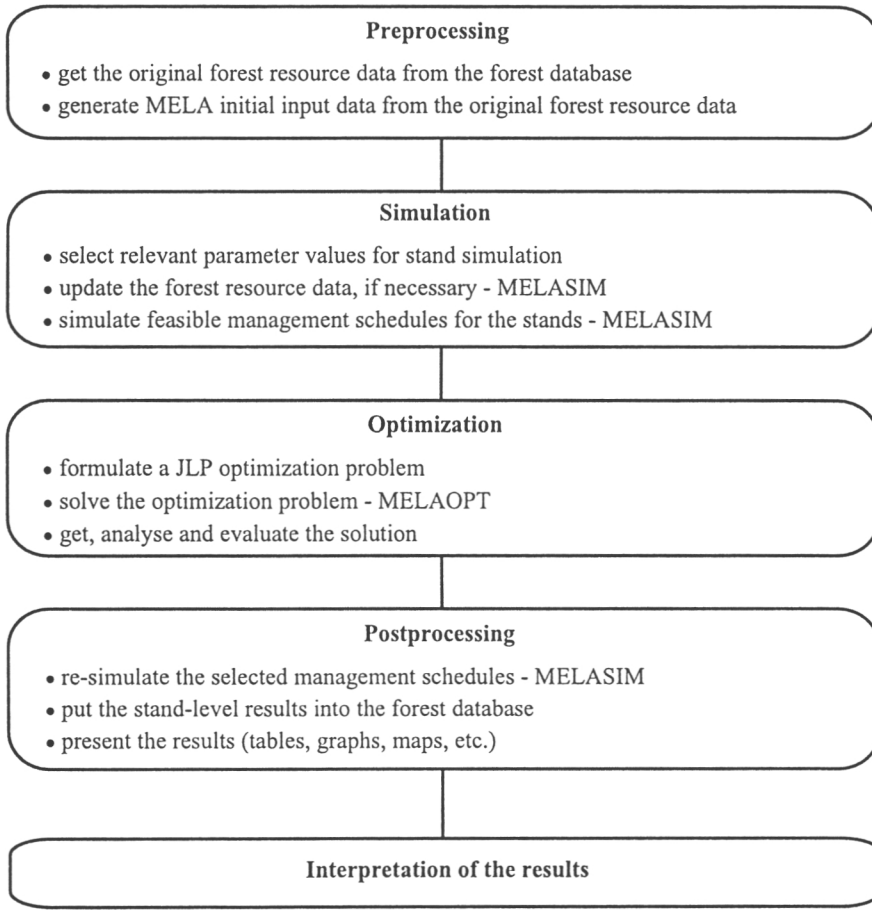

Figure 4.1. The steps of the MELA analysis.

MELA results are supplied as:

- temporary run-time reports (lists and tables on the computer display),
- text files (for example, lists and tables in **sum, mrg, sch, shp** and **sol** type files, see Appendix C.2) for printing or for displaying the results in another window, and
- system files (for example, **msc, msd, sms, smr** and **mps** type files, see Appendix C.2) for further processing by the MELA programs or by other programs.

Some of the MELA results are generated automatically, but most of the results are optional. The optional results are requested by the user with parameter or option definitions (e.g. the OUTPUT parameter, see Appendix B.2) or with MELA commands (e.g. the REPORT command, see Chapter 3.5.2.2).

> NOTE: Temporary run-time reports on the computer display can be usually directed and stored also in files, for example, log files of batch runs, see instructions of your operating system.

MELA results are multi-dimensional by their nature. The analysis provides a remarkable number of interrelated variables (see simulation and decision data records in Appendix D) from the multiple hierarchical levels of trees and stands to the whole forestry unit (see Figure 1.4) over time (see the YEARS parameter in Appendix B.2). The analyst should make this information comprehensible to the decision maker. In principle, one should be able to look at a glance easily at the interrelated information in order to visualize and grasp the relationships. In spite of the development of the visualization software, the presentation of the huge amount of essential information is still more demanding than the limited physical size of the current presentation media (such as computer displays and book pages) allows.

> NOTE: In the current MELA version, there are no built-in graphics for the presentation of the results. However, MELA text files and some system files can be easily converted for further processing by commercial graphic or spreadsheet packages.

4.1.3 Optimization Results from MELAOPT

4.1.3.1 Summary results at the forest level

The forest level values for decision variables over time are the primary results from a MELA optimization task. The summary shows the temporal behaviour and relations of the decision variables at a glance. The forest level results from MELAOPT come from two interrelated sources:

- directly from the JLP memory (from the solution of the linear programming problem), and
- by summarizing decision variables (see Appendix D.4) of the selected management schedules from management schedule (**msc** and **msd** type) files (see Appendix C.2).

The MELAOPT command SOLVE provides automatically on the computer display the JLP forest level solution (see Example 2.1 and Appendix H.5) for all the domains and decision variables referred in the JLP problem formulation in the **mdl** type file.

The forest level solution on the display from the JLP memory can be repeated by the MELAOPT command

```
MELAOPT>REPORT SOLUTION
```

The standard JLP report is printed either by the MELAOPT command (see Chapter 3.5.2.2)

```
MELAOPT>REPORT JLP_SOLUTION
```

or by the following commands in the JLP mode (see Chapter 3.5.2.3 and Lappi 1992)

```
MELAOPT> JLP
JLP> printlevel 3
JLP> recall
JLP> end
MELAOPT>
```

The summary of decision variables from management schedule files into **mrg, sch, shp, sol** and **sum** type files (see Appendix C.2) is generated using the MELAOPT command

```
MELAOPT>REPORT SUMMARY
```

For the options and details of the REPORT command, see Chapter 3.5.2.2.

The most detailed forest level results are obtained from the re-simulation of the selected management schedules. This feature is discussed in Chapter 4.1.4.1. See Examples H.45 to H.48.

The list of summary variables to be printed and the instructions for printing are supplied in a summary report definition (**tab** type) file (see Appendix C.2). See Examples H.3, H.4, H.8 and H.48.

4.1.3.2 Shadow prices and reduced costs

Shadow prices constitute the solution of the dual problem of the original linear programming problem. Dual problem can be used to analyze the marginal changes of the objective function caused by the slight modifications in the current optimization problem. In JLP, shadow prices are calculated for constraints, for x variables, for management units (for their area constraints) and for management schedules. For example, the shadow price of a constraint shows the change of the objective function value in response to a small change of the right hand side indicating also how much it is at best profitable to pay (in terms of the objective function) for adding an extra unit to the value of the constraint. For further details of the shadow prices, for reduced costs and for the marginal analysis capabilities of JLP in general, see Lappi (1992).

> NOTE: The shadow prices are valid only with the solution of the defined linear programming problem. The shadow prices may be sensitive to the changes of the problem making their generalization uncertain. The sensitivity may also be due to the small number of management units and the discontinuous character of management schedules.

If the constraint is not effective (i.e. nonbinding) in the MELAOPT solution, the value of the shadow price is zero indicating that there is no use for an extra unit of the constraint.

> NOTE: Each effective constraint in the MELAOPT solution may split a management unit into parts for two or several management schedules. As a rule, the number of management unit splits is (less or) equal to the number of effective (or binding) constraints.

The values of the shadow prices for constraints and x variables are obtained by the MELAOPT command (see Example H.44)

```
MELAOPT>REPORT SHADOW_PRICES
```

The standard JLP report containing the shadow prices and the reduced costs is printed either by the MELAOPT command (see Chapter 3.5.2.2 and Example H.41)

```
MELAOPT>REPORT JLP_SOLUTION
```

or by the following commands in the JLP mode (see Chapter 3.5.2.3 and Lappi 1992)

```
MELAOPT> JLP
JLP> printlevel 3
JLP> recall
JLP> end
MELAOPT>
```

See also Chapter 4.1.3.4.

Shadow prices are one of the strong capabilities of linear programming. They can be used, for example, for the search of more efficient problem formulations and solutions and for sensitivity analyses. Shadow prices of economically relevant variables can be compiled into economical terms, such as the internal rates of return. According to Kilkki (1987), the shadow prices contain the information to select the management for the stands based on the MELAOPT solution (see also Chapter 4.3.5).

The users of MELA are strongly encouraged to get familiar with the concept of the shadow price and the practical interpretation of the shadow prices starting, for example with Dykstra (1984), Kilkki (1987) and Lappi (1992).

4.1.3.3 Cost of increase and cost of decrease

JLP introduced a new concept, the cost of increase and the cost of decrease of x variables (Lappi 1992) besides the conventional marginal analysis of the dual solution, such as the shadow prices and the reduced costs. The cost of increase or decrease indicates the change in the objective function value if a JLP x variable (a decision variable in the 'xvar' section of a **mdl** type file) should get a slightly larger (the cost of increase) or smaller value (the cost of decrease) than in the current solution while all original constraints stay unchanged. The possibly resulting infeasibility is expressed by the infinite value of the cost in question.

The costs of increase and decrease are useful, for example in the selection of new constraints to the linear programming problem without trying each variable separately.

The costs of increase and decrease for x variables are calculated in MELAOPT by request (see the REPORT MARGINALS command in Chapter 3.5.2.2) for the variables referred in the current problem definition (see the JLP 'xvar' section in **mdl** type files).

The values for the costs of increase and decrease are obtained from the MELAOPT solution by the MELAOPT command

```
MELAOPT>REPORT MARGINALS
```

The standard JLP report is printed by the JLP mode commands (see Chapter 3.5.2.3 and Lappi 1992)

```
MELAOPT> JLP
JLP> printlevel 3
JLP> show/cost
JLP> recall
JLP> show/nocost
JLP> end
MELAOPT>
```

NOTE: The calculation of the costs of decrease and increase may take a remarkable computing time.

4.1.3.4 Management unit level results

The management schedules selected in the optimum solution constitute the management unit level result of the optimization. The list of the selected management schedules for management units is requested by the MELAOPT command

```
MELAOPT>REPORT SCHEDULES
```

The standard JLP report containing also the shadow prices of the management units and the management schedules is printed by the following commands in the JLP mode (see Lappi 1992)

```
MELAOPT> JLP
JLP> printlevel 3
JLP> schedules
JLP> end
MELAOPT>
```

NOTE: In the current MELAOPT version, there is no direct built-in report for showing the parameters (e.g. the proposed cuttings and growth projections) of the management schedules selected in the optimum solution. See Chapter 4.1.3.5 and Appendix H.7 for the transfer of management schedule information into **mps** type files for further processing.

NOTE: The detailed management unit level results obtainable from the re-simulation of the selected management schedules are discussed in Chapter 4.1.4.2.

4.1.3.5 Materials for further processing

The management unit level information is provided for the management schedules selected in the optimum solution. This information can be saved into stand management (**mps** type, see Appendix C.2) files during a MELAOPT session and further transferred to user applications, for example to the stand database.

The management report records are generated for each management schedule from the decision data and management schedule records of the management schedule (**msd** type) files. The optimum solution records for the management units are obtained from the MELAOPT solution.

The generation of management report records in MELAOPT is controlled by the MPS_VARIABLES parameter (the variables to be picked into the management report records).

> NOTE: The item (1) of the OUTPUT parameter controls the storing of **msc** and **msd** type files in MELASIM. The parameters MSD_VARIABLES (management schedule data) and MSR_VARIABLES (management schedule records from simulation records) control the selection of variables to the respective records. For further details of these parameters, see Appendix B.2.

The stand management (**mps** type) files are generated by the MELAOPT command

```
MELAOPT>REPORT SUMMARY
```

See Examples B.34, B.35 and H.49 to H.52.

4.1.4 Re-simulation Results from MELASIM

4.1.4.1 Introduction to re-simulation

The immediate results of MELAOPT originate from the management schedule information transferred from MELASIM via intermediate files, such as management schedule (**msc** and **msd** type) files. The information types and the variables are limited to the most important ones due to the limited disk space. However, the re-simulation of the management schedules selected in the MELAOPT solution allows to generate afterwards all the management schedule details and consequently the detailed forest level summaries missing from the original MELAOPT results.

For the instructions of the re-simulation of the selected management schedules, see the MELASIM command SIMULATE and Examples 3.13 and H.45 to H.48.

> NOTE: The RE_SIMULATION_INSTRUCTIONS parameter (see Appendix B.2) controls the storing of re-simulation instructions for all management schedules in the management schedule (**msc** and **msd** type) files in MELASIM. The re-simulation

instructions for all management schedules from MELASIM are required for the generation of the re-simulation instructions for the selected management schedules (**sms** type files) in MELAOPT.

The re-simulation instructions for the selected management schedules (**sms** type files) are generated in MELAOPT, assuming that the simulation instructions for all management schedules do exist in management schedule (**msd** type) files, by the MELAOPT command

```
MELAOPT>REPORT SUMMARY
```

For the details and options of the REPORT command, see Chapter 3.5.2.2.

4.1.4.2 Forest level results

The summarized values of all the decision variables (see the variables of the decision data record in Appendix D.4) for the forestry unit (and the lowest level sub-units, if they do exist) over the calculation period constitute the forest level results of re-simulation. The forest level values of the decision variables are presented in MELA summary reports comparable to the MELAOPT summary reports generated by the REPORT SUMMARY command. See Example H.48.

The summary report from the re-simulation can be stored in a summary report (**sum** type) file (see Appendix C.2). The item (2) of the OUTPUT parameter controls in MELASIM the generation of summary reports. The variables to be printed and the formatting instructions are supplied in a summary report definition (**tab** type) file (see Appendix C.2 and Examples H.3 and H.4).

4.1.4.3 Management unit level results

In principle, any details of management units, sample plots and sample trees can be obtained from the re-simulation of the management schedules selected in the MELAOPT solution. The standard management unit level reports available comprise, for example

- the management schedule summary (controlled by the item (3) of the OUTPUT parameter, see Examples H.9 and H.10), and
- the simulation data reports, a complete list of the simulation records (see Appendix D.3) at different points of time (controlled by the item (4) of the OUTPUT parameter, see Examples H.11 and H.12).

The management schedule summary report is recommended if an overview of the selected management schedules for management units is required.

4.1.4.4 Materials for further processing

Initial data (**rsd** type) files contain the original forest resource data of management units.

Management schedule (**msd** type) files generated in the re-simulation of the management schedules selected in the MELAOPT solution may contain

- decision variables in decision data records (controlled by the MSD_VARIABLES parameter and the item (1) of the OUTPUT parameter, see Appendix B.2),
- simulation variables at the management unit level in management schedule records (controlled by the MSR_VARIABLES parameter and the item (1) of the OUTPUT parameter, see Appendix B.2), and
- forest level values for all the decision variables (see Appendix D.4) in forest level summary data (**msc** and **msd** type) files (controlled by the OUTPUT parameter in Appendix B.2).

> NOTE: The old versions of management schedule (**msc** and **msd** type) files should be saved or renamed using operating system commands if the item (1) of the OUTPUT parameter is set to '1' in the re-simulation. Otherwise originally simulated management schedules will be lost.

Simulation record (**smr** type) files generated in the re-simulation contain complete simulation records at different points of time. The generation of simulation record (**smr** type) files is controlled by the item (9) of the OUTPUT parameter and the item (12) of the SIMULATION_CONTROL parameter. For the details of the simulation records, see Appendix D.3. See also Example H.15.

> NOTE: Simulation record (**smr** type) files are accepted as input data of MELASIM instead of initial data (**rsd** type) files. However, the extension of the file name has to be renamed from **smr** to **rsd** before the use of the simulation record files. For further details, see Appendix C.2. Notice that there are currently no management unit (c variable) records in **smr** type files.

4.2 Some Forestry Analysis and Forest Management Planning Problems

4.2.1 Iterative Use of Linear Programming for Forest Management Planning

In the MELA Handbook, planning is defined as the analysis of future potentials, decisions and operations for decision making (see Chapter 1.1). Decision making implies a choice between alternatives. The choice is made by ranking alternatives according to the desirability of the outcomes. The desirability of alternatives is often expressed (or illustrated) via the concept of the utility function.

In practical forestry, there are seldom explicit utility functions. The multiple pertinent factors and the future uncertainties make the decision situations in forestry complex. Intercorrelated alternatives appear simultaneously at several levels of forest production and stand management over the production cycles of decades or centuries. The structure of the forests and the preferences of the forest owners are far from constant. Even the goals for forestry - or the variables of the utility function - may seem at first obscure to the decision maker. In the absence of the explicit utility function, decision making and planning in forestry practice becomes often an iterative search and evaluation process.

In this chapter, forest management planning is introduced as an interactive two-phase process:

- the analysis of decision potentials (i.e. future production and management possibilities), and

- the selection of the final production and management program,

where linear programming and the alternative management schedules for management units are used iteratively in both phases to solve the resulting analysis tasks.

During the interactive analysis process, the decision maker should first learn the decision potentials via analyses of future production and management possibilities and then use this overall information for the choice of the final production and management program. The decision maker should also become aware of the variables of the utility function even if the variables and their coefficients are neither explicitly searched nor found. The learning process and decisions should be strongly supported by the general impression on the overall level of the pertinent factors (resources, natural processes, production, management), the potential decisions with their conditionalities and interactions over time both at the forest and management unit levels.

Chapter 4.2.2 introduces some optimization problems to describe the timber production potentials of forests. A trade-off curve is also an example how to illustrate the interdependencies of forest production. The examples here should just get you started and involved in forestry analysis. More thorough-going experiments and analyses should be designed for each particular decision situation, of course.

Chapter 4.2.3 deals with the selection of the final timber production and forest management program for a forestry unit.

The rough and stereotyped analysis results should be clearly interpreted as tools to support decision making rather than as decisions. On the other hand, the predicted effects of the decisions can well be examined and illustrated by the analysis results.

> NOTE: The strategic type analyses introduced here are valid as well at the forest holding as at the national level.

4.2.2 Analysis of Production and Decision Potentials

4.2.2.1 Cutting potential based on forest management regimes

How much can we harvest from our forests without violating conventional silvicultural recommendations? Cutting potential is defined here as an annual cutting removal supposing that all stands are harvested when they reach the feasibility criteria of immediate cutting defined by the silvicultural regimes.

The optimization problem in Example H.16 is used to determine the cutting potential by selecting the maximum annual harvests during the first sub-period. The violation of the silvicultural regimes is prevented by the simulation of the feasible management schedules subject to the forest management regimes (otherwise the problem formulation presented here is irrelevant for the determination of the cutting potential). The net present value in the beginning of the planning horizon is maximized. A high interest rate (5 % in Finnish conditions) guarantees that the earliest possible cuttings will be selected.

The timber production based on the cutting potential (or a fixed interest rate in general) as a guideline will fluctuate in time. The temporal fluctuation depends on the structure of the forests. The even flow of timber with this type of goal setting should be reached only in a fully regulated (normal) forest.

> NOTE: Depending on the length of the first sub-period, remarkably different estimates for the annual cutting potential will be obtained.

NOTE: The problem in Example H.16 is a typical stand level optimization problem without forest level constraints. Forest level optimization is not necessarily needed for solving stand management optimization problems without binding forest level constraints.

See the main results of the cutting potential problem in Examples H.17 and H.18. Notice that Example H.16 is a reproduction of the **P5.MDL** problem in Part 2 though now it deals with the whole forestry unit FX.

4.2.2.2 Maximum sustained yield

How much can we cut on a sustainable basis? What is the level of the maximum sustained (non-declining) timber production?

There are several definitions for the sustainability of forestry. The conventional approaches may require, for example, the even development of the age structure or total volume, or the total drain may not exceed the total growth. Actually, there may be no absolute or universal measure of sustainability in practice due to the uncertainties of forest information and such external factors as changing climatic conditions, economic environment and human behaviours over time (see also considerations on the regulation and adaptation strategy for timber production and sustainability in Chapter 1.3).

The approach here concerning the estimation of the maximum sustained yield is to assume forestry as an ongoing and efficient business. The definition of the maximum sustained yield over time (see Example H.19) consists of three components:

- the yield maximization and overall efficiency requirement via the maximization of the net present value of timber production in the beginning of the calculation period (here decision variable (804)),

  subject to

- the even or increasing development of cutting removals and net revenues as the sustainability constraints during the calculation period (here decision variables (193), (195) and (370)), and

- keeping up the future yield level after the calculation period via the net present value (NPV) constraints at the end of the calculation period (here decision variable (804)).

In our analyses concerning the maximum sustainable yield, the interest rate for calculating net present values represents approximately the mean value increment of our forests.

We do not know any universal measure for keeping up the sustainability of the yield level after the calculation period. For example, the volume of the growing stock (decision variables (681) - (700)) does not take into account the value of timber, resulting the accumulation of less valuable tree species at the end of the calculation period. The value of the growing stock (decision variables (796) - (800)) at the end of the planning period does not necessarily correlate with the yield potential after the calculation period. Therefore, the present value of the future net revenues (decision variables (801) - (805)) at the end of the calculation period is often selected to represent the volume, the value and the future development aspects simultaneously. However, our net present values in the beginning and at the end of the calculation period are not directly comparable due to the calculation method. That's why the net present value constraint is adjusted to produce a reasonable volume and structure of the growing stock at the end of the calculation period in order to guarantee the sustainable yield level after the calculation period. The role of the final state constraint is emphasized when a short calculation period is applied, and vice versa. Sensitivity analysis subject to the effects of the final state constraints is recommended.

The estimate for the maximum sustained yield depends also on the assumptions concerning the future management and the changes in the management of forests, expressed by the simulation parameters. This estimate should be revised at reasonable intervals even if the abundant forest resources may provide a temporary buffer for the sustainability of timber production against the unexpected changes in forest management, the errors of data and the future uncertainties.

See the main results of the maximum sustained yield problem in Examples H.20 and H.21. Notice that Example H.19 is a reproduction of the **S4.MDL** problem in Part 2.

4.2.2.3 Development of forests with regard to assumed harvest levels

How are forest resources expected to develop with regard to the assumed level and structure of timber harvests?

Various reasonings may be found behind this general question. What are the long-term effects of recent cuttings in general? Are we overcutting or underutilizing our forest resources? Is there enough commercial wood or certain kind of timber in the forests for the new industries being planned? What are the impacts of our recent or planned harvests to the future development of local forests? What if I just want to cut like this? In spite of my own harvests, is my forest in an acceptable state for my children after 25 years? Why not to change the current spruce dominated forests to old deciduous forests in the future? How soon should we move to pine or aspen plantations with a short rotation for pulp in Nordic conditions?

Sufficient answers to some of these questions are often found by the interpretation of the results of the previous general analyses, such as the estimate for the maximum sustained yield or its variants.

Direct constraints for harvest level and structure can be used to predict the development of forest resources under given conditions, see Examples H.22 to H.24.

Examples H.25 to H.27 demonstrate another viewpoint, the search for the level of timber harvests bound to the total increment over the calculation period. Other constraints define the minimum saw log percentage in cutting removal and the maximum annual regeneration area. The maximization of the 4 % net present value indicates slightly more intensive forest management strategy compared with the recent average level in Finland. Notice the unbalanced linkage of cutting removal and total increment without regard to waste wood and mortality; what kind of consequences should be expected resulting from this kind of formulation in different forest conditions? - This schematic problem formulation should be modified for any actual analysis.

4.2.2.4 Trade-off curves

The products and benefits attainable from forests depend on each others, for example land use allocation between timber production and conservation. What are the losses of potential timber production subject to increasing conservation of old forests? Or how much more can we protect old forests while increasingly withdrawing from timber production? How does the timber production and the protection of old forests change as a result of intensified or less effective management of commercial forests? Assuming a timber production requirement, how the protection potential of old forests will change as a result of increasing reforestation of abandoned agricultural lands?

These interdependencies and the answers to questions of this kind can be illustrated by trade-off curves generated from a set of calculations. A trade-off curve is a multidimensional surface consisting of the maximum output combinations achievable with a fixed amount of inputs and the full employment of the resources. The generation of a trade-off curve requires an analysis design with changing values for input variables and consequently several computer runs. If there are only two outputs, the surface is a curve, see a schematic example in Figure 4.2.

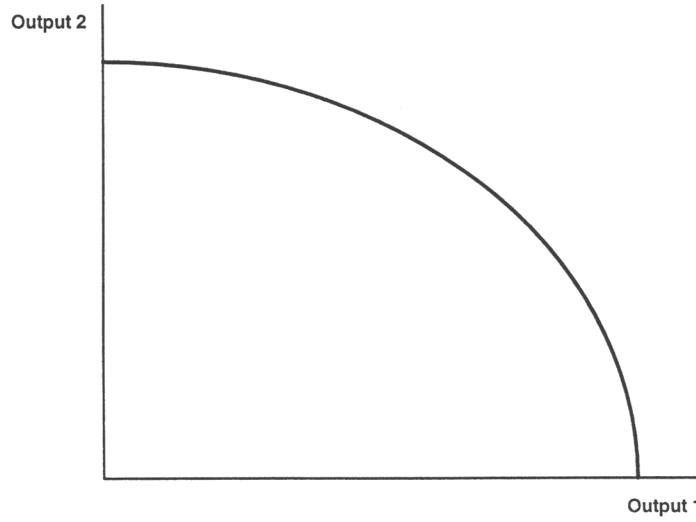

Figure 4.2. A hypothetical trade-off curve between two alternative outputs.

4.2.3 Selection of a Production and Management Program

4.2.3.1 Iterative (converging) search

In the absence of the explicit utility function, the selection of a satisfactory forest production and management program is an interactive search and learning process after the general analysis of the future production potentials (see Chapter 4.2.2). Potential decisions and their consequences are further surveyed and evaluated against the preferences of the decision maker. For example, what is achieved with regard to liquidity, profitability, stability, safety and risks over time.

Usually several individual MELA problems need to be solved for the selection of a satisfactory production and management program. Multiple analysis rounds or specific analysis designs may be required in order to examine the effects of such individual factors as a regeneration area and different cutting options.

An individual analysis should be started from a simple problem with few constraints. Sometimes one of the previous analysis steps may serve as a starting point. In each analysis step, the current problem is solved and the solution is evaluated. One by one, new constraints are added or old ones are changed in the optimization problem in accordance with the preferability of the solution obtained. The iterative search and the evaluation (or selection) process is continued until a satisfactory solution is found with no details to change.

The iterative search from scratch in each particular decision situation may appear a laborious planning method for small-scale practical forestry. The iteration process could be facilitated for practical purposes, for example, by a systematic selection of well-defined and proved optimization problems covering a whole range of common decision situations. The problems could be routinely solved and served for the evaluation of the decision maker in the first phase of the planning process. The examples in Chapter 4.2.2 should do as a starting point. As well, dedicated analysis designs could be automatically compiled from the actual preferences expressed by the decision maker.

4.2.3.2 Goal programming

Goal programming (GP) provides an analytical way to manage several objectives simultaneously in one optimization problem. The precondition is however

- to know a priori the relative weights of the different objectives, or
- to have as such commensurable objectives.

These preconditions are seldom valid in practical decision situations except hypothetical weights, for example, in the examination of infeasible optimization problems.

In MELA, goal programming problems are formulated using JLP x and z variables for the deviations of actual values of constraint variables and their target values (see Lappi 1992).

4.2.4 Forest Level Summary Data in Optimization

Examples H.34 to H.38 show how to import forest level summary data into a MELAOPT optimization problem. This kind of approach, for example, makes it possible to force a lower level optimum solution into an upper level optimization problem. As well, the imported summary data may represent a region where more detailed information about management alternatives is not available.

4.3 Stand Management Instructions based on MELA Solutions

4.3.1 Introduction

MELA integrates stand management optimization and forest level production planning into a simultaneous hierarchical optimization problem. Both forest and management unit level solutions are based on the same management schedules and the user-supplied forest level objectives. The management proposals for the management units in a MELAOPT solution are obtained in the form of the selected management schedules.

The aggregation level and quality of forest resource data and the management options in the simulation of management schedules should be taken into account when considering the applicability of the management unit results as stand management guidelines. The forest resource data can consist of:

- genuine stands,
- sample of genuine stands,
- lightly aggregated forest resource data (artificial or "average" stands), and
- heavily aggregated forest resource data.

Genuine stands should be used as forest resource data whenever possible in order to take into account stand level aspects and impacts and to get stand level results without further analyses or interpretations. Sampling and aggregation of stands should be limited to large-scale strategic analyses where stand level results are not absolutely necessary. However, available computing capacity may limit the use of stands as forest resource data at any level.

The tools in the current MELA version to obtain management unit level results and to transfer them for further processing are:

- **mps** type files (see the MELAOPT command REPORT SUMMARY in Chapter 3.5.2.2) for transferring management unit level simulation information (see the MPS_VARIABLES parameter in Appendix B.2 and Examples H.49 to H.52) to be processed by user routines,

- the MELASIM command SIMULATE (after the MELAOPT command REPORT SOLUTION only) for the re-simulation (see Chapter 3.4.2.1) and printing a summary of the selected management schedules (see the item (3) of the OUTPUT parameter in Appendix B.2 and Examples H.45 to H.48), and

- the MELAOPT command REPORT SCHEDULES for a list of management units and the selected management schedules without any detailed information (see Chapters 3.5.2.2 and 4.1.3.4 and Example H.43).

4.3.2 Genuine Stands

If the management units consist of genuine stands, the MELAOPT solution as such provides forest management proposals for each stand. The management proposals are selected from the management schedules available in the optimization. Feasible management options considering the decision problem should be among the management schedules.

Besides their direct use, the stand level results, for example the cutting proposals, may well be summarized into forest management outlines, for example, in the form of correlation tables as a function of such stand characteristics as tree species, age, density, etc.

4.3.3 Sample of Genuine Stands

The results from a sample of stands do not provide direct results for all stands. A large number of sample stands should provide material for further visualization, analysis and generalization of the stand level results, see Chapter 4.3.2. See also Chapter 4.3.5.

4.3.4 Lightly Aggregated Forest Resource Data

The results from the light aggregates of stands do not provide results for all stands directly. However, the management schedules for the management units should suit as management guidelines for all stands belonging to the same management unit. The management unit results can also be used as material for further analysis and visualization at the stand level (see Chapter 4.3.2). See also Chapter 4.3.5.

4.3.5 Heavily Aggregated Forest Resource Data

The results from heavily aggregated forest resource data do not provide stand level results directly. In such cases, stand level optimization in MELASIM based on the shadow prices of the forest level solution and true stand data in question should produce relevant stand level results and management instructions (see Kilkki 1987).

> NOTE: Stand level optimization based on the shadow prices is disabled in the current MELASIM version.

4.4 Analysis Designs and Comparisons of Multiple Solutions

Several forestry analysis tasks consist of comparisons or evaluations of two or more alternatives in order to select the most preferable one. The scope and depth of the comparisons may vary from the management options of individual stands to national and multinational land use and forest policy considerations. There are also differences in the complexity of the comparisons depending on the size and structure of the decision object and the interrelations of the pertinent factors. In fact, the solution of the integrated forest and stand level optimization problems presented in the MELA Handbook is based on a huge number of comparisons of management unit alternatives and their combinations in the optimization process.

The universal scheme of comparisons is to generate relevant alternatives, an analysis design, and to evaluate the alternatives for the selection. The individual questions, evaluation criteria, analysis designs and selection methods, even in simple comparisons at one level do vary.

MELA provides tools for the generation of stand, forest level and integrated alternatives:

- The conventional management schedules directly from the stand simulation (MELASIM) may be used in the pure stand level comparisons and analyses. Standwise simulation instructions may be needed to generate the specific alternatives, instead of the automatically controlled simulation of the management schedules.

- The optional, lower decision level optimization (MELAOPT) solutions may serve as input for upper decision level comparisons, for example forest management outlines.

- The optimization (MELAOPT) solutions provide also management unit level results. Both the forest and management unit level solutions and their differences can be compared simultaneously, for example, for the comparison of the stand level consequences and effects of forest level decisions. The re-simulation of the management schedules selected in the optimization solution may be required for the generation of the non-stored details (see Chapter 4.1.4).

For example, results or material for the following type of comparisons should be obtained using MELA tools and analyses:

- what ... if comparisons,
- sensitivity analyses,
- analysis of profitability and losses, and
- effects of different kind of errors and uncertainties.

Systematic analysis designs are required for the generation of comparable alternatives.

4.5 Determination of Land and Forest Value

4.5.1 Land Value

Land value (land expectation value, soil expectation value), the net present value of the perpetually repeated optimal rotations with the same optimal management schedules or the value of the future tree generations, is one of the fundamental concepts in forest economics. From the economic point of view, forest land and standing timber are invested capital, and therefore the profit it earns has to be compared to the best alternative. The land expectation value has been proved a theoretically correct opportunity cost of standing timber (e.g. Johansson & Löfgren 1985). It determines also the maximum price profitable to pay for bare land.

Stand level optimization is a suitable method for the determination of the land expectation value. The calculation of the land expectation value is started from bare land and forest is managed only as a source of wood. The actual land expectation value depends remarkably on the interest rate, the production potential of the site (e.g. soil and local climatic conditions), and the price of timber.

In the MELA simulation, there is a particular mode for the determination of land values compatible with local conditions. The land value calculation mode is activated by the value '1' of the item (16) and the value '-1' of the item (17) of the SIMULATION_CONTROL parameter (see Appendix B.2). The land values are calculated using five optional (user-supplied) interest rates simultaneously. The stand level optimization maximizes the land value for each interest rate separately. Specific management units (bare land of different site types) and event definitions (see the EVENT parameter in Appendix B.2) for the determination of land values are required.

> NOTE: In the MELA simulation, the land value is needed for the calculation of the net present value of future revenues (see decision variables (801) - (805) in Appendix D.4) to represent the value of the future tree generations after the simulation period. The user is responsible for supplying compatible land values considering the local conditions and the analysis in question. Land values are determined using the LAND_VALUES parameter, see Appendix B.2.

The land values obtained from the analysis above should be set as values for the LAND_VALUES parameter to be used in the simulation of management schedules and in other simulation tasks.

4.5.2 Forest Value

From the viewpoint of timber production and pure economic efficiency, the value of forest is the present value of future net revenues. This kind of problem can be solved in MELA, by the maximization of the net present value (see decision variables (801) - (805) in Appendix D.4) without constraints.

Decision makers often have other targets in timber production than pure economic efficiency, such as the even flow of incomes or the sustainability of cuttings. In these cases, the economic efficiency criterion like the maximum net present value may lay far from the value of forest for the decision maker.

For example, the following analyses should be worth considering in the calculation of the forest value:

- The net present value of a production program based on the preferences and expectations of the decision maker (see Chapter 4.2.3) should provide a starting point.

- If the preferences are obscure, a more thoroughful analysis of the production possibilities (see Chapter 4.2.2) will probably enlighten the foundations of the forest value for the decision maker.

- The value of an additional forest area can be examined from the difference in the production programs and resulting forest values with and without the additional forest.

- The marginal analysis of the MELAOPT solution (e.g., the shadow prices, see Chapter 4.1.3) may also reveal important aspects to the decision maker.

These considerations suggest that there is probably no absolute value of forest. The value of (the same) forest is peculiar to each decision maker in each decision situation.

> NOTE: The value of forest is analyzed here on the basis of the timber production potential without paying attention to the actual prices. The value of forest in regard to other benefits than timber production is not considered here either.

4.6 Customizing MELA

4.6.1 Introduction

The possibility to change old applications and to design new ones makes MELA versatile. On the other hand, the system as such can't run at all without user-supplied forest resource data and the values of some crucial parameters. Application dependent parameters are discussed in details in Chapters 3.4 and 3.5 and in Appendix B.

There are available some proved MELA applications (see Chapters 4.2 - 4.5) and there are several options for the users to tailor old MELA applications and to design completely new ones. Some of customizing possibilities are discussed in the following chapters.

4.6.2 Generating MELAOPT Problem Definitions

A MELA optimization problem is open, there are no preformed or built-in decision criteria. Users can, in fact, they must define their own optimization problems for different applications and decision situations. Besides the MELA decision variables (see Appendix D.4) as such, and their linear combinations, JLP transformations (see Lappi 1992) are also available for the formulation of optimization problems.

Simple problem formulations and problem definition (**mdl** type) files are introduced in Chapter 4.2 and in Appendices C.2 and H. Problem definition files are text files and thus they can be generated and edited using a text editor.

4.6.3 Setting MELASIM Parameters

Different simulation applications and optional details of simulation are specified by customizing parameter definitions (see Chapter 3.2.1.4 and **par** type files in Appendices C.2 and H)

Different simulation parameter definitions to MELASIM are supplied from parameter (**par** type) files (preferably) or from keyboard (not recommended or comfortable). Each group of related parameter definitions, for example, consisting of a large number of input lines or belonging to the same application are stored in the same file. For the hierarchical organization of parameter files, see the INCLUDE command in Chapter 3.2.2.2.

There are some often customized parameter files:

- Parameters common to all applications are stored in the **MELA_SET.PAR** file. This file contains usually the naming instructions of MELA files (see the FILE_NAMING parameter in Appendices B.2 and H.1). The name of the actual decision hierarchy (see the FORESTRY_UNIT parameter in Appendix B.2) should also find a place in the **MELA_SET.PAR** file instead of being supplied from keyboard.

- The levels and the members of the actual decision hierarchy are supplied using the **forestry_unit.PAR** file. (Decision hierarchy levels and members are user parameters the name of which starts at column 2, see Chapter 3.2.1.4 and Examples 3.11 and H.34).

- The parameters defining a particular type of simulation application are supplied in the **application.PAR** file. Some of the typical simulation parameters are YEARS, OUTPUT, SIMULATION_CONTROL and MSD_VARIABLES. There are also other MELASIM parameters (see Appendix B.2). A handy way to supply the parameters requiring many items is to have a separate file for each parameter and use the INCLUDE command (see Chapter 3.2.2.2.) to attach them into the **application.PAR** file.

- Event definitions for each individual simulation application are usually stored in separate files and attached to the **application.PAR** file using the INCLUDE command. User-supplied event definitions are always needed; there are no default values for event definitions. For more information about event definitions, see the EVENT parameter in Appendix B.2 and Example H.6.

  NOTE: The relevance of the simulated and selected management schedules depends much on the validity of the event definitions. Event definitions should be therefore carefully designed and their validity checked for every application.

4.6.4 Generation of Initial Data

4.6.4.1 Forest resource data

The results of MELA analyses depend greatly on the forest resource data. The good quality of the data is of outmost importance for the conclusions drawn and the decisions made from the analyses. Thoroughly measured, up-to-date forest resource data give the basis for predictions of the development and consequently for estimates of the production possibilities of forests. The details of the data should match with the problems being examined and the analyses being done.

MELA was originally designed for the utilization of the data from the Finnish National Forest Inventory (FNFI). The stand and tree variables in MELA originate often from the FNFI. The conceptional compatibility of the classifications of MELA variables and the user data is required. For example, the growth predictions of the MELA models depend on the compatibility of the modeling data and the FNFI definitions with the user's site quality classifications.

Initial forest resource data are provided by the user, see **rsd** type files in Appendix C.2. In most cases, the existing forest resource information is used for their generation. There are currently no general routines in the MELA System to perform this task.

If the original forest inventory data consist of sample plots and sample trees, they are used as initial forest resource data as far as possible. Classifications are changed to be compatible with MELA and simulated values are provided to the missing data. The initial data records can be generated with a simple routine (see the initial data record in Appendix D.1).

If the original inventory data consist of stand level variables such as basal area, mean diameter, mean height and mean age, the MELA input data can be generated by the simulation of tree level data. Two alternative approaches have been used so far.

- On the basis of stand variables, appropriate sample plots are searched from a general sample plot and sample tree material, such as the data of the Finnish National Forest Inventory.

- The trees of the MELA input data are generated with appropriate general models. For example, the parameters of the diameter distribution model, such as a Weibull or beta function, are predicted on the basis of the stand variables. A sample of trees is taken from the diameter distribution and the tree variables, for example, height and age are simulated using general tree models.

4.6.4.2 Standwise simulation instructions

Standwise simulation instructions can be provided using simulation instruction records in **sms** type files, see Appendices C.2 and D.7. If standwise simulation instructions are given, they are obeyed instead or before the general event definitions. The user can control how the standwise simulation instructions and the general event definitions are combined.

Typically, the simulation instructions are used in the re-simulation of the MELAOPT solution. The management proposals of the field inventory can also be provided in **sms** type files for the simulation of management schedules. In such cases, management proposals are simulated first and, depending on the given instructions, optional treatments according to the general event definitions are simulated after that.

Simulation instructions from the field proposals are generated by user routines. For the structure of the record, see the simulation instruction record in Appendix D.7.

4.6.4.3 Management unit records

Standwise classification variables for optimization can be stored in management unit (c variable) records of initial forest resource data (**rsd** type) files. The variables of management unit records are defined and the management unit (c variable) records generated by user and by user routines. For details, see **rsd** type files in Appendix C.2 and management unit (c variable) records in Appendix D.2.

4.6.5 Programming MELASIM Events

All the optional events for MELASIM have to be defined by user. However, in the MELA standard package there is a **par** type file **MS_EVENT.PAR** containing a sample set of event definitions for the simulation of management schedules in Finnish conditions, see Example H.6.

The events consist of natural processes and human activities. The event definitions are supplied via the EVENT and EVENT_DEFAULTS parameters. Every single event requires its own EVENT definition. Event definitions for a simulation application are usually collected into a **par** type file for reading by the MELA command INCLUDE in the file of application parameters, for example. The maximum number of optional events in one session is defined by the item (2) of the SIMULATION_CONTROL parameter.

In some cases, a copy of the **MS_EVENT.PAR** file may serve as a starting point for the programming of MELASIM events. If the changes are few, this technique is preferable. Otherwise, it is recommended to design the events independently.

For more details of the EVENT and EVENT_DEFAULTS parameters, see Appendix B.2.

4.6.6 Generation of MELA Stem Volume Tables

Stem volume and timber assortments of the trees are obtained in the current MELASIM version from the stem volume tables stored in a **vol** type file (see Appendix C.2).

The current stem volume tables were generated from stem curve models for the Finnish conditions as a function of tree species, diameter and height (Laasasenaho 1982). Since the stem volume estimates of the Finnish models are not universally applicable and the timber assortments do vary with different logging practices, there may be a need to generate local stem volume tables and **vol** type files for different conditions.

Relevant stem volume and timber assortment information, for example, stem curve or volume and timber assortment models are required for the generation of stem volume tables. Contact to the MELA Team for the generation of stem volume tables and **vol** type files.

4.6.7 Designing MELA Summary Reports

Designing application specific forest level reports makes it possible to adapt MELA reports for specific needs in accordance with user preferences. Various summary reports are required, for example, for shorter and longer documents, for different MELA applications and for different language versions.

MELA summary reports should provide at a glance a comprehensible and concise overview about each MELA forest level solution, demonstrating the most important features of the solution and the interactions of decision variables. For example, the selection of essential decision variables considering the decision in question, the order of variables on one page or on the display and the hierarchical order of pages should facilitate the interpretation of results. Existing **tab** type files may serve as a starting point (see Examples H.3 and H.4 and corresponding results) for own designs.

MELA summary reports are described in user-supplied summary report definition (**tab** type) files (see Appendix C.2) using summary report definition records (see Appendix D.8), and selected in MELA sessions by the MELA_TABLE parameter (see Appendix B.2). For storing and using summary reports, see **sum** type files in Appendix C.2. Use the MSD_VARIABLES parameter (see Appendix B.2) in MELASIM to select the decision data variables (see Appendix D.4) available for reporting in MELAOPT.

4.7 Further Exercises

Practical decision problems in forestry are often more complex than the simple examples of the MELA Handbook. Consider, for example, the following questions, technical details and substance, resulting analysis designs and respective results as steps towards full-scale analysis.

- How to minimize memory needs in the case of large data sets and optimization problems? What is achieved and what is lost with memory savings?

- How to integrate operational and strategic analysis? Try different numbers and variating lengths of sub-periods for different analyses for the integration of stand level and forest level aspects into the same optimization problem. For example, start from the following values of the YEARS parameter in the simulation of management schedules:

  ```
  YEARS 1 3 7 11 21 31
  ```

  Which MELA definitions must be changed for the whole analysis process? Notice also the formal and the substantive incompatibilities of management schedule files with different parameter settings.

- Examine the forest level sensitivity of the analysis results with regard to forest growth. Create an analysis design with optional increment levels in simulation and solve the same optimization problems for the increment levels respectively.

  Are there other aspects of sensitivity worth examining? Various assumptions concerning forest management practices in the future? Changes in timber prices? The intensity of forest management with regard to the different expectations on the future needs of timber, incomes and biodiversity? What else?

  See also future conditionalities, uncertainties and risks below.

- How sensitive is the management of individual stands with regard to forest level production strategies? Study, for example, the thinning and regeneration proposals for individual stands and their priority with regard to the total harvests and their timing in different kinds of solutions. Study also the results of marginal analysis (see Chapter 4.1.3 and Lappi 1992). What are the roles of forest resource data, the growth models, the costs and the prices, the objectives and the formulation of the optimization problem to the sensitivity results in each particular case.

- How would you concretize the sustainability concept for forestry? Chapter 4.2.2 and the examples in Appendix H.5 may serve as the starting point for your own considerations and analyses. Compare the solutions from economic, ecological and social viewpoints in your decision situation, besides timber production.

- Solve the same optimization problem with forest level sustainability constraints for different kinds of domain combinations, for example, for the forestry unit as a whole and for each of the individual sub-units separately. Start from Examples H.28 and H.31. What

is the formal reason for the differences obtained? Which individual factor determines the extent of the difference? (What is the difference if you just double the same forestry unit?) Interpret the results for different decision situations.

- What if the future development will differ from the assumptions of the calculations? For example, how does the estimate of the maximum sustained yield change in the future as a result of the actual development? Design an analysis with different levels of assumed cuttings for the first sub-period and calculate the respective maximum sustained yield after the first sub-period, and so on for the following sub-periods. What difference does the conditionality of the development subject to the preceding development make for the interpretation of the results of the first sub-period and the later ones?

- How to manage future risks and uncertainties in the MELA analysis and in the consecutive decisions? For example, how to take into account the sensitivity of the results subject to increment levels and different forest management policies for timber production and cutting decisions, for silvicultural activities and for industrial investment decisions? - Examine also the need of the precaution and conservativeness (for the sake of the sustainability) often obeyed in the harvest decisions with respect to the uncertainties (for example, the potential biases in the initial data and in the increment level), the security requirements and the (long term) increment and total yield. - Are the sensitivity assumptions being applied sufficient and relevant considering the decision in question?

- How to validate the analysis results? The analysis process provides plenty of opportunities for errors, mistakes and misusage. Which potential errors should be recognized? Which factors may spoil the analysis and the results? Which factors are missing from the analysis? Make your own checking list for the validation of your analysis.

  Consider also following aspects, besides your own ones and those presented in Chapter 4.1.1.1. What is the problem being solved? Is the problem solvable with MELA? How about the skills of the analyst and the decision maker, their experiences, ambitions and judgment? Are the current data, models, methods and optimization problems relevant for the analysis?

  Check the results before you publish them! See the session logs for desired parameter values and error messages. Consider the relevance of each individual characteristic. Don't just omit unpleasant details. Be careful with the "minor changes". Evaluate the relevance of each new simulation application and optimization problem with sufficient test materials from the deep details to the full-scale analysis.

In the usage of MELA, the expertise of the analysts will show up in their ability to recognize solvable problems and in their skills to compile the actual decision problems, pertinent factors and unavoidable uncertainties into relevant analysis designs and interpretations consisting of simulation and optimization tasks with the available information.

4.8 Further Readings

For an introduction to the use of linear programming in forestry as well as an overview on the state-of-the-art in forestry modeling and analysis, start, for example, from the following textbooks and recent publications:

Buongiorno, J. & Gilless, J. K. 1987. Forest Management and Economics: A Primer in Quantitative Methods. Macmillan, New York. ISBN 0-02-948740-4.

Clutter, J., Fortson, J., Pienaar, L., Brister, G. & Bailey, R. 1983. Timber management. A Quantitative Approach. John Wiley & Sons, New York.

Dykstra, D. P. 1984. Mathematical programming for natural resource management. McGraw-Hill, New York. ISBN 007-0185522.

Hof, J. 1993. Coactive forest management. Academic Press, San Diego. ISBN 0-12-351820-2.

Kilkki, P. 1987. Timber management planning. 2nd edition. Silva Carelica 5. ISSN 0780-8232, ISBN 951-696-528-8.

Leushner, W. A. 1990. Forest regulation, harvest scheduling, and planning techniques. John Wiley & Sons, New York. ISBN 0-471-61405-X.

Nabuurs, G. J. & Päivinen, R.1996. Large Scale Forestry Scenario Models - a Compilation and Review. European Forest Institute Working Paper No. 10. ISBN 952-9844-12-3, ISSN 1237-5136.

Päivinen, R., Roihuvuo, L. & Siitonen, M. (Eds.). 1996. Large-scale Forestry Scenario Models: Experiences and Requirements. EFI Proceedings No. 5. ISSN 1237-8801, ISBN 952-9844-13-1.

Sessions, J. & Brodie, J. D. (eds.). 1995. Proceedings of the 1994 Symposium on Systems Analysis in Forest Resources, Management Systems for a Global Economy with Global Resource Concerns, Asilomar Conference Center, Pacific Grove, California, U.S.A., September 6-9, 1994.

References

References

Dykstra, D. P. 1984. Mathematical programming for natural resource management. McGraw-Hill, New York. 318 pp. ISBN 007-0185522.

The Forest 2000 Programme. Guidelines for developing Finnish forestry and the forest industries. 1986. Silva Fennica 20(1): 35-44.

Johansson, P.-O. & Löfgren, K.-G. 1985. The economics of forestry and natural resources. Blackwell, Oxford. 292 pp. ISBN 0-63-114162-6.

Kilkki, P. 1968. Income oriented cutting budget. Acta Forestalia Fennica 91. 54 pp.

Kilkki, P. 1987. Timber management planning. 2nd edition. Silva Carelica 5. 159 pp. ISBN 951-696-528-8, ISSN 0780-8232.

Kilkki, P., Kuusela, K. & Siitonen, M. 1977. Puuntuotanto-ohjelmat Etelä-Suomen piirimetsälautakuntien alueilla. Summary: Timber production programs for the forestry board districts of Southern Finland. Folia Forestalia 307. 61 pp. ISBN 951-40-0272-5, ISSN 0015-5543.

Kilkki, P. & Pökälä, R. 1975. A long-term timber production model and its application to a large forest area. Acta Forestalia Fennica 143. 46 pp. ISBN 951-651-018-3.

Kilkki, P. & Siitonen, M. 1976. Principles of a forest information system, XVI IUFRO World Congress, Division IV, Proceedings: 154-163.

Kilkki, P. & Väisänen, U. 1969. Determination of the optimum cutting policy for the forest stand by means of dynamic programming. Acta Forestalia Fennica 102. 23 pp. ISSN 0001-5636.

Kuusela, K. & Nyyssönen, A. 1962. Tavoitehakkuulaskelma. Summary: The cutting budget for a desirable growing stock. Acta Forestalia Fennica 74(6). 34 pp.

Laasasenaho, J. 1982. Taper curves and volume functions for pine, spruce and birch. Communicationes Instituti Forestalis Fenniae 108. 74 pp. ISBN 951-40-0589-9, ISSN 0358-9609.

Laasasenaho, J. & Sevola, Y. 1971. Mänty- ja kuusirunkojen puutavarasuhteet ja kantoarvot. Summary: Timber assortment relationship and stumpage value of Scots pine and Norway spruce. Communicationes Instituti Forestalis Fenniae 74(3). 87 pp.

Lappi, J. 1992. JLP: A linear programming package for management planning. The Finnish Forest Research Institute. Research Papers 414. 134 pp. ISBN 951-40-1218-6, ISSN 0358-4283.

Lappi, J., Nuutinen, T., & Siitonen, M. 1994. A linear programming software for multilevel forest management planning. In: Sessions, J. & Brodie, J. D. (eds.) Proceedings of the 1994 Symposium on Systems Analysis in Forest Resources, Management Systems for a Global Economy with Global Resource Concerns, Asilomar Conference Center, Pacific Grove, California, U.S.A., September 6-9, 1994:470-482.

Nuutinen, T. 1994. Spatial analysis and heuristic optimization in short-term forest planning. In: Sessions, J. & Brodie, J. D. (eds.) Proceedings of the 1994 Symposium on Systems Analysis in Forest Resources, Management Systems for a Global Economy with Global Resource Concerns, Asilomar Conference Center, Pacific Grove, California, U.S.A., September 6-9, 1994:316-326.

Ojansuu, R., Hynynen, J., Koivunen, J. & Luoma, P. 1991. Luonnonprosessit metsälaskelmassa (MELA) - Metsä 2000-versio. (Natural process models in the MELA System, in Finnish). Metsäntutkimuslaitoksen tiedonantoja 385. 59 pp. ISBN 951-40-1268-2, ISSN 0015-5543.

The Presentation of the Revised Forest 2000 Program. 1992. Finnish Forestry Association.

Salminen, S. 1993. Eteläisimmän Suomen metsävarat 1986-88. Summary: Forest resources of Southernmost Finland, 1986-1988. Folia Forestalia 825. 111 pp. ISBN 951-40-1347-6, ISSN 0015-5543.

Siitonen, M. 1972. Dynaaminen malli metsikön optimihakkuuohjelman määrittämiseksi. Summary: A dynamic model for the determination of the optimum cutting policy for a forest stand. Helsingin yliopiston metsänarvioimistieteen laitoksen julkaisuja 2.

Siitonen, M. 1983. A long term forestry planning system based on data from the Finnish national forest inventory. Proceedings of the IUFRO subject group 4.02 meeting in Finland, September 5-9, 1983. University of Helsinki, Department of Forest Mensuration and Management. Research Notes 17: 195-207. ISBN 951-45-3171-X, ISSN 0355-1164.

Siitonen, M. 1993. Experiences in the use of forest management planning models. Silva Fennica 27(2):167-178. ISSN 0037-5330.

Siitonen, M. 1994a. Some large-scale applications of the Finnish MELA System. In: Sessions, J. & Brodie, J. D. (eds.) Proceedings of the 1994 Symposium on Systems Analysis in Forest Resources, Management Systems for a Global Economy with Global Resource Concerns, Asilomar Conference Center, Pacific Grove, California, U.S.A., September 6-9, 1994:327-342.

Siitonen, M. 1994b. The MELA System as a forestry modeling framework. Lesnictvi-Forestry, 41,1995 (4): 173-178. ISSN 0024-1105.

Tomppo, E. & Siitonen, M. 1991. The National Forest Inventory of Finland. Paper and Timber 73(2):90-97.

Appendices

This part of the MELA Handbook is a collection of deep details, such as the descriptions of files, records and variables, in the form of appendices.

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Appendix A
MELA Delivery and Installation

Appendix A provides information about the MELA delivery.

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Appendix A

MELA Delivery and Installation

A.1 Standard Delivery

The following components and materials are found in the MELA standard delivery:

- MELA programs, MELASIM and MELAOPT,
- stem volume table file, **VOLUME.VOL**,
- symbol definition file for the English version, **SYMBOL.SYM**, and
- demonstration material:

- initial data files	(**rsd** type files),
- parameter files	(**par** type files),
- problem definition files	(**mdl** type files)
- instructions for summary report generation	(**tab** type files), and
- results of sample runs	(report (for example, **sum** type) files).

NOTE: The MELA programs run only with the **USER.PAR** file containing the license information. This file should never be tampered by the user.

Example A.1. The files of the MELA standard delivery.

- **MELA_SET.PAR**, **SYMBOL.SYM** (text files)
  general MELA parameters and symbols for MELASIM and MELAOPT
- **MELASIM.EXE** (binary file)
  MELA simulator program
- **F1.RSD**,...,**F5.RSD**, **WR.RSD** (binary files)
  initial stand data for MELASIM and MELAOPT
- **MS.PAR**, **MS_EVENT.PAR**, **MSR.PAR** (text files)
  simulation parameters for MELASIM
- **VOLUME.VOL** (binary file)
  volumes and timber assortments of stems for MELASIM
- **MELAOPT.EXE** (binary file)
  MELA optimizer program
- **P1.MDL**,...,**P5.MDL**, **S1.MDL**,...,**S5.MDL** (text files)
  problem definitions for MELAOPT
- **FX.PAR** (text file)
  decision hierarchy definitions for MELASIM and MELAOPT
- **TABLE.TAB** (text file)
  instructions how to generate MELA summary reports for MELASIM and MELAOPT
- demonstration data files (see Appendix H)

NOTE: MELA text files can be read, printed or edited by the user, but binary MELA system files cannot be edited and should not be tampered by the users.

A.2 Versions

Operating systems

The MELA software runs in the following computing environments:

- Windows 3.1x,
- OS/2 2.x,
- VAX/VMS, and
- UNIX (SunOS, Solaris, HP-UX, ULTRIX, OSF/1)

The PC versions (for Windows 3.1x, and OS/2 2.x) are compiled with the WATCOM F77[32] FORTRAN compiler.

For other versions, contact to the MELA Team.

Capacity

The MELA software is delivered in different size versions for different applications.

Language

The MELA user interface and messages are originally in Finnish. Different language versions are generated by modifying the symbol definition file (**SYMBOL.SYM**) and the instructions for summary report generation (**tab** type) files.

A.3 Minimum Requirements for PC

An Intel 80486 compatible or higher micro computer equipped with a floating-point processor is needed to run the MELA programs. The minimum requirement for random access memory (RAM) is 8 Mb (or more).

The programs require approximately 3 Mb hard disk space.

The actual memory and disk requirements are highly dependent on the problem to be solved. A minimum of 5 Mb disk space is required to store the MELA demonstration material. For user data materials, at least tens or hundreds of Mb disk space will be needed. Disk requirements should be estimated by making experiments with actual data materials and applications in question.

Processor, memory, disk space available and the MELA version at hand set the ultimate limits to the size of simulation and optimization tasks and consequently to MELA problems being solved.

A.4 Installation Instructions

The MELA programs and data files can be installed

- both into the same directory, or
- the programs into one directory and data and parameter files into another.

The programs must be started from the data directory in question. For the instructions how to use the MELA System, see Parts 2 and 3.

> NOTE: MELA commands, parameter and symbol names, and command argument values (and consequently file names) must be in UPPER CASE LETTERS (also numbers 0-9 are allowed). In spite of this general rule, some operating systems (e.g. Windows, OS/2 and VAX/VMS) may accept both case letters in file names.
>
> NOTE: Some operating systems have limits to the length and allowable characters of the file names. Usually at least eight letters are allowed.
>
> NOTE: In many cases, it is sensible to run the MELA programs in batch mode or in background if it is possible on the operating system. Especially this is recommended if actual data material is extensive (or simulation time is long) or if the problem definition is complicated.

Specific installation and start-up instructions for different operating systems are delivered with the MELA package. See your MELA delivery material.

Appendix B
MELA Parameters

Appendix B describes the MELA parameters. Instructions and examples are also provided how to use the parameters.

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Appendix B
MELA Parameters

B.1 Introduction

The MELA parameters are presented here in alphabetical order.

All MELA parameters are optional, in principle. The MELA programs use default values for most of the parameters. Usually, parameter definitions are needed only if the built-in defaults are substituted. However, there are some parameters that should be defined for every application (see Chapters 3.4.3 and 3.5.3 and Example H.5).

The general syntax of parameters is introduced in Chapter 3.2.1.4. User-defined parts in the parameter names are expressed here in lower case letters (see also Chapter 3.3).

B.2 Parameters

Current MELA parameters:

In English:	Generic names in Finnish:
C_VARIABLES	C_MUUTTUJAT
D_CLASSES_IN_REMOVAL	KERTYMAN_LPM_LUOKAT
DISCOUNT_RATES	LASKENTAKOROT
EVENT	TAPAHTUMA
EVENT_DEFAULTS	TAPAHTUMA_OLETUSARVOT
FILE_NAMING	TIEDOSTOT
FORESTRY_UNIT	METSATALOUS_YKSIKKO
forestry_unit_LEVELS	metsatalous_yksikko_TASOT
forestry_unit_members	metsatalous_yksikko_jasenet
GROWTH_CALIBRATION	KASVUN_TASOKORJAUS
INTEGERAPPROXIMATION	KOKONAISLUKURATKAISU
LAND_VALUES	MAAN_ARVOT
LOG_VOLUME_REDUCTION	TUKKIVAHENNYS
LOWEST_LEVEL	ALIN_TASO
MANAGEMENT_CATEGORY_GROUPS	KASITTELYLUOKKARYHMAT
MAX_LENGTH_OF_FILENAME	TIEDOSTONIMEN_PITUUS
MELA_TABLE	MELATAULUKKO
MIN_BASAL_AREA_AFTER_THINNING	MIN_PPA_HARV_JALKEEN
MIN_NUMBER_OF_SEEDLINGS	MIN_VILJELYTIHEYS
MIN_REGENERATION_AGE	MIN_UUDISTUSIKA
MIN_REGENERATION_DIAMETER	MIN_UUDISTUSLAPIMTTA
MPS_OUTPUT	MPS_TULOSTUS
MPS_VARIABLES	MPS_MUUTTUJAT
MSD_VARIABLES	MSD_MUUTTUJAT
MSR_VARIABLES	MSR_MUUTTUJAT
OUTPUT	TULOSTUS
PRINT_INPUT_LINES	SYOTTORIVIEN_TULOSTUS
RE_SIMULATION_INSTRUCTIONS	TOISTO_OHJE
ROADSIDE_LOG_PRICE_ADJUSTMENT	TIENVARSIHINNAN_JAREYSKORJAUS
ROADSIDE_PRICES	TIENVARSIHINNAT
SILVICULTURAL_COSTS	METSANHOITOKUSTANNUKSET
SIMULATION_CONTROL	SIMULOINNIN_OHJAUS
STUMPAGE_PRICES	KANTOHINNAT
TIMBER_PRODUCTION_LAND	PUUNTUOTANNON_MAA
UNUSED_GROWTH_ESTIMATES	KASVUMUISTI
VOLUME_CALIBRATION	TILAVUUDEN_TASOKORJAUS
YEARS	VUODET

C_VARIABLES

Functions

The C_VARIABLES parameter defines the names of the c variables (character strings) stored in the management unit records of **rsd** type files.

Generic name in Finnish: C_MUUTTUJAT
Origin: System parameter
Program: MELAOPT
Type: Character
Number of items: Optional, the number of c variables in the management unit records of an actual **rsd** type file
Default values: None

In MELAOPT, c variables are used to define JLP domains (for JLP domains, see Chapter 3.3.3).

Management unit records are provided by the user, see Appendix D.2.

> NOTE: User is responsible for the compatibility of the c variables in management unit records and the values of the C_VARIABLES parameter.

Legend

(1) - (n) Names (character strings) of the c variables in a management unit record.

Example B.1. A definition of the C_VARIABLES parameter.

```
C_VARIABLES#SITE#AGE#OWNER
```

There are three c variables in the management unit records and the names of these variables are 'SITE', 'AGE' and 'OWNER'.

D_CLASSES_IN_REMOVAL

Functions

The D_CLASSES_IN_REMOVAL parameter defines the diameter classes of cutting removal when collecting the variables (121) - (180) of the decision data record, see Appendix D.4.

Generic name in Finnish: KERTYMAN_LPM_LUOKAT
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 4
Default values: 10.4999 20.4999 30.4999 99.9999

Default values above define four diameter classes (0 - 10.4999 cm, 10.5 - 20.4999 cm, 20.5 - 30.4999 cm and 30.5 - 99.9999 cm).

Legend

(1) - (4) Upper limits for diameter classes of cutting removal when collecting the decision data record variables (121) - (180), cm.

NOTE: The diameter classification of cutting removal is based on the diameter of the individual trees being cut, see the tree variable (3) of the simulation record in Appendix D.3.

NOTE: The diameter classes are collected during the simulation in MELASIM. The diameter classes cannot be changed afterwards in MELAOPT. User is responsible for checking the compatibility of the explanations in the instructions for the generation of summary reports (**tab** type files) and the values of the D_CLASSES_IN_REMOVAL parameter.

Example B.2. A definition of the D_CLASSES_IN_REMOVAL parameter.

```
D_CLASSES_IN_REMOVAL 20.4999 30.4999 40.4999 99.9999
```

The cutting removal will be divided in four diameter classes (0 - 20.4999 cm, 20.5 - 30.4999 cm, 30.5 - 40.4999 cm and 40.5 - 99.9999 cm) when collecting the variables (121) - (180) of the decision data record.

DISCOUNT_RATES

Functions

The DISCOUNT_RATES parameter defines the optional discount rates applied in the calculation of net present values for management schedules in MELASIM.

Generic name in Finnish: LASKENTAKOROT
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 5
Default values: 1.010 1.020 1.030 1.040 1.050

The net present values are calculated using five optional discount rates. Default rates are 1, 2, 3, 4 and 5 %. See the variables (801) - (810) of the decision data record in Appendix D.4.

NOTE: The discount rates applied in MELASIM cannot be changed in MELAOPT.

NOTE: User has to take care of the compatibility of the discount rates and the land values, see the LAND_VALUES parameter.

Legend

(1) - (5) Optional discount rates.

Example B.3. A definition of the DISCOUNT_RATES parameter.

```
DISCOUNT_RATES 1.020 1.025 1.030 1.035 1.040
```

The discount rates for the calculation of net present values are 2, 2.5, 3, 3.5 and 4 %.

EVENT

Functions

The EVENT parameter defines the optional events (natural processes and human activities) for the simulation of management schedules.

The EVENT parameter makes it possible for the user to provide a dedicated set of optional events for each simulation application in the limits of the built-in basic event routines and their arguments in MELASIM. Same basic event routines can also be referred several times in the same application with different parameter settings in order to generate slightly different management options, for example concerning thinnings.

Each occurrence of the EVENT parameter generates one optional event for simulation, see Chapter 3.4.1. Every optional event has to be defined separately. For the maximum number of event definitions, see the item (2) of the SIMULATION_CONTROL parameter.

> NOTE: User-supplied event definitions are always required for each simulation application.

Generic name in Finnish: TAPAHTUMA
Origin: System parameter
Program: MELASIM
Type: Character (character items may contain also numerical parts)
Number of items: Optional
Default values: None

The purpose of the simulation of management schedules is to generate a set of different management options for stands over time and use them for the forest level selection of a production and management program. The simulation of management schedules consists of states and events (see Chapter 1.2.2.2). Events are natural processes and human activities that are simulated by the built-in basic event routines of MELASIM. The basic events in the basic event routines are the generic steps of the MELA simulation.

The tasks of the basic event routines in the simulation are to

- decide the feasibility of the basic events in each state of the management unit,
- simulate the details of the basic events, and
- collect the summarized values of decision variables (see the decision data variables in Appendix D.4).

The basic event routines and the respective basic event groups in the current MELASIM version are:

- natural processes,
- cuttings,
- tending of young stands,
- artificial regeneration,

- clearing of regeneration area,
- soil preparation,
- drainage of peatlands,
- fertilization,
- pruning of pine, and
- changing the values of management unit variables.

The actual choice of optional events is generated using the EVENT parameter and event definitions. Besides the general event identification and event definition items, each event definition contains one call or several calls of the basic event routines in accordance with the desired simulation actions.

The basic events and the calls of the basic event routines with their arguments are introduced in the chapter Calls of basic event routines below.

Legend

Each occurrence of the EVENT parameter consists of three types of items:
- an event identification line (item (1)),
- up to seven optional event definition items (items (2) - (8)), and
- one or more calls of the basic event routines (items (9) - (n)).

The items of the EVENT parameter are:

(Event identification line)

```
(1) #event_identification characterization
```

(Optional event definition items)

```
(2) #EVENT_YEARS year[ year] repeat_interval
(3) #EVENT_INTERVALS interval[ interval]
(4) #EVENT_BRANCHING value[ value]
(5) #COMPARABLE_EVENTS event_identification[ event_identification]
(6) #FEASIBLE_PRECEDESSORS event_identification[ event_identification]
(7) #FOREST_CATEGORIES feasibility_condition
(8) #EVENT_PROBABILITY value[ value]
```

(Calls of basic event routines)

```
(9)-(n) #EVENT_CALL argument_value[ argument_value]
```

> NOTE: Each of the event definition items must not occupy more than one input line (131 characters in total). They cannot have continuation lines (see the syntax of the character type parameters in Chapter 3.2.1.4).

The event identification line is the header of the event definition. Optional event definition items control the simulation of the events in general and describe the relationships of the events. Basic event calls are references to the basic event routines equipped with application specific argument values.

The event identification line (the item (1) of the EVENT parameter) and at least one basic event routine call (the item (9) of the EVENT parameter) must appear in each event definition. Optional event definition items are required if they differ from the user-supplied default values (see the EVENT_DEFAULTS parameter). The COMPARABLE_EVENTS and FEASIBLE_PRECEDESSORS items are usually required for all event definitions. Notice that there are no built-in default values of the basic event calls.

The details of the event definition items are discussed below.

Example B.4. A definition of the EVENT parameter.

```
* Thinning based on number of stems/ha

EVENT
* Event identification (10) and characterization in words
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS

* Optional event definition item (5)
#COMPARABLE_EVENTS 20 25 28 29 50

* Optional event definition item (6)
#FEASIBLE_PRECEDESSORS 70 71 99

* Optional event definition item (7)
#FOREST_CATEGORIES 3 30 0 -6.99999

* One basic event call
#EVENT_CALL 2 1 3 1 0 800 800 8 12 0.6 1500 1 0.5 0 0 0 0
```

A thinning of young stands is defined. The items (2) - (4) and (8) (EVENT_YEARS, EVENT_INTERVALS, EVENT_BRANCHING and EVENT_PROBABILITY) are assumed to come from the definition of the EVENT_DEFAULTS parameter.

Event identification line of the EVENT parameter

Item (1) of the EVENT parameter: event_identification

Functions: The identification line of the EVENT parameter is the header of the event definition.

The general syntax of the event identification line is

```
#event_identification characterization
```

event_identification	An integer number to identify the event. The identification number must be unique for each event in the same application.
characterization	A character string describing the event in words.

In Example B.4, the event identification number is '10' and the rest of the line constitutes the characterization of the event 'FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS'.

Optional event definition items (items (2) - (8) of the EVENT parameter)

Item (2) of the EVENT parameter: EVENT_YEARS

Functions: The EVENT_YEARS item defines the relative years when the event can be simulated.
Generic name in Finnish: TAPAHTUMAVUODET

The general syntax of the EVENT_YEARS item is

```
#EVENT_YEARS year[ year] repeat_interval
```

EVENT_YEARS	The name of the event definition item.
year	A relative year when the event can be simulated, usually a year in the middle of the sub-period in question. The event years can be provided for the whole simulation period or any period when the event can be simulated. The events after the last year are simulated according to the repeat_interval argument. The sub-periods are defined by the YEARS parameter.
repeat_interval	The number of years between the event years after the last event year provided. This is the last argument of the EVENT_YEARS item.

NOTE: User is responsible for the compatibility of the EVENT_YEARS item and the YEARS parameter.

NOTE: If an event should only be simulated for the selected sub-periods, the repetition can be omitted by providing a high value for the repeated interval.

Example B.5. A definition of the EVENT_YEARS item of the EVENT parameter.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#EVENT_YEARS 6 10

* The event can be simulated with 10-year intervals
* beginning from the relative year 6 (i.e. in the middle
* of each 10-year sub-period).
```

Item (3) of the EVENT parameter: EVENT_INTERVALS

Functions: The EVENT_INTERVALS item defines the minimum intervals between the occurrences of the event and the comparable events in a management schedule. For the concept of comparable events, see the event definition item COMPARABLE_EVENTS.
Generic name in Finnish: LYHIMMAT_TOTEUTUSVALIT

The general syntax of the EVENT_INTERVALS item is

```
#EVENT_INTERVALS interval[ interval]
```

EVENT_INTERVALS	The name of the event definition item.
interval	The minimum time interval between the event and the comparable events in a management schedule. Minimum intervals are required for each event year defined by the EVENT_YEARS item. The last interval value is repeated as a minimum interval, if required.

Example B.6. A definition of the EVENT_INTERVALS item of the EVENT parameter.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#EVENT_INTERVALS 10

* The intervals between the occurrences of this event
* and the comparable events has to be at least 10 years
* for all event years provided.
```

Item (4) of the EVENT parameter: EVENT_BRANCHING

Functions: The EVENT_BRANCHING item controls the branching of the simulation of management schedules. If branching is allowed, the event may have alternative events (or "branches") in the same state; the event is optional in that state (supposing that it is feasible). If branching is denied, the event cannot have alternative events in the same state; the event is obligatory (supposing that it is feasible).

Generic name in Finnish: HAARAUTUMINEN

The general syntax of the EVENT_BRANCHING item is

```
#EVENT_BRANCHING value[ value]
```

EVENT_BRANCHING — The name of the event definition item.

value — The branching control for each event year. The last value is repeated if further branching control is required. Branching control can have either the value '0' or the value '1'.

The value '0' of EVENT_BRANCHING denies alternative events. An event is obligatory in the event year and only that the event is simulated if it is feasible. If all events are obligatory, only one management schedule will be as a result supposing that there are feasible events. The order of the event definition occurrences determinates the priority of the obligatory events in the simulation.

The value '1' of EVENT_BRANCHING allows alternative events in the event year. An optional event means that alternative events can be simulated in the same event year resulting to several alternative management schedules, assuming that several events are feasible in the event year.

Example B.7. A definition of the EVENT_BRANCHING item of the EVENT parameter.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#EVENT_BRANCHING 0

* The event is simulated whenever feasible without any
* alternative events.
```

In Example B.7, first thinning would always be chosen in the optimization, because it has no alternative management options.

NOTE: Constraints in the optimization should never be provided for decision variables originating from obligatory events in the simulation. In the case of Example B.7, no constraints should be given in the optimization concerning first thinnings.

Item (5) of the EVENT parameter: COMPARABLE_EVENTS

Functions: The COMPARABLE_EVENTS item defines the comparable events when deciding minimum time intervals between events. For minimum intervals between events, see the EVENT_INTERVALS item.
Generic name in Finnish: VASTAAVAT_TAPAHTUMAT

The general syntax of the COMPARABLE_EVENTS item is

```
#COMPARABLE_EVENTS event_identification[ event_identification]
```

COMPARABLE_EVENTS	The name of the event definition item.
event_identification	The identification number of an event defined for the application, see event_identification in the item (1) of the EVENT parameter.

Example B.8. A definition of the COMPARABLE_EVENTS item of the EVENT parameter.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#COMPARABLE_EVENTS 20 25 28 29 50
#EVENT_INTERVALS 10

* Comparable events to first thinning are events
* 20, 25, 28, 29 and 50. The minimum interval between
* these events and first thinnings is 10 years as well as
* between first thinnings (see the EVENT_INTERVALS item).
```

Item (6) of the EVENT parameter: FEASIBLE_PRECEDESSORS

Functions: The FEASIBLE_PRECEDESSORS item defines the events that may immediately (i.e. in the same year) precede the event.
Generic name in Finnish: SALLITUT_EDELTAJAT

The general syntax of the FEASIBLE_PRECEDESSORS item is

```
#FEASIBLE_PRECEDESSORS event_identification[ event_identification]
```

FEASIBLE_PRECEDESSORS	The name of the event definition item.
event_identification	The identification number of an event defined for the application, see event_identification in the item (1) of the EVENT parameter.

Example B.9. A definition of the FEASIBLE_PRECEDESSORS item of the EVENT parameter.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#FEASIBLE_PRECEDESSORS 70 71 99

* Events 70, 71 and 99 may immediately precede first thinning.
```

Item (7) of the EVENT parameter: FOREST_CATEGORIES

Functions: The FOREST_CATEGORIES item defines the conditions of management units under which the event can be simulated. The conditions are expressed using the management unit variables of the simulation data (see simulation data variables in Appendix D.3).
Generic name in Finnish: METSIKKOEHDOT

The general syntax of the FOREST_CATEGORIES item is

```
#FOREST_CATEGORIES feasibility_condition
```

FOREST_CATEGORIES The name of the event definition item.

feasibility_condition:

```
category_group[ 0 category_group]
```

category_group:

```
category_definition[ category_definition]
```

category_definition:

```
number variable value[ value]
```

'0' The delimiter of category groups denoting the logical operator OR between adjacent category groups (see Example B.13).

number The number of the following arguments (variable and value(s)) in the current category definition.

variable A management unit variable in the simulation record (see simulation data variables in Appendix D.3).

value A relevant value of the management unit variable for defining the feasibility of the event. The values with the sign '-' define a range from the previous value to the absolute value of the variable, see Examples B.10, B.11, B.12 and B.13.

The event is feasible and it can be simulated with regard to the FOREST_CATEGORIES item if the **feasibility condition** calculated from the actual management unit variables is TRUE. The logical operator (expressed by the delimiter '0') between the adjacent category groups is OR. If any of the category groups is TRUE, then the feasibility condition is TRUE.

The logical operator between the adjacent **category definitions** is AND. If any of the category definitions is FALSE, then the category group is FALSE. The delimiter between category definitions is the space character (' '). See Examples B.12 and B.13.

The logical operator between adjacent **values and/or ranges** is OR. If any of the values or ranges is TRUE, then the category definition is TRUE.

> NOTE: The default value '0' of the FOREST_CATEGORIES item means that the event can be simulated for any of the forest management categories (see Example B.18).

Example B.10. A definition of the FOREST_CATEGORIES item of the EVENT parameter, one category definition.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#FOREST_CATEGORIES 2 30 1

* The event can be simulated
* if the value of the management unit variable (30) in
* the simulation record is equal to 1.
```

Example B.11. A definition of the FOREST_CATEGORIES item of the EVENT parameter, a range type category definition.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#FOREST_CATEGORIES 3 30 0 -1.9999

* The event can be simulated
* if the value of the management unit variable (30) in
* the simulation record is greater or equal to 0
* and less or equal to 1.9999.
```

Example B.12. A definition of the FOREST_CATEGORIES item of the EVENT parameter, two category definitions.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#FOREST_CATEGORIES 3 30 0 -1.9999 4 32 1 3 5

* The event can be simulated if the value of
* the management unit variable (30) is
* greater or equal to 0 and less or equal to 1.9999
* AND
* the value of the variable (32) is equal to 1, 3 or 5.
```

Example B.13. A definition of the FOREST_CATEGORIES item of the EVENT parameter, two category groups.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#FOREST_CATEGORIES 3 30 0 -1.9999 4 32 1 3 5 0 3 30 0 -1.9999 3 36
  0 -20.00

* The event can be simulated
* if the value of the management unit variable (30) is
* greater or equal to 0 and less or equal to 1.9999
* AND
* the value of the variable (32) is 1, 3 or 5
* OR
* if the value of the variable (30) is
* greater or equal to 0 and less or equal to 1.9999
* AND
* the value of variable (36) is greater
* or equal to 0 and less or equal to 20.00.

* The variable (30) etc. refer here to management unit variables
* in the simulation record.

* Notice that the EVENT_CALL arguments above are
* on several lines due to the limited space.
```

NOTE: Event definition items must not occupy more than one input line (131 characters in total) each. Unlike in Example B.13, continuation lines of items are not allowed (see the syntax of character type parameters in Chapter 3.2.1.4).

Item (8) of the EVENT parameter: EVENT_PROBABILITY

Functions: The EVENT_PROBABILITY item defines the probability to simulate the event for each year defined by the EVENT_YEARS item. EVENT_PROBABILITY less than 1.0 should be used only as an extreme way to limit the total number of management schedules in a random order in cases where computer capacity would otherwise be exceeded.
Generic name in Finnish: TODENNAKOISYYS

The general syntax of the EVENT_PROBABILITY item is

```
#EVENT_PROBABILITY value [ value]
```

EVENT_PROBABILITY	The name of the event definition item.
value	A value '0.0' - '1.0' for defining the probability to simulate the event for each year defined by the EVENT_YEARS item. The last value is automatically repeated if required. Usually the only relevant value is '1.0'.

Example B.14. A definition of the EVENT_PROBABILITY item of the EVENT parameter.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#EVENT_PROBABILITY 1.0

* The probability 1.0 is used to simulate the event for
* all years defined by the EVENT_YEARS parameter.

* It is recommended to define the EVENT_PROBABILITY item
* using the EVENT_DEFAULTS parameter only.
```

Calls of basic event routines

Items (9) - (n) of the EVENT parameter: EVENT_CALL

Functions: The item EVENT_CALL calls for and transfers the user-supplied argument values to the basic event routine. EVENT_CALL arguments make it possible to call the same basic event routines in optional ways for slightly different events and for different applications.
Generic name in Finnish: TAPAHTUMAKUTSU

There has to be one or more EVENT_CALL items for each definition of the EVENT parameter. There are no default values for the definitions of the EVENT_CALL parameter.

The general syntax of the EVENT_CALL item is

```
#EVENT_CALL argument_value[ argument_value]
```

EVENT_CALL — The name of the event definition item.

argument_value — The value of an event call argument. The number of EVENT_CALL arguments is different for each basic event group. Common and event-specific EVENT_CALL arguments are discussed in details later in this Appendix. Both types of EVENT_CALL arguments are provided adjacently in any event call.

Example B.15. A definition of the EVENT_CALL item of the EVENT parameter and the different EVENT_CALL argument types.

```
EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
#EVENT_CALL      2 1  3 1 0 800 800 8 12 0.6 1500  1
*                A B  1 2 3   4   5 6  7   8    9 10

  0.5  0  0  0  0  1  3  3 99  3  3 15 99  3  1
*  11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

    1  2 -1 -1  8 -0.5  1  0  0  0  8 -0.5  1
*  26 27 28 29 30   31 32 33 34 35 36   37 38

* argument types: common (A, B) and specific (1-38)
*                 arguments

* Notice that the EVENT_CALL arguments above are
* on several lines due to the limited space.
```

NOTE: Event definition items must not occupy more than one input line (131 characters in total) each. Unlike in Example B.15, continuation lines of items are not allowed (see the syntax of character type parameters in Chapter 3.2.1.4).

EVENT_CALL argument types

There are two types of EVENT_CALL arguments

- common EVENT_CALL arguments for all basic events (see A and B in Example B.15), and
- specific EVENT_CALL arguments (see 1 to 38 in Example B.15) for each basic event.

In the respective basic event routines, there are built-in default selection instructions for the general MELA tree selection routine. User-supplied tree selection instructions can be provided for cuttings (see arguments 16 to 38 in Example B.15) and tending of young stands using the specific EVENT_CALL arguments. Notice that the formal structure of the user-supplied tree selection instructions is checked, but not the validity of argument values. For the details of the tree selection procedure and the instructions, see Appendix F and specific EVENT_CALL arguments in Examples B.15 and B.17.

Common EVENT_CALL arguments for all basic events

(A) identification number of the basic event routine being called

'1'	natural processes
'2'	cuttings
'3'	tending of young stands
'4'	artificial regeneration
'5'	clearing of regeneration area
'6'	soil preparation
'7'	drainage of peatlands
'8'	fertilization
'9'	pruning of pine
'11'	run-time change in the value of a management unit level variable in the simulation record, for example, the change of the forest management category

(B) '1'

Specific EVENT_CALL arguments for each basic event

1. Specific EVENT_CALL arguments for natural processes

(1)	'1' (number of simulation steps in one call of natural processes - not in use)
(2)	'5' (length of the simulation step, years - not in use)
(3)	'0' (not in use)
(4)	general adjustment coefficient for basal area increment models (on tree level), basic level = 1.0
(5)	general adjustment coefficient for height increment models (on tree level), basic level = 1.0
(6)	general adjustment coefficient for ingrowth models (on tree level), basic level = 1.0
(7)	general adjustment coefficient for mortality models (on tree level), basic level = 1.0

NOTE: The actual effects of the general adjustment coefficients to the volume increment should be examined in each particular case with a relevant test material.

2. Specific EVENT_CALL arguments for cuttings

There are six cutting methods available for event definitions:

2.1 thinning based on basal area instructions
2.2 clear cutting
2.3 thinning based on number of stems instructions
2.4 over story removal
2.5 seed tree cutting (for natural regeneration of pine)
2.6 shelterwood cutting (for natural regeneration of spruce)

Each of the cutting methods has specific EVENT_CALL arguments.

2.1 Thinning based on basal area instructions

The principal parameters to regulate the simulation of thinnings in MELA are

- thinning intensity,
- tree size selection (from below, equal, from above),
- tree species selection, and
- minimum cutting removal/ha.

Methods to select the thinning intensity in MELASIM are

(a) relative thinning intensity ("thinning percentages"), and

(b) minimum growing stock after thinning ("thinning models", see the MIN_BASAL_AREA_AFTER_THINNING parameter).

The latter method was popular for the average regulation of forest management and in the absence of the comparison of alternatives. It is still a valid method if any deviations from the preformed average regulations are not allowed. The first method serves a more relevant alternative for the dynamic analysis of thinning options. However, the number of alternative management schedules may rise high with several intensities and other thinning options.

The tree size and tree species selection is controlled by the tree selection instructions of the EVENT_CALL arguments, see also Appendix F. The minimum cutting removal is supplied among the EVENT_CALL arguments.

The specific EVENT_CALL arguments for thinning based on basal area instructions are

(1) '1' (cutting method = thinning based on basal area instructions)

(2) '1' (probability to simulate the event - not in use)

(3) proportion of basal area to be removed (0 - 1.0) if the relative thinning intensity or method (a) is applied; otherwise '0'

(4) minimum removal in management unit, m^2/ha

(5) minimum removal on sample plot, m^2/ha

(6) minimum mean height before thinning, m

(7) maximum mean diameter before thinning in relation to the recommended minimum regeneration diameter (0 - 10.0) (see the MIN_REGENERATION_ DIAMETER parameter)

(8) minimum acceptable basal area after thinning in relation to the recommended basal area (0 - 10.0) if the relative thinning intensity or method (a) is applied; otherwise '0' (see the MIN_BASAL_AREA_AFTER_THINNING parameter)

(9) maximum mean age before thinning in relation to the recommended minimum regeneration age (0 - 10.0) (see the MIN_REGENERATION_AGE parameter)

(10) basal area after thinning in relation to the recommended minimum basal area (0 - 10.0) if the minimum growing stock after thinning or method (b) is applied; otherwise '0' (see the MIN_BASAL_AREA_AFTER_THINNING parameter)

(11) maximum proportion of basal area to be removed in thinning (0 - 1.0) if the minimum growing stock after thinning or method (b) is applied; otherwise '0'

(12) '0' (not in use)

(13) '0' (not in use)

(14) '0' (not in use)

(15) '0' (not in use)

(16) - (n) user-supplied tree selection instructions, see Appendix F (optional)

The trees to be removed (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of basal area, see the tree variable (5) of the simulation record in Appendix D.3.

2.2 Clear cutting

The specific EVENT_CALL arguments for clear cutting are

(1) '2' (cutting method = clear cutting)

(2) '1' (probability to simulate the event - not in use)

(3) '1' (proportion of basal area to be removed in clear cutting - not in use)

(4) minimum removal in management unit, m^2/ha

(5) minimum removal on sample plot, m^2/ha

(6) minimum mean diameter before cutting in relation to the recommended minimum regeneration diameter (see the MIN_REGENERATION_ DIAMETER parameter)
0 - 10.0 relative mean diameter
>10 absolute mean diameter

(7) minimum mean age before cutting in relation to the recommended minimum regeneration age (see the MIN_REGENERATION_AGE parameter)
0 - 10.0 relative mean diameter
>10 absolute mean diameter

(8) maximum basal area (mean diameter >8 cm) or number of stems (mean diameter < 8 cm) before cutting in relation to the respective minimum recommendation (0 - 10.0) for the recognition of the low-stocked stands and the generation of a clear cutting option (see the MIN_BASAL_AREA_AFTER_THINNING parameter)

(9) minimum mean age before cutting in relation to the recommended regeneration age if the site type category is 6, 7 or 8 (barren sites, rocky or sandy areas or open mountains), see the sample plot variable (13) of the simulation record in Appendix D.3 and the MINIMUM_REGENERATION_AGE parameter in Appendix B.2
0 - 10.0 relative mean age
>10 absolute mean age

(10) minimum mean age in relation to the recommended regeneration age when clear cutting option is always simulated, see the MINIMUM_REGENERATION_ AGE parameter in Appendix B.2
0 - 10.0 relative mean age
>10 absolute mean age

(11) '0' (not in use)

(12) '0' (not in use)

(13) '0' (not in use)

(14) '0' (not in use)

(15) '0' (not in use)

(16) - (n) user-supplied tree selection instructions, see Appendix F (optional)

NOTE: If either diameter (6) or mean age (7) is reached, clear cutting can be simulated with regard to the rotation period rules (6) and (7).

The trees to be removed (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of basal area, see the tree variable (5) of the simulation record in Appendix D.3.

2.3 Thinning based on number of stems instructions

For the methods (a) and (b) regarding the thinning intensity selection, see the cutting method 2.1 'thinning based on basal area instructions'.

The specific EVENT_CALL arguments for thinning based on number of stems instructions are

(1) '3' (cutting method = thinning based on number of stems instructions)

(2) '1' (probability to simulate the event - not in use)

(3) proportion of number of stems to be removed (0 - 1.0) if the relative thinning intensity or method (a) is applied; otherwise '0'

(4) minimum removal in management unit, stems/ha

(5) minimum removal on sample plot, stems/ha

(6) minimum mean diameter before thinning, cm

(7) maximum mean height before thinning, m

(8) minimum acceptable number of stems per hectare after thinning in relation to the built-in recommendation (0 - 10.0) if the relative thinning intensity or method (a) is applied; otherwise '0'

(9) minimum number of stems per hectare before cutting, stems/ha

(10) number of stems per hectare after thinning in relation to the built-in recommendation (0 - 10.0) if the minimum growing stock after thinning or method (b) is applied; otherwise '0'

(11) maximum proportion of stems per hectare to be removed in thinning (0 - 1.0) if the minimum growing stock after thinning or method (b) is applied; otherwise '0'

(12) '0' (not in use)

(13) '0' (not in use)

(14) '0' (not in use)

(15) '0' (not in use)

(16) - (n) user-supplied tree selection instructions, see Appendix F (optional)

The trees to be removed (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of number of stems per hectare, see the tree variable (1) of the simulation record in Appendix D.3.

2.4 Over story removal

The specific EVENT_CALL arguments for over story removal are

(1) '4' (cutting method = over story removal)

(2) '1' (probability to simulate the event - not in use)

(3) proportion of basal area to be removed in cutting (0 - 1.0)

(4) minimum removal in management unit, m^2/ha

(5) minimum removal on sample plot, m^2/ha

(6) minimum mean diameter before cutting in relation to the recommended minimum regeneration diameter (0 - 10.0) (see the MIN_REGENERATION_DIAMETER parameter)

(7) minimum mean age before cutting in relation to the recommended minimum regeneration age (0 - 10.0) (see the MIN_REGENERATION_AGE parameter)

(8) '0' (not in use)

(9) '0' (not in use)

(10) minimum number of stems per hectare before over story removal in relation to the recommended number of plants after regeneration (0 - 10.0) (see the MIN_NUMBER_OF_SEEDLINGS parameter)

(11) '0' (not in use)

(12) '0' (not in use)

(13) '0' (not in use)

(14) '0' (not in use)

(15) '0' (not in use)

(16) - (n) user-supplied tree selection instructions, see Appendix F (optional)

The trees to be removed (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of basal area, see the tree variable (5) of the simulation record in Appendix D.3.

2.5 Seed tree cutting (for natural regeneration of pine)

The specific EVENT_CALL arguments for seed tree cutting are

(1) '5' (cutting method = seed tree cutting for natural regeneration of pine)

(2) '1' (probability to simulate the event - not in use)

(3) '0' (not in use)

(4) minimum removal in management unit, stems/ha

(5) minimum removal on sample plot, stems/ha

(6) minimum mean diameter before cutting in relation to the recommended minimum regeneration diameter (see the MIN_REGENERATION_DIAMETER parameter)
0 - 10.0 relative mean diameter
>10 absolute mean diameter

(7) minimum mean age before cutting in relation to the recommended minimum regeneration age (see the MIN_REGENERATION_AGE parameter)
0 - 10.0 relative mean diameter
>10 absolute mean diameter

(8) minimum basal area before cutting in relation to the recommended minimum after thinning (see the MIN_BASAL_AREA_AFTER_THINNING parameter)

(9) maximum mean age before cutting in relation to the recommended minimum regeneration age (see the MIN_REGENERATION_AGE parameter)
0 - 10.0 relative mean diameter
>10 absolute mean diameter

(10) '0' (not in use)

(11) '0' (not in use)

(12) '0' (not in use)

(13) '0' (not in use)

(14) '0' (not in use)

(15) '0' (not in use)

(16) - (n) user-supplied tree selection instructions, see Appendix F (optional)

NOTE: If either the minimum diameter (6) or the minimum mean age (7) is reached, seed tree cutting can be simulated with regard to the rotation period rules (6) and (7).

The trees to be removed (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of number of stems per hectare, see the tree variable (1) of the simulation record in Appendix D.3.

2.6 Shelterwood cutting (for natural regeneration of spruce)

The specific EVENT_CALL arguments for shelterwood cutting are

(1) '6' (cutting method = shelterwood cutting for natural regeneration of spruce)

(2) '1' (probability to simulate the event - not in use)

(3) '0' (not in use)

(4) minimum removal in management unit, stems/ha

(5) minimum removal on sample plot, stems/ha

(6) minimum mean diameter before cutting in relation to the recommended minimum regeneration diameter (see the MIN_REGENERATION_DIAMETER parameter)
0 - 10.0 relative mean diameter
>10 absolute mean diameter

(7) minimum mean age before cutting in relation to the recommended minimum regeneration age (see the MIN_REGENERATION_AGE parameter)
0 - 10.0 relative mean age
>10 absolute mean age

(8) minimum basal area before cutting in relation to the recommended thinning model (0 - 10.0)

(9) maximum mean age before cutting in relation to the recommended minimum regeneration age (see the MIN_REGENERATION_AGE parameter)
0 - 10.0 relative mean age
>10 absolute mean age

(10) '0' (not in use)

(11) '0' (not in use)

(12) '0' (not in use)

(13) '0' (not in use)

(14) '0' (not in use)

(15) '0' (not in use)

(16) - (n) user-supplied tree selection instructions, see Appendix F (optional)

NOTE: If either the minimum diameter (6) or the minimum mean age (7) is reached, shelterwood cutting can be simulated with regard to the rotation period rules (6) and (7).

The trees to be removed (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of number of stems per hectare, see the tree variable (1) of the simulation record in Appendix D.3.

3. Specific EVENT_CALL arguments for tending of young stands

(1)	'0' (not in use)
(2)	'1' (probability to simulate the event - not in use)
(3)	adjustment coefficient to the recommended number of stems after tending (0 - 10.0) (see the MIN_NUMBER_OF_SEEDLINGS parameter)
(4)	minimum number of stems before tending in relation to the recommendation (0 - 10.0) (see the MIN_NUMBER_OF_SEEDLINGS parameter)
(5)	minimum mean diameter before tending, cm
(6)	maximum mean diameter before tending, cm
(7)	minimum number of stems to be removed in management unit and on sample plot, stems/ha
(8)	minimum mean height before tending, m
(9)	maximum mean height before tending, m
(10)	'0'
(11)	'0'
(12)	'0'
(13)	'0'
(14)	'0'
(15)	'0'
(16) - (n)	user-supplied tree selection instructions, see Appendix F (optional)

The trees to be removed (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of number of stems per hectare, see the tree variable (1) of the simulation record in Appendix D.3.

4. Specific EVENT_CALL arguments for regeneration

(1) type of regeneration
- '0' random (type 1 or 2)
- '1' seeding
- '2' planting
- '3' supplementary planting

(2) '1' (probability to simulate the event - not in use)

(3) seeding or planting: years from clear cutting to regeneration;
supplementary planting: years from regeneration to supplementary planting

(4) tree species used in regeneration (0: random; >0 tree species, for valid tree species, see the initial data record in Appendix D.1)

(5) number of plants used in regeneration, plants/ha (see the MIN_NUMBER_OF_SEEDLINGS parameter)
- 0 based on the recommended regeneration model
- <10 number of plants in relation to the recommended regeneration model
- >10 absolute number of plants

(6) mean age of plants at the moment of regeneration, year

(7) mean height of plants at the moment of regeneration, m

(8) probability of plants to survive (0 - 1.0)
- 0 based on the regeneration model (random)
- >0 probability given by user

(9) lower bound for the site type

(10) upper bound for the site type

5. Specific EVENT_CALL arguments for clearing of regeneration area

(1)	'0' (not in use)
(2)	'1' (probability to simulate the event - not in use)
(3)	lower bound for the site type, see the management unit variable (13) of the simulation record in Appendix D.3
(4)	upper bound for the site type

The trees to be removed (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of number of stems per hectare, see the tree variable (1) of the simulation record in Appendix D.3.

6. Specific EVENT_CALL arguments for site preparation

(1)	'0' (type of site preparation - not in use)
(2)	'1' (probability to simulate the event - not in use)
(3)	lower bound for the site type, see the management unit variable (13) of the simulation record in Appendix D.3
(4)	upper bound for the site type

7. Specific EVENT_CALL arguments for drainage of peatlands

(1)	type of drainage '1' new ditching '2' ditch cleaning and supplementary ditching
(2)	'1' (probability to simulate the event - not in use)

8. Specific EVENT_CALL arguments for fertilization

(1)	'1' (type of fertilization - not in use)
(2)	'1' (probability to simulate the event - not in use)
(3)	minimum mean diameter before fertilization in relation to the recommended minimum regeneration diameter (0 - 10.0) (see the MIN_REGENERATION_ DIAMETER parameter)
(4)	maximum mean diameter before fertilization in relation to the recommended minimum regeneration diameter (0 - 10.0) (see the MIN_REGENERATION_ DIAMETER parameter)
(5)	minimum basal area before fertilization in relation to the recommended minimum basal area after thinning (0 - 10.0) (see the MIN_BASAL_AREA_AFTER_ THINNING parameter)
(6)	maximum basal area before fertilization in relation to the recommended minimum basal area after thinning (0 - 10.0) (see the MIN_BASAL_AREA_ AFTER_THINNING parameter)
(7)	minimum mean age before fertilization in relation to the recommended minimum regeneration age (0 - 10.0) (see the MIN_REGENERATION_AGE parameter)
(8)	maximum mean age before fertilization in relation to the recommended minimum regeneration age (0 - 10.0) (see the MIN_REGENERATION_AGE parameter)

9. Specific EVENT_CALL arguments for pruning of pine

(1)	'0' (not in use)
(2)	'1' (probability to simulate the event - not in use)
(3)	minimum mean height before pruning, m
(4)	maximum mean height before pruning, m
(5)	number of stems to be pruned, stems/ha

The trees to be pruned (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of number of stems per hectare, see the tree variable (1) of the simulation record in Appendix D.3.

11. Specific EVENT_CALL arguments for the run-time change of the value of a management unit variable in the simulation record

(1) '0' (not in use)

(2) '1' (probability to simulate the event - not in use)

(3) management unit variable to be changed (see the simulation record in Appendix D.3)

(4) new value of management unit variable

(5) lower bound for the old value of the management unit variable

(6) upper bound for the old value of the management unit variable

(7) '0' (not in use)

(8) '0' (not in use)

(9) '0' (not in use)

Example B.16. An event definition with two event calls.

```
EVENT
* Event identification line
#30 CLEAR CUTTING WITH CLEARING OF REGENERATION AREA

* Optional event definition items
#COMPARABLE_EVENTS        10 20 25 28 29
#FEASIBLE_PRECEDESSORS    70 71 99
#FOREST_CATEGORIES        3 30 0 -1.99999

* Two successive basic event calls
* - Clear cutting
#EVENT_CALL 2 1   2 0 1 0 0 0.9 0.9 0.5 2 1.15 0 0 0 0 0
* - Clearing of regeneration area
#EVENT_CALL 5 1   0 1 1 6
```

A clear cutting and the clearing of regeneration area is declared in one event definition. The event is simulated if both basic events are successively feasible. The order of the basic event calls decides the simulation order of the basic events.

Example B.17. An event definition with an explicit tree selection instruction.

```
EVENT
* Event identification line
#20 THINNING - BASAL AREA INSTRUCTIONS

* Optional event definition item
#COMPARABLE_EVENTS  10 25 28 29 30
#FOREST_CATEGORIES  3 30 0 -6.999990

* The basic event call defining a basal area thinning
* with tree selection arguments on the second line.
#EVENT_CALL 2 1   1 1 0 4 2 10 1.5 0.85 1.5 0.9 0.35
 0 0 0 0 1 3 6 99 2 2 -1 -1 8 -0.5 1 0 0 0 8 -0.5 1

* Notice that the EVENT_CALL arguments above are
* on several lines due to the limited space.
```

NOTE: In a valid event definition, the items of the EVENT parameter cannot have continuation lines (for the syntax of character type parameters, see Chapter 3.2.1.4).

A thinning based on basal area instructions is declared with the optional tree selection instructions in the EVENT_CALL item.

For further examples of basic event calls, see the event definitions in Appendix H.6.

EVENT_DEFAULTS

Functions

The EVENT_DEFAULTS parameter defines the default values for the optional items of the event definitions. Defaults values make it possible to omit the repeated items of event definitions. If provided, default values are used instead of missing items in actual event definitions. Default values are overridden by the actual event definition items.

Generic name in Finnish: TAPAHTUMA_OLETUSARVOT
Origin: System parameter
Program: MELASIM
Type: Character (character items may contain also numerical parts)
Number of items: 1-7
Default values: None

Legend

(1) - (7) Default values for the optional items of event definitions.

There are seven optional event definition items that can have default values:

- EVENT_YEARS,
- EVENT_INTERVALS,
- EVENT_BRANCHING,
- COMPARABLE_EVENTS,
- FEASIBLE_PRECEDESSORS,
- FOREST_CATEGORIES, and
- EVENT_PROBABILITY.

> NOTE: The items EVENT_YEARS, EVENT_INTERVALS, EVENT_BRANCHING, FOREST_CATEGORIES, and EVENT_PROBABILITY can be often, but are not categorically, repeated as such from one event definition to another. COMPARABLE_EVENTS and FEASIBLE_PRECEDESSORS have almost always event-specific values.

For more information about event definition items, see the EVENT parameter.

Example B.18. A definition of the EVENT_DEFAULTS parameter.

```
EVENT_DEFAULTS
#EVENT_YEARS                6 10
#EVENT_INTERVALS              10
#EVENT_BRANCHING               1
#FEASIBLE_PRECEDESSORS        99
#FOREST_CATEGORIES             0
#EVENT_PROBABILITY             1
```

A set of default values for the items of the EVENT parameter.

NOTE: In Example B.18, the default value (= 0) of the FOREST_CATEGORIES item means that the event can be simulated for all forest management categories.

FILE_NAMING

Functions

The FILE_NAMING parameter provides user-supplied instructions for the automatic naming of MELA files linked to the input/output units in the MELA programs. Explicit instructions are needed if the actual naming of MELA files deviate from the default instructions. For the principles of the automatic file naming applied in MELA, see Chapter 3.2.3.1.

> NOTE: The FILE_NAMING parameter should be provided in the **MELA_SET.PAR** file.

Generic name in Finnish: TIEDOSTOT
Origin: System parameter
Program: MELASIM, MELAOPT
Type: Character (character items may contain also numerical parts)
Number of items: Optional, explicit instructions are needed for those files deviating from default instructions
Default values: For the current defaults, see the definitions of each file type in Appendix C

Legend

The general syntax of the FILE_NAMING parameter is

```
(1) - (n) unit_number ext delimiter name_component[ name_component]
```

unit_number	The number of the input/output unit. Unit numbers are built-in constants in MELA programs and they cannot be changed by the user.
ext	The extension of the file name.
delimiter	A delimiter between the naming components in the file name. The character '-' prevents the use of delimiters in the file name.
name_component	The name of the file naming component. The naming components can be names of command arguments, names of character type parameters, and character constants (see Chapter 3.2.3.1).

In the generation of the file name, the names of command arguments and parameters get substituted by their actual values provided in the MELA program session while character constants are used as such. For instance in Example B.19, APPLICATION is the name of the MELASIM command argument (i.e. the name of the **par** type file containing MELASIM parameters), PROBLEM is the name of the MELAOPT command argument (i.e. the name of

the **mdl** type file containing JLP problem definitions) and FORESTRY_UNIT is the value of the character type parameter FORESTRY_UNIT likewise SUB_UNIT is the name of the lowest level sub-unit.

If a file naming component does not find any interpretation, the name of the naming component is treated as a character constant. A delimiter, if provided, is added between each of the naming components.

A relevant way to define file names depends on the MELA application in question. The current defaults of file naming instructions (see the default naming of MELA files in Appendix C.2 and Examples 3.10 and B.19) are designed for managing a single or hierarchical forestry unit with one simulation application and multiple optimization problems. In the case of more complicated analysis designs, more naming components are likely needed and they should be carefully designed in order to generate unique file names (see Example B.19).

> NOTE: Confusions with files are likely to appear, for example, if the file naming is not compatible with the analysis design or if the file names get longer than the maximum length allowed by the operating system (see also the MAX_LENGTH_OF_ FILENAME parameter).

For a comprehensive introduction to and a list of MELA files, see Appendix C.

Example B.19. How to change the default naming instructions of MELA files.

```
* SOME SAMPLE FILES TO DEMONSTRATE HOW TO CHANGE
* THE DEFAULT NAMING INSTRUCTIONS OF MELA FILES

* current defaults: hierarchical forestry units,
*                   single simulation application,
*                   multiple optimization problems

FILE_NAMING
* initial data files
#9   RSD  _  SUB_UNIT
* management schedule files
#10  MSC  _  SUB_UNIT
#11  MSD  _  SUB_UNIT
* forest level summary files of MELAOPT
#22  MSC  _  FORESTRY_UNIT  SUB_UNIT  PROBLEM  O
#23  MSD  _  FORESTRY_UNIT  SUB_UNIT  PROBLEM  O

* option 1: single forestry unit,
*           single simulation application,
*           multiple optimization problems

FILE_NAMING
* initial data files
#9   RSD  _  FORESTRY_UNIT
* management schedule files
#10  MSC  _  FORESTRY_UNIT
#11  MSD  _  FORESTRY_UNIT
* forest level summary files of MELAOPT
#22  MSC  _  FORESTRY_UNIT  PROBLEM  O
#23  MSD  _  FORESTRY_UNIT  PROBLEM  O

* option 2: hierarchical forestry units,
*           multiple simulation applications,
*           multiple optimization problems

FILE_NAMING
* initial data files
#9   RSD  _  SUB_UNIT
* management schedule files
#10  MSC  _  SUB_UNIT  APPLICATION
#11  MSD  _  SUB_UNIT  APPLICATION
* forest level summary files of MELAOPT
#22  MSC  _  FORESTRY_UNIT  SUB_UNIT  APPLICATION  PROBLEM  O
#23  MSD  _  FORESTRY_UNIT  SUB_UNIT  APPLICATION  PROBLEM  O
```

FORESTRY_UNIT

Functions

The FORESTRY_UNIT parameter provides the name of the forestry unit for a MELA program session. The definition is valid until the next definition. The name of the forestry unit is needed, for example for the decision hierarchy operations in the case of multiple level forestry units. For the concept of the decision hierarchy, see Chapter 3.3.2.

The FORESTRY_UNIT parameter defines also the name of the **par** type file containing the decision hierarchy definitions for the forestry unit in question. MELA programs try to read the **forestry_unit.PAR** file for the case that the definitions are provided in this file.

A separate parameter reference and a decision hierarchy definition file make it possible to refer also to the lower level members of the decision hierarchy in MELA commands, besides the uppermost ones. See the MELASIM command SIMULATE in Chapter 3.4 and the MELAOPT command SOLVE in Chapter 3.5. See also the parameters forestry_unit_LEVELS and forestry_unit_members.

> NOTE: The user-defined parameters forestry_unit_LEVELS and forestry_unit_members are usually provided together in the same **par** type, decision hierarchy definition file to be referred by the FORESTRY_UNIT parameter in a MELA program session.

Generic name in Finnish: METSATALOUS_YKSIKKO
Origin: System parameter
Program: MELASIM, MELAOPT
Type: Character
Number of items: 1
Default values: None

Legend

(1) Name of the forestry unit in a MELA program session.

> NOTE: For the convenience, the default value of the FORESTRY_UNIT parameter should be provided in the **MELA_SET.PAR** file if there is no particular reason to define it later in the MELA session.

Example B.20. A definition of the FORESTRY_UNIT parameter.

```
FORESTRY_UNIT#FX
```

The name of the forestry unit is FX. Decision hierarchy definitions are found from the **FX.PAR** file if it exists.

For the contents of the **FX.PAR** file, see Example 3.11.

forestry_unit_LEVELS

Functions

The forestry_unit_LEVELS parameter defines the names of the decision hierarchy levels appearing in the forestry_unit_members parameter. In the parameter definition, the string 'forestry_unit' is substituted by the actual name of the forestry unit. For the activation of the decision hierarchy definitions in a MELA program session, see the FORESTRY_UNIT parameter. For the concept of decision hierarchy, see Chapter 3.3.2. For the run-time regulation of decision hierarchy levels, see the LOWEST_LEVEL parameter.

Generic name in Finnish: metsatalous_yksikko_TASOT
Origin: User parameter
Program: MELASIM, MELAOPT
Type: Character
Number of items: Optional
Default values: None

Legend

(1) - (n) Names of the decision hierarchy levels appearing in the definition of the forestry_unit_members parameter.

Example B.21. A definition of the forestry_unit_LEVELS parameter.

```
* Parameter forestry_unit_LEVELS for the forestry unit FX
 FX_LEVELS
#FX
#REGION
#DISTRICT

* Notice that the name of a user parameter begins at column 2.
```

The three hierarchy levels of the forestry unit FX have the names FX, REGION and DISTRICT.

NOTE: The user-defined parameters forestry_unit_LEVELS and forestry_unit_members are usually provided together in the same **par** type, decision hierarchy definition file that is referred via the FORESTRY_UNIT parameter in a MELA program session.

forestry_unit_members

Functions

The forestry_unit_members parameter defines the names of the sub-units. This parameter has to be defined for each decision hierarchy member having lower level members, i.e. sub-units. The name of each upper level member is used once as a parameter name at the lower level and the names of the lower level members as parameter values (see Example 3.11). For the activation of the decision hierarchy definitions in a MELA program session, see the FORESTRY_UNIT parameter. For the concept of decision hierarchy, see Chapter 3.3.2. For the definition of the decision hierarchy levels, see the forestry_unit_LEVELS parameter.

> NOTE: Several MELA files are organized and managed according to the actual decision hierarchy. For example, the initial data (**rsd** type) files are required for each lowest level member of the decision hierarchy, or members that currently have no further lower level members.

> NOTE: In the file naming context, SUB_UNIT is a special argument (the generic name in Finnish is PERUSALUE) that gets its value from the name of the lowest level hierarchy member in question (i.e. the name of the sub-unit containing the applied management unit data).

Generic name in Finnish: metsatalous_yksikko_jasenet
Origin: User parameter
Program: MELASIM, MELAOPT
Type: Character
Number of items: Optional
Default values: None

Legend

(1) - (n) **name_of_sub_unit**[explanation]

name_of_sub_unit	The name of the lower level member (or sub-unit) in a decision hierarchy.
explanation	A verbal description, for example explanatory comment.

For an example, see Example 3.11.

> NOTE: The user-defined parameters forestry_unit_LEVELS and forestry_unit_members are usually provided together in the same **par** type, decision hierarchy definition file that is referred via the FORESTRY_UNIT parameter in a MELA program session.

GROWTH_CALIBRATION

Functions

The GROWTH_CALIBRATION parameter provides the adjustment coefficients of the growth models by tree species and forestry board districts (see also the specific EVENT_CALL arguments for natural processes).

Generic name in Finnish: KASVUN_TASOKORJAUS
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 1 or 100
Default values: 0

NOTE: The number of items has to be 1 (user does not calibrate the models) or 100 (user provides the adjustment coefficients).

Legend

either
(1) Calibration of growth models.
'0' no calibration (default)

or
(1) - (100) User-supplied calibration coefficients of the growth models by tree species and forestry board districts (see Example B.22).

Categories:
- tree species: 4 (pine, spruce, birch, other deciduous species)
- forestry board districts: 20 (see the stand variable (29) of the simulation record in Appendix D)

NOTE: The actual effects of the calibration coefficients to the volume increment should be examined and adjusted in each particular case with a relevant test material.

Example B.22. A definition of the GROWTH_CALIBRATION parameter.

```
GROWTH_CALIBRATION

* (1) forestry board district
* (2) pine
* (3) spruce
* (4) birch
* (5) other deciduous species

* (1)  (2)  (3)  (4)  (5)
* forestry board district 0
   0  1.10 1.15 1.00 1.00
* forestry board district 1
   1  1.10 1.15 1.00 1.00
   2  1.10 1.15 1.00 1.00
   3  1.10 1.15 1.00 1.00
   4  1.10 1.15 1.00 1.00
   5  1.10 1.15 1.00 1.00
   6  1.10 1.15 1.00 1.00
   7  1.10 1.15 1.00 1.00
   8  1.10 1.15 1.00 1.00
   9  1.10 1.15 1.00 1.00
   10 1.10 1.15 1.00 1.00
   11 1.10 1.15 1.00 1.00
   12 1.10 1.15 1.00 1.00
   13 1.10 1.15 1.00 1.00
   14 1.10 1.15 1.00 1.00
   15 1.10 1.15 1.00 1.00
   16 1.10 1.15 1.00 1.00
   17 1.10 1.15 1.00 1.00
   18 1.10 1.15 1.00 1.00
* forestry board district 19
   19 1.10 1.15 1.00 1.00
```

NOTE: The adjustment coefficients in Example B.22 are hypothetical.

INTEGERAPPROXIMATION

Functions

The INTEGERAPPROXIMATION parameter controls the computation of an integer approximation from the conventional JLP solution (see also the MELAOPT command SOLVE in Chapter 3.5.2.1).

Generic name in Finnish: KOKONAISLUKURATKAISU
Origin: System parameter
Program: MELAOPT
Type: Numerical
Number of items: 1
Default values: 0

Legend

(1) Calculation of the integer approximation.

'0' no integer approximation (default)
'1' integer approximation is calculated and presented

When INTEGERAPPROXIMATION is set, JLP computes values for the decision variables (JLP x variables) so that the management schedule with the largest weight only is applied for each management unit. Two types of reports are generated, one without integer approximation and another with integer approximation. However, no true integer optimization is done, and the integer approximation of the solution does not generally satisfy the constraints in the optimization problem.

Example B.23. A definition of the INTEGERAPPROXIMATION parameter.

```
INTEGERAPPROXIMATION 1
```

An integer approximation of the solution will be computed.

LAND_VALUES

Functions

The LAND_VALUES parameter defines the land values for the calculation of the net present value of future revenues (NPV, see Appendices D.4 and E). Relevant land values are needed for every region, application, growth models, prices, costs, etc. For the generation of the land values by the MELA simulation, see Chapter 4.5.1 and the items (16) and (17) of the SIMULATION_CONTROL parameter.

Generic name in Finnish: MAAN_ARVOT
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 160
Default values: See Example B.24

The default land values have been calculated using discount rates of 1, 2, 3, 4 and 5 %.

> NOTE: User has to ensure that the land values are compatible with the discount rates and other parameter values used in the simulation (see the DISCOUNT_RATES parameter) and with the summary reports (see a **tab** type file) being applied.

Legend

(1) - (160) Land values, FIM per hectare.

Categories (see Example B.24):
- discount rate: 5 (see the DISCOUNT_RATES parameter)
- forest site type category: 8 (see the sample plot variable (13) of the simulation data record in Appendix D.3)
- soil and peatland category: 4 (see the sample plot variable (12) of the simulation record in Appendix D.3)

Example B.24. A definition of the LAND_VALUES parameter.

```
LAND_VALUES
* Default discount rates, %
*    1      2      3      4      5
* SOIL AND PEATLAND CATEGORY 1
*   Forest site type category 1
141732  42917  16741   6501   1976
*   Forest site type category 2
132218  37405  13725   4948   1190
*   Forest site type category 3
104958  31079  11942   4948   1913
*   Forest site type category 4
 66326  18161   6485   2344    607
*   Forest site type category 5
 61551  15619   5073   1755    418
*   Forest site type category 6
 11264   1057      0      0      0
*   Forest site type category 7
 10568    707      0      0      0
*   Forest site type category 8
 16595   3085    186      0      0
* SOIL AND PEATLAND CATEGORY 2
141732  42917  16741   6501   1976
132218  37405  13725   4948   1190
104958  31079  11942   4948   1913
 66326  18161   6485   2344    607
 61551  15619   5073   1755    418
 11264   1057      0      0      0
 10568    707      0      0      0
 16595   3085    186      0      0
* SOIL AND PEATLAND CATEGORY 3
141732  42917  16741   6501   1976
132218  37405  13725   4948   1190
104958  31079  11942   4948   1913
 66326  18161   6485   2344    607
 61551  15619   5073   1755    418
 11264   1057      0      0      0
 10568    707      0      0      0
 16595   3085    186      0      0
* SOIL AND PEATLAND CATEGORY 4-5
     0      0      0      0      0
     0      0      0      0      0
     0      0      0      0      0
     0      0      0      0      0
     0      0      0      0      0
     0      0      0      0      0
     0      0      0      0      0
     0      0      0      0      0
```

The current default land values were calculated for mineral soils and peatlands in Southern Finland. Notice that the default values should never be used without checking their relevance concerning the analysis in question.

LOG_VOLUME_REDUCTION

Functions

The LOG_VOLUME_REDUCTION parameter controls the use of the built-in saw log volume reduction model. This model provides an empirical reduction to the saw log volume obtained from the log volume model on the basis of tree species, diameter and height. The current saw log volume reduction is a function of tree species, age and diameter.

Generic name in Finnish: TUKKIVAHENNYS
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 1
Default values: 1

Legend

(1) Application of the saw log volume reduction model.

'0' no saw log volume reduction
'1' saw log volume reduction on the basis of the built-in reduction model (default)

Example B.25. A definition of the LOG_VOLUME_REDUCTION parameter.

```
LOG_VOLUME_REDUCTION 0
```

The saw log volume reduction model is omitted in the simulation.

LOWEST_LEVEL

Functions

The LOWEST_LEVEL parameter limits the depth of the decision hierarchy in the MELA program session up to the specified level instead of using the complete hierarchy defined by the forestry_unit_LEVELS parameter.

The LOWEST_LEVEL parameter makes it possible to avoid multiple decision hierarchy definitions for the same forestry unit if, for example, an upper level sample is required instead of the complete decision hierarchy in some step of the analysis process. For the data requirements, see the forestry_unit_members parameter.

> NOTE: The LOWEST_LEVEL parameter is provided as an option of a command (see Chapter 3.2.1.3).

Generic name in Finnish: ALIN_TASO
Origin: System parameter
Program: MELASIM, MELAOPT
Type: Character
Number of items: 1
Default values: None

Legend

(1) Name of the lowest level of the decision hierarchy in the current MELA program session.

Example B.26. A definition and the use of the LOWEST_LEVEL parameter.

```
FORESTRY_UNIT#FX
SIMULATE/LOWEST_LEVEL=REGION MS FX
```

The decision hierarchy for the forestry unit FX (see Example 3.11) is limited up to the level REGION. **SR.RSD**, **NR.RSD** and **WR.RSD** will be used as initial data files in the simulation. The initial data files would be **F1.RSD**, ..., **F5.RSD** and **WR.RSD** without the definition 'LOWEST_LEVEL=REGION'.

```
FORESTRY_UNIT#FX
SOLVE/LOWEST_LEVEL=REGION S1 FX
```

The decision hierarchy for the forestry unit FX (see Example 3.11) is limited up to the level REGION. Correspondingly, **SR.RSD**, **SR.MSC**, **SR.MSD**, **NR.RSD**, **NR.MSC**, **NR.MSD**, **WR.RSD**, **WR.MSC** and **WR.MSD** will be used as input data files in the optimization.

MANAGEMENT_CATEGORY_GROUPS

Functions

The MANAGEMENT_CATEGORY_GROUPS parameter defines ten forest management category groups (see the sample plot variable (30) of the simulation record in Appendix D.3) for collecting variables of the decision data record (see Appendix D.4).

The general definition of the MANAGEMENT_CATEGORY_GROUPS parameter allows the same management unit to belong to several management category groups making it possible to define groups that are sums of other groups as well as any other aggregates of management units. User is responsible for checking the consistency of the definitions provided.

> NOTE: The MANAGEMENT_CATEGORY_GROUPS parameter is independent from the definition of the TIMBER_PRODUCTION_LAND parameter. User is responsible for the consistency of the definitions.

Generic name in Finnish: KASITTELYLUOKKARYHMAT
Origin: System parameter
Program: MELASIM
Type: Character (character items may contain also numerical parts)
Number of items: 10
Default values:

```
MANAGEMENT_CATEGORY_GROUPS
#1   0 -1.99999
#2   2 -2.99999
#3   3 -3.99999
#4   2 -4.99999
#5   0 -5.99999
#6   6 -6.99999
#7   7 -7.99999
#8   8 -8.99999
#9   7 -9.99999
#10  0 -10.99999
```

The first default management category group consists of the sample plots with a value of the sample plot variable (30) from 0 to 1.99999 in the simulation record, the second group from 2 to 2.99999, etc. Notice that the groups can be overlapping, such as groups 4, 5, 9, and 10. For example, the tenth group contains the sum over all sample plots with value from 0 to 10.99999.

Legend

(1) - (10) **group_id management_category**[[-]management_category]

group_id — The index of the management category group.

management_category — The value of the forest management category (the sample plot variable (30) of the simulation record in Appendix D.3) belonging to the management category group. The sign '-' immediately preceding the management category refers to a range from the previous value of the management category to the current absolute value.

Example B.27. A definition of the MANAGEMENT_CATEGORY_GROUPS parameter.

```
MANAGEMENT_CATEGORY_GROUPS
#1  1.1 1.3
#2  1.2 1.4 -1.7 1.9
#3  1.8 2 -3.3
#4  4 -5.3
#5  6
#6  7.1 -7.3
#7  8.1 -8.3 9.1 -9.3
#8  0 -5.3
#9  7 -9.3
#10 0 -9.3
```

The management category groups for the collection of decision data variables can be generated from any relevant value combinations of the sample plot variable (30) of the simulation record. In Example B.27, groups 8, 9, and 10 are overlapping sums of management units.

MAX_LENGTH_OF_FILENAME

Functions

The MAX_LENGTH_OF_FILENAME parameter defines the maximum allowable length for file names generated by the MELA programs.

On some operating systems, the length of the file name is restricted, for example, up to eight characters. The MAX_LENGTH_OF_FILENAME parameter makes it possible to truncate extra characters from the end of the file name generated by the MELA programs. In the case of truncation, confusions are likely to appear. Instead of truncation, shorter naming components (see the FILE_NAMING parameter), for example command argument values, should be used to keep the file names simultaneously unique and short.

Generic name in Finnish: TIEDOSTONIMEN_PITUUS
Origin: System parameter
Program: MELASIM, MELAOPT
Type: Numerical
Number of items: 1
Default values: None

Legend

(1) Maximum number of characters in a file name (extension excluded).

Example B.28. A definition of the MAX_LENGTH_OF_FILENAME parameter.

```
MAX_LENGTH_OF_FILENAME 8
```

The maximum length of the file name (extension excluded) will be eight characters. Extra characters are truncated and confusions with the file names are likely to occur.

MELA_TABLE

Functions

The MELA_TABLE parameter provides the name of the summary report definition (**tab** type) file. The file contains the instructions how to generate a MELA summary report into a **sum** type file. For further information about the **tab** and **sum** type files, see Appendix C.2. For the current defaults, see the definitions of each file type in Appendix C.2.

Generic name in Finnish: MELATAULUKKO
Origin: System parameter
Program: MELASIM, MELAOPT
Type: Character
Number of items: 1
Default values: TABLE.TAB

Legend

(1) Name of the **tab** type file.

Example B.29. A definition of the MELA_TABLE parameter.

```
MELA_TABLE#LONG.TAB
```

The instructions given in the **LONG.TAB** file is used in the generation of the summary report (**sum** type) file.

MIN_BASAL_AREA_AFTER_THINNING

Functions

The MIN_BASAL_AREA_AFTER_THINNING parameter defines the minimum basal areas after thinning. This parameter is provided by forestry board districts (see the sample plot variable (29) of the simulation record in Appendix D.3).

Generic name in Finnish: MIN_PPA_HARV_JALKEEN
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 133 for each forestry board district, the maximum number of districts is limited to 10
Default values: See Example B.30

Legend

(1) Forestry board district.

(2) - (133) Minimum basal areas (m^2 per hectare) after thinning for the district in (1).

Categories:
- tree species: 3 (pine, spruce, birch)
- forest site type category: 4 (see the sample plot variable (13) of the simulation data record in Appendix D.3)
  - 1 for values 1 and 2 of the sample plot variable (13)
  - 2 for value 3 of the sample plot variable (13)
  - 3 for value 4 of the sample plot variable (13)
  - 4 for values 5, 6, 7 and 8 of the sample plot variable (13)
- mean height before thinning: 11 (6, 8, ..., 24, 26 m)

Example B.30. A definition of the MIN_BASAL_AREA_AFTER_THINNING parameter.

```
MIN_BASAL_AREA_AFTER_THINNING
* District 1
1
* Minimum basal area after thinning for district 1.
* Mean height before thinning, m
*  6    8   10   12   14   16   18   20   22   24   26
* FOREST SITE TYPE CATEGORY 1-2
*   pine
 7.0 10.0 13.0 16.0 17.8 19.6 21.0 22.2 22.7 23.0 23.0
*   spruce
 6.4  9.5 12.7 15.7 18.0 20.2 21.9 23.3 24.2 24.5 24.5
*   birch
 4.0  5.5  7.0  8.5 10.0 11.5 13.4 14.6 15.8 16.6 17.0
* FOREST SITE TYPE CATEGORY 3
 7.0 10.0 13.0 16.0 17.8 19.6 21.0 22.2 22.7 23.0 23.0
 6.4  9.5 12.6 15.5 17.3 18.7 20.1 21.1 21.9 22.3 22.4
 4.0  5.5  7.0  8.5 10.0 11.5 13.4 14.6 15.8 16.6 17.0
* FOREST SITE TYPE CATEGORY 4
 7.0 10.0 13.0 15.4 17.2 18.5 19.4 19.8 20.0 20.0 20.0
 6.4  9.5 12.6 15.5 17.3 18.7 20.1 21.1 21.9 22.3 22.4
 4.0  5.5  7.0  8.5 10.0 11.5 13.4 14.6 15.8 16.6 17.0
* FOREST SITE TYPE CATEGORY 5-8
 4.5  7.0  9.0 11.2 13.2 14.8 15.9 16.4 16.5 16.5 16.5
 6.4  9.5 12.6 15.5 17.3 18.7 20.1 21.1 21.9 22.3 22.4
 4.0  5.5  7.0  8.5 10.0 11.5 13.4 14.6 15.8 16.6 17.0
*
* District 18
18
* FOREST SITE TYPE CATEGORY 1-2
 6.1  8.8 11.5 14.1 16.1 17.6 19.0 19.6 20.1 20.1 20.1
 6.0  8.6 11.0 13.5 15.4 17.1 18.5 19.5 20.2 20.2 20.2
 6.0  8.6 11.0 13.5 15.4 17.1 18.5 19.5 20.2 20.2 20.2
* FOREST SITE TYPE CATEGORY 3
 6.1  8.8 11.5 14.1 16.1 17.6 19.0 19.6 20.1 20.1 20.1
 6.0  8.6 11.0 13.5 15.4 17.1 18.5 19.5 20.2 20.2 20.2
 6.0  8.6 11.0 13.5 15.4 17.1 18.5 19.5 20.2 20.2 20.2
* FOREST SITE TYPE CATEGORY 4
 5.6  8.0 10.3 13.0 15.0 16.5 17.8 18.7 19.2 19.3 19.3
 6.0  8.6 11.0 13.5 15.4 17.1 18.5 19.5 20.2 20.2 20.2
 5.6  8.0 10.3 13.0 15.0 16.5 17.8 18.7 19.2 19.3 19.3
* FOREST SITE TYPE CATEGORY 5-8
*   pine
 4.6  6.9  9.0 11.0 12.9 14.4 15.3 16.0 16.0 16.0 16.0
*   spruce
 6.0  8.6 11.0 13.5 15.4 17.1 18.5 19.5 20.2 20.2 20.2
*   birch
 4.6  6.9  9.0 11.0 12.9 14.4 15.3 16.0 16.0 16.0 16.0
```

The user-supplied basal areas after thinning are used for districts 1 and 18. For all other districts, the default basal areas after thinning will be applied.

NOTE: The default values of the MIN_BASAL_AREA_AFTER_THINNING parameter for districts 0-17 are the same as the values for district 1 in Example B.30 and for districts 18-19 the same as the values for district 18.

MIN_NUMBER_OF_SEEDLINGS

Functions

The MIN_NUMBER_OF_SEEDLINGS parameter defines the minimum seedling density in artificial regeneration. This parameter is provided by forestry board districts (see the sample plot variable (29) of the simulation record in Appendix D.3).

Generic name in Finnish: MIN_VILJELYTIHEYS
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 13 for each forestry board district, the maximum number of districts is limited to 10
Default values: See Example B.31

Legend

(1) Forestry board district.

(2) - (13) Minimum seedling densities (number of seedlings per hectare) in artificial regeneration for the district in (1).

Categories:
- tree species: 3 (pine, spruce, birch)
- forest site type category: 4 (see the sample plot variable (13) of the simulation data record in Appendix D.3)
  1 for values 1 and 2 of the sample plot variable (13)
  2 for value 3 of the sample plot variable (13)
  3 for value 4 of the sample plot variable (13)
  4 for values 5, 6, 7 and 8 of the sample plot variable (13)

Example B.31. A definition of the MIN_NUMBER_OF_SEEDLINGS parameter.

```
MIN_NUMBER_OF_SEEDLINGS
* District 1
 1
* The minimum density of seedlings
* pine  spruce  birch
*   FOREST SITE TYPE CATEGORY 1-2
  2000  2000    1600
*   FOREST SITE TYPE CATEGORY 3
  2000  2000    1600
*   FOREST SITE TYPE CATEGORY 4
  2000  2000    1600
*   FOREST SITE TYPE CATEGORY 5-8
  2000  2000    1600
```

The user-supplied seedling densities in artificial regeneration are used for district 1. The default seedling densities will be applied for all other districts.

NOTE: The default values of the MIN_NUMBER_OF_SEEDLINGS parameter for districts 0-19 are the same as the values for district 1 in Example B.31.

MIN_REGENERATION_AGE

Functions

The MIN_REGENERATION_AGE parameter defines the minimum rotation periods in terms of biological age. This parameter is provided by forestry board districts (see the sample plot variable (29) of the simulation record in Appendix D.3).

Generic name in Finnish: MIN_UUDISTUSIKA
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 13 for each forestry board district, the maximum number of districts is limited to 10
Default values: See Example B.32

NOTE: When either the minimum rotation period or the minimum mean diameter before regeneration is reached, the regeneration is allowed in the simulation. For the minimum mean diameter, see the MIN_REGENERATION_DIAMETER parameter.

Legend

(1) Forestry board district.

(2) - (17) Minimum rotation periods based on biological age (years) for district in (1).

Categories:
- tree species: 4 (pine, spruce, birch, other deciduous species)
- forest site type category: 4 (see the sample plot variable (13) of the simulation data record in Appendix D.3)
  - 1 for values 1 and 2 of the sample plot variable (13)
  - 2 for value 3 of the sample plot variable (13)
  - 3 for value 4 of the sample plot variable (13)
  - 4 for values 5, 6, 7 and 8 of the sample plot variable (13)

Example B.32. A definition of the MIN_REGENERATION_AGE parameter.

```
MIN_REGENERATION_AGE
* District 1
 1
* The minimum rotation periods for district 1.
*  pine  spruce  birch  other deciduous species
*     FOREST SITE TYPE CATEGORY 1-2
   80     80       60      40
*     FOREST SITE TYPE CATEGORY 3
   80     90       70      40
*     FOREST SITE TYPE CATEGORY 4
   90     90       70      40
*     FOREST SITE TYPE CATEGORY 5-8
  120     90       70      40
*
* District 13
 13
   85     85       70      40
   85     95       70      40
   95     95       70      40
  120     95       70      40
*
* District 16
 16
  100    100       60      40
  100    100       60      40
  110    100       60      40
  130    100       60      40
*
* District 18
 18
  110    120       70      40
  110    120       70      40
  120    120       70      40
  140    120       70      40
```

The user-supplied rotation periods are used for districts 1, 13, 16 and 18. For all other districts, the default rotation periods will be applied.

NOTE: The default values of the MIN_REGENERATION_AGE parameter are presented in Example B.32. The default rotation periods

- for districts 0-12 and 14 are the same as the values for district 1,
- for districts 13 and 15 are the same as the values for district 13,
- for districts 16 and 17 are the same as the values for district 16, and
- for districts 18 and 19 are the same as the values for district 18.

MIN_REGENERATION_DIAMETER

Functions

The MIN_REGENERATION_DIAMETER parameter defines the minimum mean diameters before regeneration. This parameter is provided by forestry board districts (see the sample plot variable (29) of the simulation record in Appendix D.3).

Generic name in Finnish: MIN_UUDISTUSLAPIMITTA
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 17 for each of the maximum of 10 districts
Default values: See Example B.33

NOTE: When either the minimum mean diameter before regeneration or the minimum rotation period is reached, the regeneration is allowed in the simulation. For the minimum rotation period, see the MIN_REGENERATION_AGE parameter.

Legend

(1) Forestry board district.

(2) - (17) Minimum mean diameters (cm) before regeneration for the district in (1).

Categories:
- tree species: 4 (pine, spruce, birch, other deciduous species)
- forest site type category: 4 (see the sample plot variable (13) of the simulation record in Appendix D.3)
  - 1 for values 1 and 2 of the sample plot variable (13)
  - 2 for value 3 of the sample plot variable (13)
  - 3 for value 4 of the sample plot variable (13)
  - 4 for values 5, 6, 7 and 8 of the sample plot variable (13)

Example B.33. A definition of the MIN_REGENERATION_DIAMETER parameter.

```
MIN_REGENERATION_DIAMETER
* District 1
 1
* The minimum mean diameters before regeneration
*  pine  spruce  birch  other deciduous species
*  FOREST SITE TYPE CATEGORY 1-2
   28     26       25      20
*    FOREST SITE TYPE CATEGORY 3
   28     25       25      20
*    FOREST SITE TYPE CATEGORY 4
   26     25       25      20
*    FOREST SITE TYPE CATEGORY 5-8
   24     25       25      20
*
* District 13
 13
   28     26       25      20
   28     25       25      20
   26     25       25      20
   24     25       25      20
*
* District 16
 16
   25     24       20      15
   25     24       20      15
   24     24       20      15
   22     24       20      15
*
* District 18
 18
   24     23       20      15
   24     23       20      15
   23     23       20      15
   22     23       20      15
```

The user-supplied mean diameters before regeneration are used for districts 1, 13, 16 and 18. For all other districts, the default mean diameters will be applied.

NOTE: The default values of the MIN_REGENERATION_DIAMETER are presented in Example B.33. The default mean diameters

- for districts 0-12 and 14 are the same as the values for district 1,
- for districts 13 and 15 are the same as the values for district 13,
- for districts 16 and 17 are the same as the values for district 16, and
- for districts 18 and 19 are the same as the values for district 18.

MPS_OUTPUT

Functions

The MPS_OUTPUT parameter controls the transmission of the information about the selected management schedules to user programs via one or several **mps** type files (see Appendix C). See also the MPS_VARIABLES parameter.

Generic name in Finnish: MPS_TULOSTUS
Origin: System parameter
Program: MELAOPT
Type: Numerical
Number of items: 1
Default values: 0

Legend

(1) Generation of **mps** type files.

'0' mps information is written into several files on the basis of the actual **rsd** type files
'1' mps information is written into one forestry unit level file

Example B.34. A definition of the MPS_OUTPUT parameter.

```
MPS_OUTPUT 1
```

The information about management units is written into one file for the whole forestry unit.

MPS_VARIABLES

Functions

The MPS_VARIABLES parameter names the variables of the management report records (see Appendix D.6) for storing into **mps** type files (see Appendix C.2) and further for the transmission of information about the selected management schedules to user programs and databases.

Management report records are constructed in MELAOPT from the variables of management schedule records (see Appendix D.5) originating from simulation records (see Appendix D.3) and decision data records (see Appendix D.4) assuming that the variables in question are stored in **msc** and **msd** type files in MELASIM. Use the MSD_VARIABLES parameter for storing variables of the decision data record and the MSR_VARIABLES parameter for storing variables of the management schedule record in MELASIM.

The MELAOPT command REPORT SUMMARY generates **mps** type files, see Chapter 3.5.2.2 and Appendix C.2. See also the item (1) of the OUTPUT parameter and the MPS_OUTPUT parameter.

Generic name in Finnish: MPS_MUUTTUJAT
Origin: System parameter
Program: MELAOPT
Type: Character (character items may contain also numerical parts)
Number of items: Optional, up to 500 items.
Default values: None

Legend

(1) - (n) **`origin sub-period variable`**

for the variables originating from **decision data** records

`origin` 'MSD'

`sub-period` The index of the sub-period (see the actual definition of the YEARS parameter and the **mdl** type files in Appendix C.2)
'0' for the beginning of the first sub-period
'1' for the first sub-period and its end
'2' for the second sub-period and its end
etc.

`variable` The number of the decision variable (see variables of the decision data record in Appendix D.4)

for the variables in management schedule records (originating from **simulation records**)

origin	'MSR'
sub-period	'0'
variable	The index of the variable in a management schedule record generated according to the instructions of the MSR_VARIABLES parameter

NOTE: 'MSD' and 'MSR' type variables may appear in the same definition of the MPS_VARIABLES parameter.

NOTE: The order of the variables in management report records in **mps** type files is the same as in the definition of the MPS_VARIABLES parameter.

Example B.35. A definition of the MPS_VARIABLES parameter with the preceding definitions of the parameters YEARS, MSR_VARIABLES and MSD_VARIABLES in MELASIM.

The preceding MELASIM session

```
* The beginning (0) and the ends (1) and (2)
* of the sub-periods in the simulation
*
YEARS  1   11  21
*     (0) (1) (2)
*
* variables (1)-(22) of the management schedule
*
* record for storing into a msd type file
*
MSR_VARIABLES
*       Variables (1)-(3) of the management schedule record
  1  1  3
*       Variables (4)-(6) of the management schedule record
  1 32 33
  1 36 36
*       Variables (7)-(8) of the management schedule record
 11 28 28
 11 70 70
*       Variables (9)-(16) of the management schedule record
 11  1  3
 11 32 33
 11 36 36
 21 28 28
 21 70 70
*      Variables (17)-(22) of the management schedule record
 21  1  3
 21 32 33
 21 36 36
*
* variables of the decision data record
* for storing into a msd type file
*
MSD_VARIABLES
* numbers of the decision variables
* ...
700 195 350
* ...
```

The following MELAOPT session

```
* Variables (1)-(26) in a management report record
* for storing into a mps type file.
* Variables in the record are in the order of
* the provided definition
*
MPS_VARIABLES
*
* item variable in the 'MSR' case:
* index of the variable in a management schedule record
*
* item variable in the 'MSD' case:
* number of the variable in a decision data record
*
#MSR 0 2
#MSR 0 3
#MSR 0 4
#MSR 0 5
#MSR 0 6
#MSD 0 700
#MSR 0 7
#MSR 0 8
#MSD 1 195
#MSD 1 370
*
#MSR 0 10
#MSR 0 11
#MSR 0 12
#MSR 0 13
#MSR 0 14
#MSD 1 700
#MSR 0 15
#MSR 0 16
#MSD 2 195
#MSD 2 370
*
#MSR 0 18
#MSR 0 19
#MSR 0 20
#MSR 0 21
#MSR 0 22
#MSD 2 700
```

Sample interpretations of the variables (14) and (26) of the management report record defined in Example B.35:

(14) '#MSR 0 13' is a reference to the variable (13) of the management schedule record, i.e. the management unit variable (33) of the simulation record (mean age of the dominant story) in relative year 11, see the MSR_VARIABLES parameter above.

(26) '#MSD 2 700' is a reference to the variable (700) of the decision data record (volume of the growing stock) at the end of the second sub-period, i.e. in the beginning of relative year 21, see the YEARS parameter above.

MSD_VARIABLES

Functions

The MSD_VARIABLES parameter expresses in MELASIM the variables of the decision data record (see Appendix D.4) to be stored in management schedule (**msc** and **msd** type) files for further processing by MELAOPT. Decision variables are stored automatically for all the sub-periods defined by the YEARS parameter.

The decision variables should be selected according to the actual decision problems and the reporting needs. See also the re-simulation of the selected management schedules in Chapters 3.4 and 4.1.4.

Generic name in Finnish: MSD_MUUTTUJAT
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: Optional up to 1 000
Default values: See Example B.36

Legend

```
(1) - (n) variable[ [-]variable]
```

variable — The identification number of the decision data variable. The sign '-' immediately preceding an identification number refers to a range from the previous identification number to the current absolute value of this number.

Example B.36. A definition of the MSD_VARIABLES parameter.

```
MSD_VARIABLES
   1    2    4  -15   20   25  -27   29   30   35  -38
  60   65   86  -90  100  181 -195  210  225  240  260
 265  270  340  346 -350  365  370  445  454  458  462
 466  470  474  478  482  486  490  494  498 -510  537
 600  620  640  660  680  684  688  692  696 -700  705
 710  715  720  725  800 -810  816 -823  840  845  850
 900  915  920  925  940 1000
```

MSR_VARIABLES

Functions

The MSR_VARIABLES parameter defines the management unit variables of the simulation record (see Appendix D.3) that are stored in management schedule records in **msc** and **msd** type files and transmitted via MELAOPT for further processing. Management unit variables are stored in management schedule records for the defined years only. See also the MPS_VARIABLES parameter and the re-simulation of the selected management schedules in Chapters 3.4 and 4.1.4.

Generic name in Finnish: MSR_MUUTTUJAT
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: Optional up to 200
Default values: None

NOTE: The variables of management schedule records are not used in the MELAOPT optimization. They are only transferred through MELAOPT.

Legend

```
year first_variable last_variable [ year first_variable last_variable]
```

year	A relative year. The relative year '0' refers to the initial state before pre-simulation (see Chapter 3.4.1 and the YEARS parameter in Appendix B.2).
first_variable	The index of the first management unit variable in the simulation record to be included in the management schedule record by this definition.
last_variable	The index of the last management unit variable in the simulation record to be included in the management schedule record by this definition.

NOTE: first_variable and last_variable have the same value if there is only one variable in a definition.

For a sample definition of the MSR_VARIABLES parameter, see Example B.35. In Example B.35, the following management unit variables of the simulation record are ordered for storing into management schedule records in **msc** and **msd** type files: the variables (1) to (3) (32), (33) and (36) in the relative year 1, among others.

OUTPUT

Functions

The OUTPUT parameter selects terminal printing and file generation options for simulation.

Generic name in Finnish: TULOSTUS
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 10
Default values: 1 0 2 0 0 0 0 0 0 0

Legend

(1) Generation of management schedule (**msc** and **msd** type) files for the transfer of simulation information from MELASIM to MELAOPT, see Appendix C.2. For decision data, see the MSD_VARIABLES parameter and Appendix D.4, for simulation data, see the MSR_VARIABLES parameter and Appendix D.3, and for re-simulation instructions, see the RE_SIMULATION_INSTRUCTIONS parameter and Appendix D.7.

'0' generation of **msc** and **msd** files disabled
'1' generation of **msc** and **msd** files enabled

(2) Generation of forest level summary report (**sum** type) files for printing and forest level summary data (**msc** and **msd** type) files for further processing, see Appendix C.2. In the simulation of optional management schedules, the summary information comes from the management schedules with the highest 3 % net present value for each management unit. In the re-simulation, the summary information comes from the management schedules selected in the MELAOPT solution in question, providing more information than the respective MELAOPT summary generated from the variables of management schedule (**msc** and **msd** type) files. See also the MELA_TABLE parameter and **tab** type files in Appendix C.2.

'0' generation of forestry unit level summary information files disabled
'1' generation of forestry unit level summary information files enabled

(3) Generation of a management schedule summary report to the terminal from all management schedules being simulated, see Examples H.10 and H.47. The report is intended for monitoring both the simulation of optional management schedules and the re-simulation of selected management schedules. The report is generated mainly from the management unit variables of the simulation record converted to per hectare form. Notice the large size of reports in larger simulation tasks.

'0' generation of a management schedule summary report disabled
'1' generation of a minimal (one management schedule per line) report
'2' generation of a one sub-period per line report without repeated first lines
'3' generation of a one sub-period per line report with repeated first lines

(4) Generation of a simulation data report to the terminal, see Example H.12. For the interpretation of the variables of simulation records, see Appendix D.3. Notice the large size of reports in any simulation tasks.

'0' generation of a simulation data report disabled
'1' generation of a simulation data report in the beginning of simulation (year 1)
'2' generation of a simulation data report by sub-periods, see the YEARS parameter
'3' generation of a simulation data report after each event

(5) Generation of a management unit level summary report (**sum** type) file from all management schedules being simulated. The report is intended for monitoring the simulation of optional management schedules and the re-simulation of selected management schedules. See also the MELA_TABLE parameter and **tab** type files in Appendix C.2. Notice the large size of reports in any simulation tasks.

'0' generation of management schedule level summary reports disabled
'1' generation of management schedule level summary reports enabled

(6) '0' (not in use)

(7) Generation of an event definition report to the terminal. For system maintenance only.

'0' generation of an event definition report disabled
'1' generation of an event definition report enabled

(8) Generation of a stepwise processing time report to the terminal (not in use).

(9) Generation of simulation record (**smr** type) files for the transfer of simulation records from MELASIM to user programs or to another MELASIM application. For the simulation record, see Appendix D.3.

- '0' generation of a **smr** type file disabled
- '1' generation of a **smr** type file enabled, simulation records are stored once under control of the item (12) of the SIMULATION_CONTROL parameter, one management unit in each record
- '1.2' generation of a **smr** type file enabled, simulation records are stored once under control of the item (12) of the SIMULATION_CONTROL parameter, one sample plot in each record
- '2' generation of a **smr** type file enabled, simulation records are stored by sub-periods defined by the YEARS parameter, one management unit in each record
- '2.2' generation of **smr** type file enabled, simulation records are stored by sub-periods defined by the YEARS parameter, one sample plot in each record
- '3' generation of a **smr** type file enabled, simulation records are stored after each event, one management unit in each record
- '3.2' generation of a **smr** type file enabled, simulation records are stored after each event, one sample plot in each record

(10) Generation of a simulation control report to the terminal. For system maintenance only.

- '0' generation of a simulation control report disabled
- '1' generation of a simulation control report enabled, standwise simulation instructions only
- '2' generation of a simulation control report enabled, standwise simulation instructions and event definitions
- '3' generation of a simulation control report enabled, printing of memory contents

Example B.37. A definition of the OUTPUT parameter.

```
OUTPUT 0 0 3 0 0 0 0 0 0 0
```

In Example B.37, management schedule summary reports are directed to the terminal. No files for further processing of management schedules are generated. This kind of definition suits, for example, for preliminary simulation tests.

PRINT_INPUT_LINES

Functions

The PRINT_INPUT_LINES parameter controls the display of input lines on the terminal making it possible to monitor the input lines included from command files.

Generic name in Finnish: SYOTTORIVIEN_NAYTTO
Origin: System parameter
Program: MELASIM, MELAOPT
Type: Numerical
Number of items: 1
Default values: 0

Legend

(1) Display of input lines on the terminal.

'0' display of input lines disabled
'1' display of input lines enabled

Example B.38. A definition of the PRINT_INPUT_LINES parameter.

```
PRINT_INPUT_LINES 1
```

All input lines are displayed.

RE_SIMULATION_INSTRUCTIONS

Functions

The RE_SIMULATION_INSTRUCTIONS parameter controls in MELASIM the storing of re-simulation instructions into **msc** and **msd** type files. Re-simulation instructions are required later on for the re-simulation of the selected management schedules on the basis of MELAOPT solutions.

Generic name in Finnish: TOISTO_OHJE
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 1
Default values: 1

Legend

(1) Storing of re-simulation instructions.

'0' storing of re-simulation instructions disabled
'1' storing of re-simulation instructions enabled

Example B.39. A definition of the RE_SIMULATION_INSTRUCTIONS parameter.

```
RE_SIMULATION_INSTRUCTIONS 0
```

Re-simulation instructions will not be stored in **msc** and **msd** type files. The re-simulation of management schedules after MELAOPT solutions and consecutive reports will be disabled.

ROADSIDE_LOG_PRICE_ADJUSTMENT

Functions

The ROADSIDE_LOG_PRICE_ADJUSTMENT parameter adjusts the average saw log price at the roadside for pine, spruce and birch on the basis of stem size. Primarily, the parameter controls the use of the default adjustment coefficients. Adjustment coefficients other than the defaults can also be provided. The average saw log prices are defined by the ROADSIDE_PRICES parameter.

Generic name in Finnish: TIENVARSIHINNAN_JAREYSKORJAUS
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 1 or 421
Default values: 1

Legend

(1) Adjustment of the average saw log price at the roadside for pine, spruce and birch.

'0' saw log price adjustment for pine, spruce and birch disabled
'1' saw log price adjustment for pine, spruce and birch enabled,
in absence of the items (2) - (421), default coefficients are applied

(2) - (421) Adjustment coefficients for average saw log prices at the roadside.

Categories:
- height classes: 10 (11, 13, 15, ..., 27, 29 m)
- diameter classes: 14 (19, 21, 23, ..., 43, 45 cm)
- tree species: 3 (pine, spruce, birch)

NOTE: The adjustment coefficients in Example B.40 (Laasasenaho & Sevola 1971) are the built-in defaults in MELASIM. A stem with diameter 25 cm and height 18 m has the adjustment coefficient 1.00.

Example B.40. Definitions of the ROADSIDE_LOG_PRICE_ADJUSTMENT parameter.

```
* (a) Saw log price adjustment disabled
ROADSIDE_LOG_PRICE_ADJUSTMENT 0
```

```
* (b) Saw log price adjustment enabled
ROADSIDE_LOG_PRICE_ADJUSTMENT 1
* Adjustment coefficients for pine, spruce and birch
* Mean height (m)
* 11   13   15   17   19   21   23   25   27   29
*
* PINE, diameter classes 19, 21, 23, ..., 43, 45 cm
*   Diameter class 19 cm
0.70 0.77 0.80 0.80 0.80 0.79 0.82 0.85 0.90 0.95
0.73 0.82 0.86 0.87 0.87 0.87 0.90 0.94 1.00 1.06
0.75 0.86 0.91 0.93 0.94 0.95 0.98 1.03 1.08 1.15
0.78 0.89 0.96 0.99 1.01 1.02 1.06 1.11 1.17 1.24
0.80 0.93 1.00 1.04 1.07 1.08 1.13 1.18 1.24 1.32
0.82 0.96 1.04 1.09 1.12 1.14 1.19 1.24 1.31 1.39
0.84 0.99 1.08 1.13 1.17 1.20 1.25 1.31 1.38 1.46
0.86 1.02 1.11 1.18 1.22 1.25 1.30 1.36 1.44 1.53
0.89 1.04 1.15 1.21 1.26 1.30 1.35 1.42 1.50 1.59
0.91 1.07 1.18 1.25 1.30 1.34 1.40 1.47 1.55 1.64
0.93 1.09 1.21 1.28 1.34 1.39 1.44 1.52 1.60 1.70
0.96 1.12 1.23 1.32 1.38 1.43 1.49 1.56 1.65 1.75
0.98 1.15 1.26 1.35 1.41 1.46 1.53 1.60 1.69 1.80
*   Diameter class 45 cm
1.01 1.17 1.29 1.38 1.44 1.50 1.56 1.64 1.74 1.84
*
* SPRUCE, diameter classes 19, 21, 23, ..., 43, 45 cm
*   Diameter class 19 cm
0.59 0.73 0.83 0.88 0.92 0.94 0.97 1.04 1.13 1.23
0.59 0.75 0.85 0.92 0.96 0.99 1.02 1.06 1.15 1.25
0.60 0.75 0.87 0.95 1.00 1.04 1.07 1.11 1.20 1.30
0.60 0.75 0.88 0.97 1.03 1.07 1.11 1.14 1.20 1.30
0.61 0.76 0.88 0.98 1.05 1.10 1.14 1.18 1.23 1.32
0.63 0.76 0.88 0.99 1.06 1.12 1.17 1.21 1.25 1.32
0.65 0.77 0.89 0.99 1.07 1.14 1.19 1.24 1.28 1.33
0.67 0.79 0.89 0.99 1.08 1.15 1.21 1.26 1.31 1.37
0.68 0.81 0.90 1.00 1.09 1.16 1.23 1.28 1.34 1.40
0.68 0.84 0.92 1.00 1.09 1.17 1.24 1.30 1.36 1.42
0.69 0.85 0.94 1.01 1.09 1.18 1.25 1.32 1.38 1.45
0.70 0.85 0.96 1.03 1.10 1.18 1.26 1.33 1.40 1.47
0.72 0.86 0.98 1.05 1.11 1.19 1.27 1.35 1.42 1.49
*   Diameter class 45 cm
0.74 0.86 0.99 1.07 1.13 1.20 1.28 1.36 1.44 1.51
*
* BIRCH, diameter classes 19, 21, 23, ..., 43, 45 cm
*   Diameter class 19 cm
0.51 0.51 0.51 0.51 0.51 0.51 0.51 0.51 0.51 0.51
0.51 0.51 0.51 0.89 0.87 0.88 0.84 0.82 0.91 0.87
0.52 0.94 0.95 0.96 0.95 0.91 1.04 1.04 1.04 1.03
1.01 1.01 1.02 0.99 0.98 1.14 1.14 1.15 1.15 1.15
1.05 1.05 1.07 1.05 1.21 1.19 1.21 1.20 1.24 1.24
1.12 1.08 1.10 1.08 1.27 1.27 1.26 1.30 1.31 1.29
1.15 1.14 1.12 1.30 1.31 1.32 1.32 1.34 1.34 1.35
1.18 1.16 1.17 1.33 1.34 1.35 1.34 1.39 1.40 1.38
1.21 1.21 1.19 1.38 1.39 1.38 1.42 1.41 1.42 1.43
1.26 1.23 1.41 1.42 1.41 1.42 1.44 1.45 1.44 1.45
1.28 1.25 1.43 1.44 1.44 1.43 1.46 1.46 1.47 1.47
1.31 1.28 1.47 1.47 1.47 1.46 1.48 1.48 1.47 1.48
1.33 1.30 1.48 1.48 1.48 1.50 1.50 1.50 1.49 1.49
*   Diameter class 45 cm
1.35 1.31 1.49 1.49 1.49 1.50 1.51 1.50 1.51 1.50
```

ROADSIDE_PRICES

Functions

The ROADSIDE_PRICES parameter provides timber prices at the roadside by tree species and timber assortments.

The roadside prices of timber and the costs of operations play a key role with in the calculation of the net revenues and the net present values, and consequently determining the preference and the priority of management operations in the analysis. The consistency of the prices and the costs is of great importance, besides the price level.

For the control of the stem size based adjustment of average saw log price, see the ROADSIDE_LOG_PRICE_ADJUSTMENT parameter. See also the STUMPAGE_PRICES parameter.

Generic name in Finnish: TIENVARSIHINNAT
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 17
Default values: See Example B.41

Legend

(1) '0'

(2) - (9) Saw log prices at the roadside by tree species.

(10) - (17) Pulpwood prices at the roadside by tree species.

For the eight tree species, see the tree variable (2) of the initial data record in Appendix D.1.

Example B.41. A definition of the ROADSIDE_PRICES parameter.

```
ROADSIDE_PRICES 0
*saw log price by tree species
 240 205 250 250 150 150 160 150
*pulpwood price by tree species
 160 180 150 150 150 150 160 150
```

Notice that the item '0' precedes the prices.

SILVICULTURAL_COSTS

Functions

The SILVICULTURAL_COSTS parameter provides the costs of silvicultural operations. The costs of operations play a key role together with the roadside prices in the calculation of the net revenues and the net present values, and consequently determining the preference and the priority of management operations in the analysis. The consistency of the prices and the costs is of great importance, besides the cost level. See also the ROADSIDE_PRICES parameter.

Generic name in Finnish: METSANHOITOKUSTANNUKSET
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 16
Default values: See Example B.42

Legend

(1) Cost of clearing of regeneration area	FIM/hectare
(2) Cost of soil preparation	FIM/hectare
(3) Cost of seeding	FIM/hectare
(4) Cost of pine planting	FIM/100 seedlings
(5) Cost of spruce planting	FIM/100 seedlings
(6) Cost of birch planting	FIM/100 seedlings
(7) Cost of supplementary planting, pine	FIM/100 seedlings
(8) Cost of supplementary planting, spruce	FIM/100 seedlings
(9) Cost of supplementary planting, birch	FIM/100 seedlings
(10) Cost of prevention of grass	FIM/hectare
(11) Cost of tending of seedling stands	FIM/hectare
(12) Cost of pruning	FIM/stem
(13) Cost of fertilization	FIM/hectare

(14) Cost of forest drainage	FIM/hectare
(15) Cost of ditch cleaning	FIM/100 meters
(16) Cost of supplementary drainage	FIM/100 meters

NOTE: In the current MELASIM version, silvicultural costs can be provided as an average for all owner groups only.

Example B.42. A definition of the SILVICULTURAL_COSTS parameter.

```
SILVICULTURAL_COSTS  330 760 680 180 200 230 180 220
                     260 500 850 4.5 820 700 210 220
```

SIMULATION_CONTROL

Functions

The SIMULATION_CONTROL parameter provides a collection of parameters for the control of the simulation process.

Generic name in Finnish: SIMULOINNIN_OHJAUS
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 17
Default values: See Example B.43

Legend

(1) Relative year when the generation of the alternative management schedules is finished in the simulation. The value '0' refers to the end of the calculation period. - Where required, the simulation of each management schedule is continued until the end of the calculation period by automatically selecting the first feasible event for each new state. In the same way, the simulation of each management schedule is continued after the calculation period until the end of the on-going rotation period for the calculation of the net present values. The unconditional finish of the simulation is provided by the item (15).

(2) Maximum number of event definitions.

(3) '0'

(4) Simulation control method.

'0' automated simulation control by event definitions
'1' interactive simulation control (for system maintenance only)

(5) '1000'

(6) '0'

(7) '1'

(8) Maximum number of management schedules for each management unit. Notice that one management schedule only with natural processes is simulated in addition to the maximum number of management schedules.

(9) '0'

(10) '0'

(11) Maximum number of sample plots for each management unit. '0' refers to all sample plots. The number of sample plots should not exceed 50-100, depending on the data in question. The additional sample plots will generate automatically extra management units with potential confusions later on.

(12) Relative year for storing simulation records into simulation record (**smr** type) files if the item (9) of the OUTPUT parameter has value '1' or '1.2'. The value '0' of the item (12) refers to the end of the calculation period.

(13) '0'

(14) '0'

(15) Relative year to always finish the simulation of management schedules. The simulation for the calculation of net present values after the calculation period is also finished even though the regeneration criterion is not met yet. If the net present value is not calculated, the item (15) should have the value '0' that refers to the end of the calculation period. See also the item (1) of the SIMULATION_CONTROL parameter.

(16) Calculation of land values. Specific input data are required. See also the LAND_VALUES parameter and the item (17) of the SIMULATION_CONTROL parameter.

'0' conventional simulation
'1' calculation of land values with specific input data

NOTE: There is no direct linkage or data transfer between the calculation of land values and the LAND_VALUES parameter.

(17) Simulation mode.

'-1' calculation of land values
- variable length calculation period controlled by the regeneration criterion and the item (15) of SIMULATION_CONTROL
- land values are calculated from simulation results

'0' conventional simulation
- fixed length calculation period controlled by the YEARS parameter and the item (15) of SIMULATION_CONTROL
- user-supplied land values are used, see the LAND_VALUES parameter

'1' stand level optimization
- variable length calculation period controlled by the regeneration criterion and the item (15) of SIMULATION_CONTROL
- user-supplied land values are used, see the LAND_VALUES parameter

Example B.43. A definition of the SIMULATION_CONTROL parameter.

```
SIMULATION_CONTROL  0 50 0 0 1000 0 1 200 0 0 100  0 0 0  151 0 0
```

In the simulation, the maximum number of management schedules is 200, the maximum number of sample plots for each management unit is 100, and no longer period for the calculation of the net present value than 151 years is allowed.

STUMPAGE_PRICES

Functions

The STUMPAGE_PRICES parameter provides stumpage prices of timber by tree species and timber assortments. Stumpage prices are used to calculate the stumpage value of the growing stock and the cutting revenues without taking costs into account. See also the ROADSIDE_PRICES parameter.

> NOTE: Stumpage prices are not used in the calculation of the net revenues and the net present values.

Generic name in Finnish: KANTOHINNAT
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 17
Default values: See Example B.44

Legend

(1) '0'

(2) - (9) Stumpage prices of saw logs by tree species.

(10) - (17) Stumpage prices of pulpwood by tree species.

For the eight tree species, see the tree variable (2) of the initial data record in Appendix D.1.

Example B.44. A definition of the STUMPAGE_PRICES parameter.

```
STUMPAGE_PRICES 0
*saw log price by tree species
220 170 230 230 85 85 90 85
*pulpwood price by tree species
 90 105  85  85 85 85 90 85
```

Notice the item '0' preceding the prices.

TIMBER_PRODUCTION_LAND

Functions

The TIMBER_PRODUCTION_LAND parameter changes the built-in upper bound of the forest management categories belonging to timberland (see the sample plot variable (30) of the initial data record in Appendix D.1) when calculating decision variables (see Appendix D.4).

> NOTE: The parameters TIMBER_PRODUCTION_LAND and MANAGEMENT_CATEGORY_GROUPS are formally independent. Users are responsible for the compatibility of their own definitions.

Generic name in Finnish: PUUNTUOTANNON_MAA
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 1
Default values: 5.9999

Legend

(1) Upper bound for forest management categories belonging to timberland when calculating decision variables.

Example B.45. A definition of the TIMBER_PRODUCTION_LAND parameter.

```
TIMBER_PRODUCTION_LAND 5.4
```

The stands with forest management category less or equal to 5.4 belong to timberland when calculating the values of the decision variables. Notice the compatibility with the definitions of the MANAGEMENT_CATEGORY_GROUPS parameter in Example B.27.

UNUSED_GROWTH_ESTIMATES

Functions

The UNUSED_GROWTH_ESTIMATES parameter controls the clearing of the unused growth estimate memory before storing simulation records (see Appendix D.3) into **smr** type files (see Appendix C.2).

In the current MELASIM, the generic time step of growth models is five years. The growth estimates for shorter steps are obtained from the annual averages of five year estimates. The unused proportions of five year estimates are stored for the next simulation step in order to avoid the bias due to the nonlinearities. The unused proportions are also stored in **smr** type files by default. The UNUSED_GROWTH_ESTIMATES parameter makes it possible to decide whether to use or not the last growth estimates of the earlier simulations in the beginning of the further simulations based on the **smr** type files.

Generic name in Finnish: KASVUMUISTI
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 1
Default values: 0

Legend

(1) Clearing of the unused growth estimates before storing simulation records into **smr** type files.

'0' don't clear unused growth estimates
'1' clear unused growth estimates

Example B.46. A definition of the UNUSED_GROWTH_ESTIMATES parameter.

```
UNUSED_GROWTH_ESTIMATES 1
```

Unused growth estimates are cleared before storing simulation records into **smr** type files.

VOLUME_CALIBRATION

Functions

The VOLUME_CALIBRATION parameter makes it possible to provide general adjustment coefficients for stem volumes (see **vol** type files in Appendix C.2) by forestry board districts (see the sample plot variable (29) of the initial data record in Appendix D.1). The parameter has an indirect influence on timber assortments, too.

Generic name in Finnish: TILAVUUDEN_TASOKORJAUS
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 100
Default values: All values equal to 1.0

Legend

(1) - (100) Adjustment coefficients for the calibration of stem volumes.

Categories:
- forestry board district: 20
- tree species category: 4 (pine, spruce, birch, other deciduous species)

Example B.47. A definition of the VOLUME_CALIBRATION parameter.

```
VOLUME_CALIBRATION

* (1) forestry board district
* (2) pine
* (3) spruce
* (4) birch
* (5) other deciduous species

* (1)   (2)     (3)     (4)     (5)
* forestry board district 0
    0 1.0000 1.0000 1.0000 1.0000
* forestry board district 1
    1 1.0000 1.0000 1.0000 1.0000
    2 1.0000 1.0000 1.0000 1.0000
    3 1.0000 1.0000 1.0000 1.0000
    4 1.0000 1.0000 1.0000 1.0000
    5 1.0000 1.0000 1.0000 1.0000
    6 1.0000 1.0000 1.0000 1.0000
    7 1.0000 1.0000 1.0000 1.0000
    8 1.0000 1.0000 1.0000 1.0000
    9 1.0000 1.0000 1.0000 1.0000
   10 1.0000 1.0000 1.0000 1.0000
   11 1.0000 1.0000 1.0000 1.0000
   12 1.0000 1.0000 1.0000 1.0000
   13 1.0000 1.0000 1.0000 1.0000
   14 1.0000 1.0000 1.0000 1.0000
   15 1.0000 1.0000 1.0000 1.0000
   16 1.0000 1.0000 1.0000 1.0000
   17 1.0000 1.0000 1.0000 1.0000
   18 1.0000 1.0000 1.0000 1.0000
* forestry board district 19
   19 1.0000 1.0000 1.0000 1.0000
```

YEARS

Functions

The YEARS parameter defines in MELASIM the calculation period and its sub-periods that constitute the time framework of the MELA analysis. For example, the decision variables are collected and the reports are generated by sub-periods. Specific definitions of the YEARS parameter are required for different MELA applications.

Time is usually expressed in MELA in terms of relative years, see Example B.48.

True (absolute) years are used for the automatic updating (pre-simulation) of growth in the management unit data to the beginning of the calculation period (or to the first absolute year) before other simulation operations, see Examples H.13 and H.14. The year of the initial data may vary by management units. As well, growth updating and other simulation operations can take place in separate MELASIM sessions; for the storing of the updated simulation data, see the item (9) of the OUTPUT parameter, see Example H.15.

> NOTE: Users are responsible for the compatibility of the parameters EVENT (the EVENT_YEARS item), EVENT_DEFAULTS, SIMULATION_CONTROL and YEARS.

Generic name in Finnish: VUODET
Origin: System parameter
Program: MELASIM
Type: Numerical
Number of items: 1 - 9 (- 20)
Default values: None

> NOTE: The maximum number of sub-periods in MELAOPT is limited to 9 due to the currently limited report generation capabilities.

Legend

(1) - (9) - (20) **year**[year]

year A relative year, starting from the year 1 (simulation begins from initial data as such)

or

a true (absolute) year (simulation begins after automated growth updating until the beginning of the first year provided).

NOTE: Absolute and relative years must not appear in the same definition of the YEARS parameter.

Years can be defined independently from the five-year intervals of the current models of natural processes. However, even number of years in the lengths of sub-periods is recommended to avoid potential biases in optimization. For considerations on the interpolation procedure, see UNUSED_GROWTH_ESTIMATES parameter.

Example B.48. Definitions of the YEARS parameter.

```
YEARS 1 11 21 31 41 51
```

The calculation period is 50 years from the beginning of the relative year 1 to the beginning of the relative year 51 consisting of five 10-year sub-periods. No automatic growth updating will take place.

```
YEARS 1 3 11 21 31 41 51
```

The first sub-period is split into two parts. Notice the even number of years in the lengths of the sub-periods.

```
YEARS 1995 2005 2015 2025 2035 2045
```

The calculation period is 50 years from the beginning of the year 1995 to the beginning of the year 2045. The input data will be updated to the beginning of the year 1995 before other simulation operations start in 1995.

Appendix C
MELA Files

Appendix C provides a short introduction to each of the MELA file types.

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Appendix C
MELA Files

C.1 Introduction

MELA files fall into two categories:

- system files, and
- user files.

User files are described here in details. System files are shortly reviewed. For a general introduction to MELA files, see Chapters 3.1 and 3.2.3.

All MELA files, both text and binary files, are processed by standard FORTRAN input/output operations in the MELA programs. Some of the files can be processed also by user programs. Compressed system files should be processed by MELA routines only.

> NOTE: There are auxiliary routines to process MELA system files. Contact the MELA Team for further details.

C.2 MELA File Types

Current file types are:

- **mdl** type files — optimization problems
- **mps** type files — data for stand management report generation
- **mrg** type files — cost of change reports
- **msc** and **msd** type files — stand level management schedules
- **msc** and **msd** type files — forest level summary data
- **par** type files — parameter definitions
- **rsd** type files — initial forest resource data
- **sch** type files — management schedule reports
- **shp** type files — shadow price reports
- **smr** type files — simulation records
- **sms** type files — standwise simulation instructions
- **sol** type files — solution reports
- **sum** type files — forest level summary reports
- **sym** type files — symbol definitions
- **tab** type files — instructions for summary report generation
- **vol** type files — volume tables

See also Figure 3.2 for the roles of some MELA files.

Problem Definition (mdl type) Files

Functions

Optimization problems for MELAOPT are provided via **mdl** type files.

Besides the use of the examples in the Handbook for solving optimization problems, users may and usually need to prepare their own problem definitions according to their own analyses, preferences and goals for forestry.

For examples, see optimization problem definition (**mdl** type) files in Part 2 and in Appendix H.

Specifications

File type: user file
Default naming: problem.**MDL**
Default unit: 23
File parameters: text file, sequential, variable length
Valid records: text rows containing valid JLP commands, definitions and comments in the JLP syntax
Output from: text editor (or user programs, if available)
Input for: MELAOPT

Generation

mdl type files are generated by text editors or by user programs. Previously defined problem definitions may prove useful starting points for the design of new problem definitions.

Instructions

A **mdl** type file may contain

- JLP commands and definitions (in the JLP syntax), and
- JLP comments (lines beginning with the character '*').

> NOTE: The JLP command 'solve' should not appear accidentally in a **mdl** type file. It is automatically executed in MELAOPT immediately after the **mdl** type file.

The JLP sections 'xvar' and 'prob' are always required in a valid **mdl** type file. For other JLP commands, see Lappi (1992).

Notice the different syntax in a 'xvar' section (the continuation of a line is expressed by the character '>' at the end of the line) and in a 'prob' section (instead of line continuation characters on problem definition lines, the character '/' finishes the whole 'prob' paragraph), see Example H.16.

The introduction and the use of MELA decision variables in mdl type files

> NOTE: In the JLP terms, MELA decision variables are called x variables. For JLP x variables, see Lappi (1992).

The MELA decision variables describing management schedules in MELAOPT come from the management schedule (**msc** and **msd** type) files. In the conventional use of JLP, 'xdat' files are used instead.

The task of the 'xvar' section in **mdl** type files is to introduce the MELA decision variables (see Appendix D.4) available for consequent 'prob' sections, MELA solution reports (see Chapter 3.5.2.2 and also **sol** type files) and JLP reports (see Chapter 3.5.2.2 and the JLP mode in Chapter 3.5.2.3). A 'xvar' section must contain at least all the variables used in the 'prob' definitions during the MELAOPT session. Only the program capacity limits the number of individual variables in the 'xvar' section.

> NOTE: Faulty results without warning or unexplained errors will obtained as a consequence of misinterpretation if all of the decision variables referred in the 'prob' section are not correctly introduced in the 'xvar' section. See also JLP z variables below and in Lappi (1992)

In the 'prob' section of a **mdl** type file, a linear programming problem is provided using the JLP conventions. The MELA decision variables introduced in the previous 'xvar' section and their linear combinations are used to define the objective function and the constraints.

For the details in the JLP 'xvar' and 'prob' paragraphs and other commands for JLP problem definitions in **mdl** type files, see Lappi (1992).

The naming of MELA decision variables in mdl type files

Decision variables are available for all years (states) or sub-periods (events) defined by the YEARS parameter in the simulation, see Appendix B.2. The following convention is used to refer to the MELA decision variables in **mdl** type files:

```
xPvvv
```

x	'x' (lower case 'x' referring to JLP x type variables).
P	The identification number of the sub-period in question, see the YEARS parameter in the current application.

vvv	The identification number of the MELA decision variable stored in actual **msc** and **msd** type files, see Appendix D.4 and the MSD_VARIABLES parameter in Appendix B.2.

The naming of decision variables in the case of four and five sub-periods defined by the YEARS parameter is as follows:

```
YEARS            1995 2005 2015 2025 2035
            decision variables describing states
                 0vvv 1vvv 2vvv 3vvv 4vvv
            decision variables describing events
                   1vvv 2vvv 3vvv 4vvv

YEARS             1    3    7   11   21   31
            decision variables describing states
                 0vvv 1vvv 2vvv 3vvv 4vvv 5vvv
            decision variables describing events
                   1vvv 2vvv 3vvv 4vvv 5vvv
```

For example, the variable 'x0700' refers to the volume of the growing stock in the initial state, and the name 'x1700' refers to the volume of the growing stock at the end of the first sub-period. Respectively, the variable name 'x1195' refers to the cutting removal on the first sub-period. Notice that the sub-periods may be of variable length.

JLP domain definitions and c variables in mdl type files

The objective and the constraints can be provided in MELAOPT

- for the whole forestry unit,
- for any of the MELA decision hierarchy members, see Chapter 3.3.2 and Example H.31, and
- for any individual JLP domain defined by the user-supplied c variables, see Chapter 3.3.3, Example H.33 and Appendix D.2, and Lappi (1992).

According to the JLP convention, constraints before any external domain definitions are for the whole forestry unit. A domain definition is followed by one or several constraints for that domain. Several sequences of domain definitions and constraints may follow each others, each referring to the specified domain only. For further details, see Lappi (1992). See Examples H.31 and H.39.

The JLP command 'show/domains' in a **mdl** type file can be used for the generation of additional domains for reporting in addition to the domains defined in the 'prob' section (for details, see Lappi 1992). See Example H.28.

JLP z variables in mdl type files

The z variables (or additional decision variables in JLP terms) are used to formulate conventional LP problems in JLP. They also make it possible to combine a MELA and conventional LP problem formulation. JLP interprets as z variables all the variables of the objective function and of the constraints which were not introduced by the preceding 'xvar' command or by the 'xtran' transformations. For further details and potential applications (e.g. in goal programming), see Lappi (1992).

> NOTE: The references (in the 'prob' section of a **mdl** type file) to the MELA decision variables not defined in the preceding 'xvar' section are also treated as z variables. If unintentionally used, unexpected results without warning will be obtained.

The naming of mdl type files

For the convenience, the name of each **mdl** type file should refer to the optimization problem described in the file. Analysis designs and their members should be named in a systematic way.

Stand Management (mps type) Files

Functions

Stand management (**mps** type) files are used to transfer management unit variables from MELASIM via/from MELAOPT to user programs, for example, for printing stand level management reports and for returning stand management proposals to user's forest database. Stand management files contain also optimum solution records providing information about the selected management schedules for management units in MELAOPT.

Specifications

File type: system file
Default naming: forestry_unit_sub_unit_problem.**MPS**
Default unit: 26
File parameters: binary, sequential, fixed length
Valid records: optimum solution records and management report records defined by the MPS_VARIABLES parameter in the MSB format (see Appendix G)
Output from: MELAOPT
Input for: user programs

Generation

The MELAOPT command REPORT SUMMARY is used to generate **mps** type files. Optimum solution records are system defined. The MPS_VARIABLES parameter selects the variables of management report records for storing into the **mps** type files.

See also in Appendix B.2 the MSD_VARIABLES and MSR_VARIABLES parameters that control the storing of information in MELASIM from decision data records and simulation records into **msc** and **msd** type files. **msc** and **msd** type files transfer the information to MELAOPT, for example, for the generation of management report records.

Instructions

For the processing of **mps** type files in user programs, see Example G.1 and Appendix H.7. The order of the variables in management report records is defined by the MPS_VARIABLES parameter.

Cost of Change Report (mrg type) Files

Functions

A cost of change (increase or decrease) report generated from the JLP solution in MELAOPT is stored by request in a **mrg** type file.

Specifications

File type: system file
Default naming: forestry_unit_sub_unit_problem.**MRG**
Default unit: 63
File parameters: text file, sequential, variable length
Valid records: text rows generated from the JLP cost of change information
Output from: MELAOPT
Input for: user interpretation

Generation

For the generation of cost of change reports into **mrg** type files in MELAOPT, see the REPORT MARGINALS command in Chapter 3.5.2.2.

Instructions

For the potential use of cost of change information, see Lappi (1992) and Chapters 3.5.7.1 and 4.1.3.3. Cost of change reports are final documents for user interpretation. For example, print or display the cost of change report in another window during the analysis process. See Example H.42.

Management Schedule (msc and msd type) Files

Functions

Management schedule (**msc** and **msd** type) files are used to store by request and to transfer the selected decision variables from MELASIM to MELAOPT (see Chapter 3).

msc type files contain the introduction of management schedule data and **msd** type files of the management schedule data. The management schedule files may optionally contain also:

- management schedule records (see Appendix D.5) for MELAOPT reports and for transmission to the user's database, and
- re-simulation instructions for management schedules (see also **sms** type files).

Specifications

File type: system files
Default naming: sub_unit.**MSC/MSD**
Default unit: 10 (**msc** type files), 11 (**msd** type files)
File parameters: binary, sequential, variable length, compressed
Valid records: decision data records, management report records, simulation instruction records in **msd** type files
Output from: MELASIM
Input for: MELAOPT

NOTE: **msc** and **msd** type files should be processed with MELA routines only.

Generation

For the generation of **msc** and **msd** type files in MELASIM, see the item (1) of the OUTPUT parameter in Appendix B.2.

Instructions

For the selection of decision variables, see the MSD_VARIABLES parameter in Appendix B.2.

For the generation of management report records, see the MSR_VARIABLES parameter in Appendix B.2.

For the generation of re-simulation instructions, see the RE_SIMULATION_ INSTRUCTIONS parameter in Appendix B.2.

The decision variables for storing should be selected in accordance with the optimization problems and with the most urgent reporting needs in order to minimize the need of disk space. Consider re-simulation reports for the details not provided directly by decision variables and MELAOPT solutions.

> NOTE: In the re-simulation, the generation of management schedule files is usually not necessary, see the item (1) of the OUTPUT parameter in Appendix B.2. Notice that the original (management unit level) management schedule files are overwritten in re-simulation. Rename the original management schedule files before re-simulation, if necessary.

> NOTE: For the storing of MELAOPT forest level solution summaries in the form of MELA management schedule files for further reports and analyses, see forest level summary (**msc** and **msd** type) files.

Forest Level Summary (msc and msd type) Files

Functions

The forest level summary of all decision variables available in MELASIM and in MELAOPT is stored by request in forest level summary (**msc** and **msd** type) files. Forest level summary files are used for storing MELAOPT solutions in binary form for further processing.

msc type files contain the introduction of summary data and **msd** type files the summary data in a comparable form with management schedule data.

Specifications

File type: system files
Default naming: forestry_unit_sub_unit_problem_**O.MSC/MSD** (MELAOPT)
forestry_unit_sub_unit_problem_**S.MSC/MSD** (MELASIM)
Default unit: 20 **msc** type files, 21 **msd** type files (MELASIM)
22 **msc** type files, 23 **msd** type files (MELAOPT)
File parameters: binary, sequential, variable length
Valid records: forest level summary of management unit level decision data records
Output from: MELAOPT
Input for: user programs, MELAOPT

NOTE: **msc** and **msd** type files should be processed with MELA routines only.

Generation

For the generation of forest level summary (**msc** and **msd** type) files in MELASIM, see the item (2) of the OUTPUT parameter in Appendix B.2, and in MELAOPT, see the REPORT SUMMARY command in Chapter 3.5.2.2. See also the MSD_VARIABLES parameter in Appendix B.2.

Instructions

Forest level summary files have use, for example, in the comparisons of different solutions and in further reports and analyses.

NOTE: See also management schedule (**msc** and **msd** type) files.

Parameter Definition (par type) Files

Functions

MELA parameter definition (**par** type) files are used to store user-defined sets of MELA parameter values (and, in general, any relevant input lines) for submission to the MELA programs. Actual parameter values control the options and the execution of the MELA programs.

There are several default parameter files in the MELA System that have default names, see MELA commands and command arguments in Part 3. Usually, users need to make and to use their own parameter files.

Specifications

File type: user file
Default naming: filename.**PAR**
Default unit: several ones, for example, 24
File parameters: text file, sequential, variable length
Valid records: MELA input lines
Output from: text editor (or user program, if available)
Input for: MELASIM, MELAOPT

Generation

par type files can be generated by a text editor or user programs.

Instructions

The general syntax of MELA parameters is described in Chapter 3.2.4 and the details of the parameters in Appendix B. Some of the most important parameters and parameter files are mentioned in conjunction with the MELA programs in Part 3. See the examples in Appendix H.

Only some run-time parameters are usually provided as terminal input while running MELA programs. All other parameters should be stored beforehand in **par** type files for reading

- automatically, for example, **MELA_SET.PAR**, see Example H.1,
- via MELA command arguments, see for example, the arguments of the MELASIM command SIMULATE in Chapter 3.4, or
- with the MELA command INCLUDE during a session or in a **par** type file, see Chapter 3.2.2.2.

There are parameters that belong together and are stored in groups in separate parameter files, for example

- parameters defining MELA applications, for example **MS.PAR** in Example H.5,
- parameters controlling the simulation of events in a MELA application, for example, **MS_EVENT.PAR** in Example H.6, and
- decision hierarchy description, see the forestry_unit parameter and the decision hierarchy definition in the **FX.PAR** file in Example 3.11.

Some common parameter definition files are shown in Appendix H.

> NOTE: A **par** type file may have also an user-defined extension in the file name (instead of default extension '**par**') if the **par** type file appears in a user-supplied command INCLUDE in another **par** type file.
>
> NOTE: In the current version, event definitions are parameter definitions and they are provided in **par** type files. The extension '**tpd**' was used in the names of event definition files in the early versions of MELA.

Initial Data (rsd type) Files

Functions

The MELA programs read forest resource data from initial data (**rsd** type) files.

The initial data files may contain two types of records:

- initial (sample plot level) data records of management units, see Appendix D.1, and
- management unit (c variable) records, see Appendix D.2.

Specifications

File type: user file (in system form)
Default naming: sub_unit.**RSD**
Default unit: 9
File parameters: binary, sequential, variable length
Valid records: initial data records and management unit (c variable) records in the MSB format (see Appendix G)
Output from: user programs
Input for: MELASIM, MELAOPT

Generation

A **rsd** type file contains the initial (sample plot level) data of

- a single, one level forestry unit, or
- one lowest level member (sub-unit) of a hierarchical forestry unit, see Chapter 3.3.2.

The initial data files are generated by user programs. The MELA programs change the sample plot data records from **rsd** type files into simulation records in the beginning of the simulation.

> NOTE: The number of management units in a **rsd** type file must not exceed the capacity of the MELA program version (usually 100 - 10 000). If the number of management units exceeds the capacity of the program, try hierarchical forestry units or change the program version.

Instructions

The MSB format records in initial data (**rsd** type) files may have several logical MELA records in one physical record. For the logical records, see the initial data record in Appendix D.1 and the management unit (c-variable) record in Appendix D.2. The structure of the physical (MSB format) record is described in Appendix G.

The initial data records belonging to the same management unit must follow each others. Management units should be in ascending order subject to the identification number of the management unit, see the sample plot variable (1) of the initial data record.

Management Schedule Report (sch type) Files

Functions

The report displaying the management schedules selected in the optimum solution in MELAOPT is stored by request from JLP memory in a **sch** type file.

Specifications

File type: system file
Default naming: forestry_unit_sub_unit_problem.**SCH**
Default unit: 64
File parameters: text file, sequential, variable length
Valid records: text rows displaying management schedules in an optimum solution
Output from: MELAOPT
Input for: user interpretation

Generation

For the generation of a management schedule report into a **sch** type file in MELAOPT, see the REPORT SCHEDULES command in Chapter 3.5.2.2.

Instructions

Management schedule reports are final documents for user interpretation. For example, print or display the management schedule report in another window during the analysis process. See Example H.43.

Shadow Price Report (shp type) Files

Functions

This report displaying the shadow prices of the constraints in the optimum solution in MELAOPT is stored by request in a **shp** type file.

Specifications

File type: system file
Default naming: forestry_unit_sub_unit_problem**.SHP**
Default unit: 62
File parameters: text file, sequential, variable length
Valid records: text rows displaying shadow prices of constraints in an optimum solution
Output from: MELAOPT
Input for: user interpretation

Generation

For the generation of the shadow price report into a **shp** type file in MELAOPT, see the REPORT SHADOW_PRICES command in Chapter 3.5.2.2.

Instructions

Shadow price reports are final documents for user interpretation. For example, print or display the shadow price report in another window during the analysis process. For an See Example H.44.

Simulation Record (smr type) Files

Functions

MELA simulation records from MELASIM can be stored by request to **smr** type files in order to transfer them later to other programs.

Specifications

File type: system file
Default naming: sub_unit.**SMR**
Default unit: 16
File parameters: binary, sequential, variable length
Valid records: MELA simulation records in the MSB format (see Appendix G)
Output from: MELASIM
Input for: user programs, MELASIM

Generation

See the item (9) of the OUTPUT parameter in Appendix B.2 for the generation of **smr** type files.

Instructions

Simulation records can be stored in a **smr** type file from one or several points of time. These records are needed as input data for simulation, e.g. in the case of pre-simulation when updating the initial data, or for further calculation with user programs.

> NOTE: The simple naming of **smr** type files implies that each file is renamed before the generation of the next one in the case of several overlapping **smr** type files for one sub-unit.

> NOTE: The size of **smr** type files may grow large if there are lots of management units and the simulation records are stored at several points of time.

If **smr** type files are used as initial data for simulation, it is necessary to change the extension 'smr' to 'rsd' using the rename file command on your operating system.

> NOTE: Management unit records are currently not stored in **smr** type files, limiting the applicability of the **smr** type files as forest resource data.

Standwise Simulation Instruction (sms type) Files

Functions

Several kinds of detailed simulation instructions for individual management units can be provided via **sms** type files to MELASIM, in addition to the general event definitions in **par** type files for the automated simulation of events.

Standwise simulation instruction (**sms** type) files are used for two main purposes:

- to transmit the re-simulation instructions of the selected management schedules from MELAOPT to MELASIM, see Chapters 3.4 and 3.5, and
- to transmit the user-supplied management proposals specific to each management unit to MELASIM, see Chapter 3.4.

Standwise simulation instructions are also needed for updating stand data by other events than natural processes only.

Specifications

File type: system file
Default naming: forestry_unit_sub_unit_problem.**SMS** (re-simulation)
sub_unit_proposals.**SMS** (management proposals)
Default unit: 13
File parameters: binary, sequential, variable length
Valid records: simulation instruction records in the MSB format (see Appendix G), see Appendix D.7
Output from: MELAOPT, user program
Input for: MELASIM

Generation

MELAOPT generates by request, see the REPORT SUMMARY command in Chapter 3.5.2.2, the standwise re-simulation instructions of the selected management schedules after the MELAOPT solution. Notice that the RE_SIMULATION_INSTRUCTIONS parameter (see Appendix B.2) controls the storing of re-simulation instructions into **msc** and **msd** type files in MELASIM, making the generation of **sms** type files possible in MELAOPT.

User-supplied management proposals specific to each management unit are generated by user routines.

See simulation instruction records in Appendix D.7.

Instructions

It is possible to provide one or several simulation instruction records for each management unit. Simulation starts with the standwise simulation instructions and can continue with the automated simulation of management schedules. For further information, see simulation instruction records in Appendix D.7.

Solution Report (sol type) Files

Functions

The short MELA report displaying a forest level optimum solution directly from the JLP memory is stored in MELAOPT by request in a **sol** type file.

Specifications

File type: system file
Default naming: forestry_unit_sub_unit_problem.**SOL**
Default unit: 61
File parameters: text file, sequential, variable length
Valid records: text rows displaying variables of optimization problem over time
Output from: MELAOPT
Input for: user interpretation

Generation

For the generation of the solution report into a **sol** type file in MELAOPT, see the REPORT SOLUTION command in Chapter 3.5.2.2.

Instructions

Solution reports are final documents for user interpretation. For example, print or display the solution report in another window during the analysis process. See Example H.30.

Notice the specific exponential expressions in MELA solution and summary reports. Bigger values than 7 digits are expressed by the notation $a*n$ where a is a numerical value and n is 3 to 9 referring to the number of zeros to be added to the value a. For example, 12345*4 should be interpreted as 123 450 000.

> NOTE: For a more comprehensive forest level summary report on the basis of the management schedules selected in a MELAOPT solution, see the REPORT SUMMARY command in Chapter 3.5.2.2 and **sum** type files. See also the re-simulation of the management schedules selected in the MELAOPT solution in Chapters 3.4.2 and 4.1.4.

Summary Report (sum type) Files

Functions

Forest level summary reports from MELAOPT and MELASIM are stored by request in **sum** type files.

Specifications

File type: system file
Default naming: forestry_unit_sub_unit_problem_**O.SUM** (MELAOPT)
forestry_unit_sub_unit_problem_**S.SUM** (MELASIM)
Default unit: 65
File parameters: text file, sequential, variable length
Valid records: text rows generated from forest level summary of decision variables
Output from: MELASIM, MELAOPT
Input for: user interpretation

Generation

sum type files are generated from the forest level summary of decision variables over the calculation period according to the user-supplied summary report definitions in **tab** type files.

For the generation of summary reports into **sum** type files

- in MELASIM, see the item (2) of the OUTPUT parameter in Appendix B.2, and
- in MELAOPT, see the REPORT SUMMARY command in Chapter 3.5.2.2 and Appendix H.5.

Instructions

Forest level summary reports are final documents for user interpretation. For example, print or display the forest level summary report in another window during the analysis process. See Examples 2.2 and H.8 and Appendix H.5.

In the optimization and in the re-simulation, forest level summary reports are generated from the management schedules selected in MELAOPT solutions.

In the simulation of management schedules, summary reports are generated by selecting the management schedule yielding the highest net present value with 3 % discount rate for each management unit without forest level constraints.

In the re-simulation, summary reports are generated from the management schedules selected in the corresponding optimum solution.

Notice the specific exponential expressions in MELA solution and summary reports. Bigger values than 7 digits are expressed by the notation *a*n* where *a* is a numerical value and *n* is 3 to 9 referring to the number of zeros to be added to the value *a*. For example, 12345*4 should be interpreted as 123 450 000.

NOTE: In MELAOPT, it may take much time to generate summary reports due to the size of management schedule files.

NOTE: For a short summary of a MELAOPT solution, see also **sol** type files.

Symbol Definition (sym type) Files

Functions

Alternative run-time values to the generic names of commands and parameters as well as message texts in the MELA programs are provided in **sym** type files.

Specifications

File type: system file
Default naming: SYMBOL.SYM
Default unit: 25
File parameters: text file, sequential, variable length
Valid records: text rows containing valid MELA symbol definitions and comments
Output from: text editor (or user programs, if available)
Input for: MELASIM, MELAOPT

Generation

The default symbol definition file **SYMBOL.SYM** is provided with the MELA standard delivery.

Instructions

Symbol definitions are used to generate different language versions of the MELA programs.

Summary Report Definition (tab type) Files

Functions

tab type files contain the row by row instructions how to generate forest level summary reports.

Specifications

File type: user file
Default naming: TABLE.TAB
Default unit: 14
File parameters: text file, sequential, variable length
Valid records: summary report definition records, see Appendix D.8
Output from: text editor (or user program, if available)
Input for: MELASIM, MELAOPT

Generation

tab type files are usually generated by text editor.

Instructions

Various summary report definition files with their own names are required, for example, for shorter and longer reports, for different MELA applications and for different language versions. See the MELA_TABLE parameter in Appendix B.2 how to apply **tab** type files in order to generate different kinds of summary reports.

The MELA standard package contains examples of **tab** type files that can be used as a basis for designing new summary report definition files. Summary report definition records are described in details in Appendix D.8.

Volume Table (vol type) Files

Functions

Volume table (**vol** type) files contain the binary tables for stem volume and timber assortment calculations in MELASIM. The default tables are only for the Finnish conditions.

Specifications

File type: system file
Default naming: VOLUME.VOL
Default unit: 71
File parameters: binary, sequential, fixed length
Valid records: specific stem and timber assortment volume tables
Output from: specific MELA volume table generation routines
Input for: MELASIM

Generation

The default volume table file **VOLUME.VOL** is provided with the MELA standard delivery.

The following estimates are found in the volume table on the basis of Finnish taper curve models and volume functions (Laasasenaho 1982):

- total volume of stem from stump height to top,
- volume of saw log section of stem,
- volume of pulpwood section of stem, and
- volume of residual section of stem above pulpwood section

for the tree species or species categories defined by the tree variable (2) of the initial data record as a function of tree diameter and height (see Appendix D.1).

The sum of saw log, pulpwood and residual sections always equals to the total volume of stem.

For changing the parameters of Finnish stem volume models, such as minimum log size, and for the generation of user-supplied stem volume tables, contact the MELA Team.

Instructions

The stem volume calculation in MELASIM is based on volume tables because of the speed of execution, however resulting minor accuracy losses in interpolation.

Appendix D
MELA Records and Variables

MELA record types are described in details: the functions, structure, variables and generation of each record type with instructions on the use of the records and the variables.

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Appendix D
MELA Records and Variables

D.1 Initial Data Record (sample plots in rsd type files)

Functions

MELA initial data records are used to transfer user's forest resource data of sample plot form in **rsd** type files (see Appendix C.2) to simulation (MELASIM, see Chapter 3.4) and to optimization (MELAOPT, see Chapter 3.5).

Structure

The MELA initial data record is a floating-point vector, see Figure D.1.

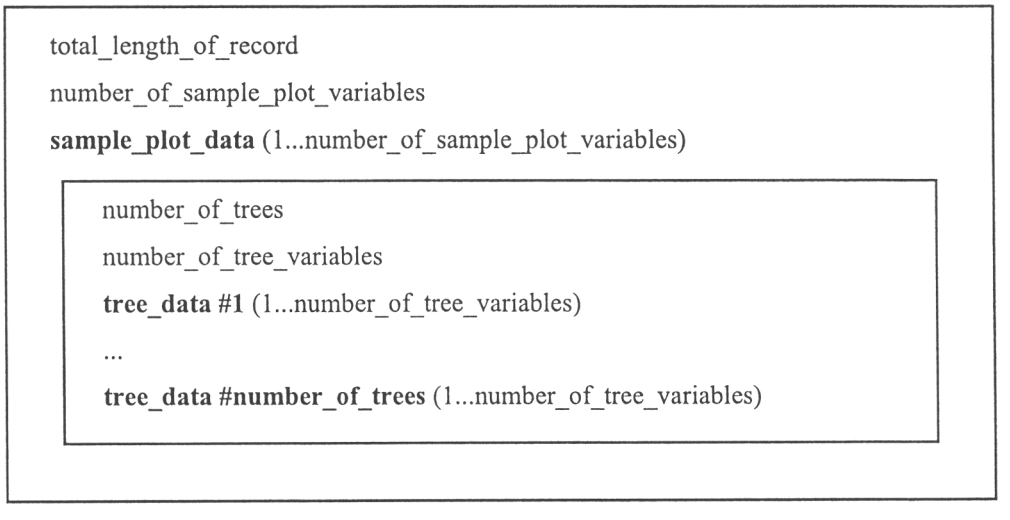

Figure D.1. The structure of the initial data record.

The logical record type of initial data records in MSB format files is 1 (see Appendix G).

Variables

NOTE: The variables equipped with the sign '-' may well have a value zero, if relevant data is not available. These variables are not currently necessary, but some of them are useful or will become useful later on.

Sample plot variables of initial data (Finnish version)

(1) Identification number of the management unit (unique id in ascending order in each **rsd** type file; length must not override 7 digits)
(2) Year, a (that the sample plot data represents, for example, 1996)
(3) Actual area, ha (or 1 000 ha on large areas)
(4) Area weight for growing stock, same value as (3) (except FNFI data)
-(5) Y coordinate, km (the Finnish coordinate system)
-(6) X coordinate, km (the Finnish coordinate system)
-(7) Identification number of the stand (if stands are equal to management units, the variable (1) can be used as a unique stand id, and the variable (7) can then be used for other purposes; length must not override 7 digits)
(8) Height of the sample plot above sea level, m
(9) Actual temperature sum, dd (appropriate values in Finland 500 - 1 350 dd)
(10) Owner category

0 private persons
1 enterprises (forest industries, etc.)
2 state (Forest and Park Service, etc.)
3 municipalities etc.
4 communities

(11) Land-use category

1 forest land
2 scrub land
3 waste land
4 other forestry land than 1 - 3
5 agricultural land
6 built-up land
7 roads, electric lines, etc.
8 lakes and rivers
9 sea
NOTE: Land-use categories 4 - 9 are not currently allowed in the simulation.

(12) Soil and peatland category

1 mineral soils
2 peatland, spruce mires (korpi in Finnish)
3 peatland, pine mires (räme in Finnish)
4 peatland, barren treeless mires (neva in Finnish)
5 peatland, rich treeless mires (letto in Finnish)

(13) Site type category

1 very rich sites (OMaT in South Finland)
2 rich sites (OMT in South Finland)
3 damp sites (MT in South Finland)
4 sub-dry sites (VT in South Finland)
5 dry sites (CT in South Finland)
6 barren sites (ClT in South Finland)
7 rocky or sandy areas
8 open mountains

(14) Reduction of forest taxation class

0 no reduction
1 stony soils
2 wet soils
3 thick moss layer expressing low soil productivity (kunttaisuus in Finnish)
4 unfavourable location (coastal areas, mountains)

(15) Finnish forest taxation class or site fertility category

1 IA respective to very rich or rich sites
2 IB respective to damp sites
3 II respective to sub-dry sites
4 III respective to dry sites
5 IV respective to barren sites or lower, if forest land
6 scrub land
7 waste land
NOTE: Forest taxation class is a combination of variables (13) and (14).

(16) Drainage category

0 undrained mineral soils
1 ditched mineral soils
2 undrained mires
3 ditched mires (unchanged productivity), (ojikko in Finnish)
4 transforming mire (improved productivity), (muuttuma in Finnish)
5 transformed mire (productivity comparable to mineral soils), (turvekangas in Finnish)

(17) Feasibility for drainage

0 drainage feasible and allowed
1 drainage not feasible or not allowed

-(18) '0'

(19) Year of the last drainage, a

(20) Year of the last fertilization, a

(21) Year of the last soil surface preparation, a

(22) Feasibility for natural regeneration

0 natural regeneration feasible
1 natural regeneration not feasible

(23) Year of the last cleaning of regeneration area, a

-(24) (development class - not used as input data)

(25) Year of the last artificial regeneration, a

(26) Year of the last tending of young stand, a

(27) Year of the last pruning, a

(28) Year of the last cutting, a

(29) Forestry Board District (default values in Finland)

0 Ahvenanmaa
1 Helsinki
2 Lounais-Suomi
3 Satakunta
4 Uusimaa-Häme
5 Pirkka-Häme
6 Itä-Häme
7 Etelä-Savo
8 Etelä-Karjala
9 Itä-Savo
10 Pohjois-Karjala
11 Pohjois-Savo
12 Keski-Suomi
13 Etelä-Pohjanmaa
14 Pohjanmaa
15 Keski-Pohjanmaa
16 Kainuu
17 Pohjois-Pohjanmaa
18 Koillis-Suomi
19 Lappi

(30) Forest management category (default values)

1 forest land, **no restrictions** for timber production
2 forest land, **administrational restrictions** for timber production
3 scrub land, no restrictions or administrational restrictions for timber production
6 waste land, no restrictions or administrational restrictions for timber production
7 forest, scrub and waste land, **no timber production** allowed

NOTE: Forest management categories are (or may be) used

- to regulate the simulation of events (each event is feasible in the categories provided by the actual event definition, default: event is always feasible), see the FOREST_CATEGORIES item of the EVENT parameter in Appendix B.2,

- to regulate the collection of decision variable values into the categories defined by the MANAGEMENT_CATEGORY_GROUPS parameter, see Appendix B.2 and the decision variables (101 - 120), (351 - 360), (371 - 380), (541 - 550) and (786 - 795) in the decision data record, and

- to define the limit between timberland (timber production activities allowed) and other forestry land (timber production activities not allowed) for collecting decision variables, see the TIMBER_PRODUCTION_LAND parameter in Appendix B.2. Most of the decision variables are currently collected for timberland only.

NOTE: Users may define and use their own values for the forest management categories in the limits of the available (10) categories, see the parameters

TIMBER_PRODUCTION_LAND and MANAGEMENT_CATEGORY_GROUPS in Appendix B.2. However, the users are responsible for the validity of the initial data, event definitions, and headings and titles of reports (see **tab** type files in Appendix C.2). It is recommended to use the default values of the parameter MANAGEMENT_CATEGORY_GROUPS allowing a large number of forest management categories for the event definitions in the form of floating-point values without the need to change any other definitions.

NOTE: There are no internal checkings to guarantee the consistency of new parameter definitions.

NOTE: The forest management category cannot change between sample plots within a management unit. The forest management category of a management unit is defined by the category of the last sample plot in the management unit.

(31) Method of the last cutting

0 no cutting (see NOTE below)
1 thinning (basal area instructions)
2 clear cutting
3 (first) thinning (number of stems/ha instructions)
4 over story removal
5 seed-tree cutting (natural regeneration for Scotch pine)
6 shelterwood cutting (natural regeneration for Norway spruce)

NOTE: The method '0' refers to the management unit or the sample plot where has NEVER been cuttings. Do not use this code if cuttings have sometimes been executed. Take also care for the compatibility of the variables (28) and (31).

(32) Municipality (codes by Statistics Finland)
(33) - not used -
(34) - not used -

Tree variables of initial data (Finnish version)

(1) Number of stems/ha (that the tree represents)
(2) Tree species (valid codes 1 - 8)

1 Scotch pine (Pinus silvestris)
2 Norway spruce (Picea abies)
3 Silver birch (Betula pendula)
4 Downy birch (Betula pubescens)
5 Aspen (Populus tremula)
6 Alder (Alnus incana, Alnus glutinosa)
7 other coniferous species than 1 or 2
8 other deciduous species than 3 - 6

(3) Diameter at 1.3 m height, cm
(4) Height, m
(5) Age at 1.3 m height, a

(6) Biological age, a
-(7) Reduction to model-based saw log volume (relative value 0.0 - 1.0)
-(8) Year of pruning (0 = no pruning), a
-(9) Age at 1.3 m height when reached 10 cm diameter, a
-(10) Origin

0 natural
1 planted
2 seeded
3 supplementary planted

-(11) Identification number of the sample tree (default: number of order on the sample plot)
-(12) Direction of the tree from the origo of the sample plot, in degrees
-(13) Distance of the tree from the origo of the sample plot, m
-(14) Height difference of the tree from the origo of the sample plot, m

Generation

Initial data records are generated by user routines, see Chapter 4.6.4 and **rsd** type files in Appendix C.2.

Instructions

The records in **rsd** type files (see Appendix C.2) are stored in the MSB format, see Appendix G. Each initial data record in a **rsd** type file must contain the data of one sample plot. The sample plots belonging to the same management unit must follow each others, and the management units should be in ascending order according to the identification number (sample plot variable (1)) of the management unit.

D.2 Management Unit Record (c variables in rsd type files)

Functions

Management unit records transfer management unit level classifications (c variables) to be used in optimization, for example, in JLP domains and transformations. For more details on domains, see Chapter 3.3, **mdl** type files in Appendix C.2 and Lappi (1992).

Structure

The management unit record is a floating-point vector consisting of user-supplied management unit variables (see Figure D.2).

management_unit_data (1...number_of_variables)

Figure D.2. The structure of the management unit record.

The logical record type of management unit records in MSB format files is 2 (see Appendix G).

Variables

The variables of management unit records are provided by user.

> NOTE: In the current MELA version, there is no direct mechanism to transfer the names of c variables from user routines to MELAOPT. Instead, the C_VARIABLES parameter defines the names of c variables, see Appendix B.2. For using c variables in the JLP optimization, see Lappi (1992).

Generation

Management unit records are generated by user routines.

Instructions

Management unit records are provided in **rsd** type files, see Appendix C.2, one record for each management unit. Each management unit record must appear immediately before the initial data record of the management unit in question.

See the examples in Appendix H.5.

D.3 Simulation Record (management units in simulation and in smr type files)

Functions

The simulation record is the internal presentation of the management unit information. All sample plots belonging to the same management unit are collected from the initial data into a simulation record. Besides initial data variables, it contains summarized variables of sample plot and management unit levels calculated from the sample tree and sample plot information. The simulation record changes dynamically over time in the simulation.

Structure

The MELA simulation record is a floating-point vector, see Figure D.3.

Variables

Management unit variables of simulation data (Finnish version)

(1...90) (see sample plot variables of simulation data and the NOTE below)

NOTE: The variables below equipped with the sign '*' have currently value zero at the management unit level.

NOTE: The variables below equipped with the sign '-' may well have value zero, if relevant data is not available. These variables are not necessary now, but some of them are useful or will become useful later on.

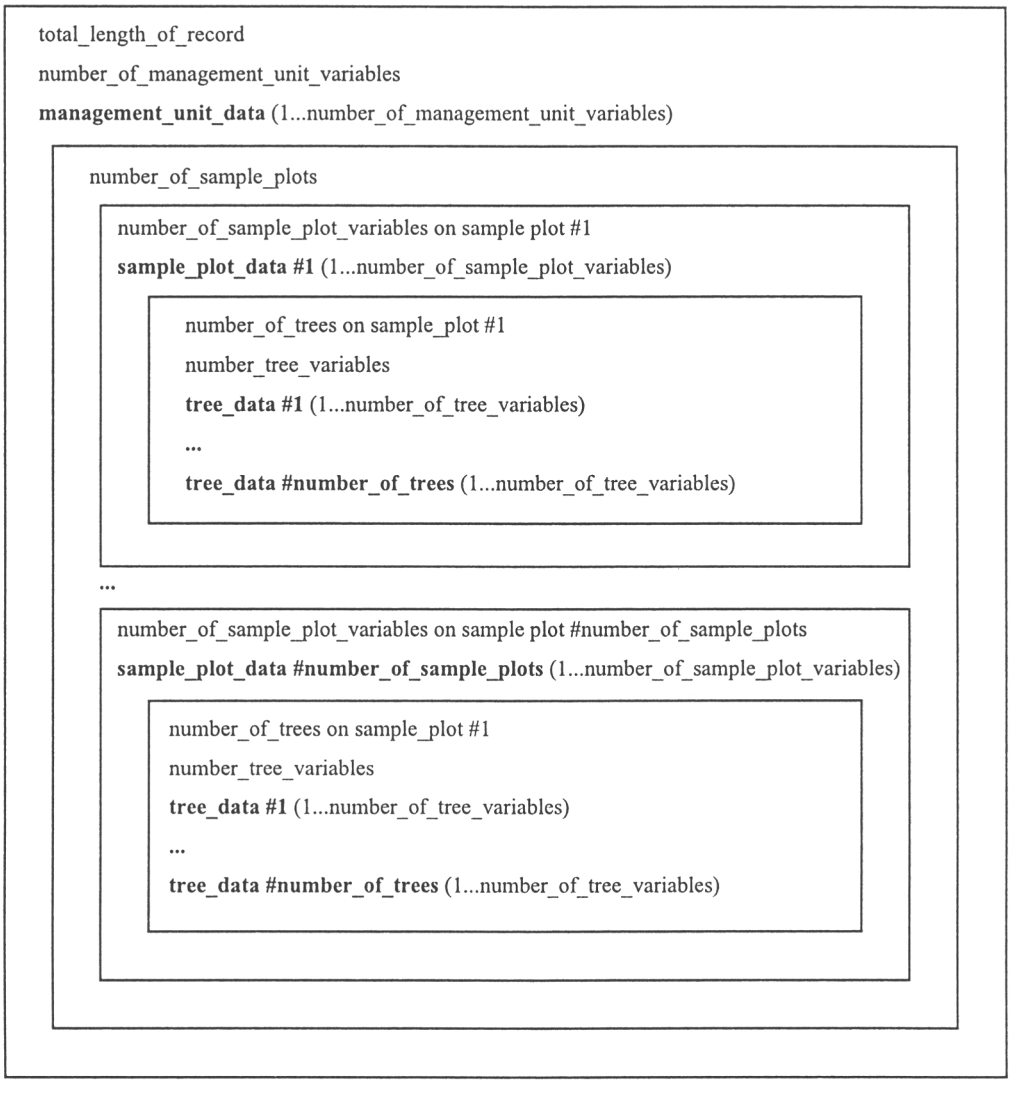

Figure D.3. The structure of the simulation record.

Sample plot variables of simulation data (Finnish version)

NOTE: The sample plot variables (1 - 23), (25 - 30), (70) and (72) come directly from the initial data.

(1) Identification number of the management unit (unique id in ascending order in each **rsd** type file; length must not override 7 digits)
(2) Year, a (that the sample plot data represents, for example, 1996)
(3) Actual area, ha (or 1000 ha on large areas)
(4) Area weight for growing stock, same value as (3) (except FNFI data)
-*(5) Y coordinate, km (the Finnish coordinate system)
-*(6) X coordinate, km (the Finnish coordinate system)
-*(7) Identification number of the stand (see the initial data record, variable (7))
(8) Height of the sample plot above sea level, m
(9) Actual temperature sum, dd (appropriate values in Finland 500 - 1 350 dd)
(10) Owner category (see the initial data record, variable (10))
(11) Land-use category (see the initial data record, variable (11))
(12) Soil and peatland category (see the initial data record, variable (12))
(13) Site type category (see the initial data record, variable (13))
*(14) Reduction of forest taxation class (see the initial data record, variable (14))
(15) Forest taxation class (see the initial data record, variable (15))
*(16) Drainage category (see the initial data record, variable (16))
*(17) Feasibility for drainage (see the initial data record, variable (17))
-(18) '0'
(19) Year of the last drainage, a
(20) Year of the last fertilization, a
(21) Year of the last soil surface preparation, a
(22) Feasibility for natural regeneration (see the initial data record, variable (22))
(23) Year of the last cleaning of regeneration area, a
-*(24) Simulated development class

0 land-use category other than forest land or unknown
1 treeless area
2 small seedling stand with over story
3 small seedling stand
4 advanced seedling stand with over story
5 advanced seedling stand
6 young thinning stand
7 advanced thinning stand
8 mature stand
9 seed tree stand
10 shelterwood stand
11 small seedling stand with protective over story
12 young thinning stand with over story

(25) Year of the last artificial regeneration, a
(26) Year of the last tending of young stand, a
(27) Year of the last pruning, a
(28) Year of the last cutting, a
(29) Forestry Board District (default values in Finland, see the initial data record, variable (29))

(30) Forest management category (see the initial data record, variable (30))

DOMINANT STORY (variables (31) - (40))

(31) Number of stems/ha (including small trees)
(32) Dominant tree species (see the tree variables of the initial data record, variable (2))
(33) Mean age, a
(34) Volume, m^3/ha
(35) Basal area, m^2/ha
(36) Mean diameter, cm
(37) Mean height, m
(38) Saw log volume, m^3/ha
(39) Value, FIM/ha
(40) Volume of commercial timber, m^3/ha

SECONDARY STORY (variables (41) - (50))

(41) Number of stems/ha (including small trees)
(42) Dominant tree species (see the tree variables of the initial data record, variable (2))
(43) Mean age, a
(44) Volume, m^3/ha
(45) Basal area, m^2/ha
(46) Mean diameter, cm
(47) Mean height, m
(48) Saw log volume, m^3/ha
(49) Value, FIM/ha
(50) Volume of commercial timber, m^3/ha

(51) Basal area of pine, m^2/ha (dominant story) - not in use -
(52) Basal area of spruce, m^2/ha (dominant story) - not in use -
(53) Basal area of silver birch, m^2/ha (dominant story) - not in use -
(54) Basal area of downy birch, m^2/ha (dominant story) - not in use -
(55) Basal area of other deciduous, m^2/ha (dominant story) - not in use -
(56) Dominant height of pine, m (dominant story) - not in use -
(57) Dominant height of spruce, m (dominant story) - not in use -
(58) Dominant height of silver birch, m (dominant story) - not in use -
(59) Dominant height of downy birch, m (dominant story) - not in use -
(60) Dominant height of other deciduous, m (dominant story) - not in use -
(61) Net increment, m^3/ha/a
(62) Net value increment, m^3/ha/a
(63) Removal, m^3/ha/a
(64) Increment, dominant story, m^3/ha/a
(65) Increment, secondary story, m^3/ha/a
*(66) Method of the last draining
*(67) Method of the last fertilization
*(68) Method of the last soil surface preparation
*(69) Method of the last artificial regeneration

(70) Method of the last cutting (see the initial data record, variable (31))
*(71) (for system use only)
(72) Municipality code (see the initial data record, variable (32))
*(73) - not in use -
*(74) - not in use -
(75) - not in use -
(76) Volume of pine, m^3/ha
(77) Volume of spruce, m^3/ha
(78) Volume of birch, m^3/ha
(79) Volume of other deciduous, m^3/ha
(80) Total volume, m^3/ha
(81) Increment of pine, m^3/ha/a
(82) Increment of spruce, m^3/ha/a
(83) Increment of birch, m^3/ha/a
(84) Increment of other deciduous, m^3/ha/a
(85) Total increment, m^3/ha/a
(86) Cutting removal of pine, m^3/ha/a
(87) Cutting removal of spruce, m^3/ha/a
(88) Cutting removal of birch, m^3/ha/a
(89) Cutting removal of other deciduous, m^3/ha/a
(90) Total cutting removal, m^3/ha/a

Tree variables of simulation data (Finnish version)

NOTE: The values of the tree variables (2), (18) and (23) - (26) come directly from the initial data.

(1) Number of stems/ha (that the tree represents)
(2) Tree species (see the tree variables of the initial data record, variable (2))
(3) Diameter at 1.3 m height, cm
(4) Height, m
(5) Basal area at 1.3 m height, m^2
(6) Age at 1.3 m height, a
(7) Initial volume, m^3
(8) Current volume, m^3
(9) Biological age, a
(10) Volume, saw timber, m^3
(11) Volume, pulpwood, m^3
(12) Value, FIM
-(13) Reduction to the model-based saw log volume (relative value 0.0 - 1.0)
(14) Simulated story

1 dominant 2 secondary

-(15) Pruned height (0 = no pruning)
-(16) Age at 1.3 m height when reached 10 cm diameter, a
(17) - not in use -
(18) Origin (see the tree variables of the initial data record, variable (10))
(19) Volume of commercial timber (saw log and pulpwood), m^3

(20) (for system use only)
(21) (for system use only)
(22) (for system use only)
(23) Identification number of the tree on the sample plot
(default: number of order on the sample plot)
-(24) Direction of the tree from the origo of sample plot, in degrees
-(25) Distance of the tree from the origo of sample plot, m
-(26) Height difference of the tree from the origo of sample plot, m

Generation

Simulation records are generated by MELA routines.

Instructions

If necessary, simulation records can be stored in **smr** type files for further processing by other programs, see Appendix C.2. The simulation data in **smr** type files may also be used as forest resource data for simulation, instead of initial data. However, the extension **smr** in the filename needs to be manually changed to the extension **rsd**.

> NOTE: Management unit records are currently not stored in **smr** type files, limiting the applicability of the **smr** type files as forest resource data.

D.4 Decision Data Record (management schedules in msc and msd type files)

Functions

Decision data records are used to transfer a selection of decision variables from MELASIM to MELAOPT via **msc** and **msd** type files.

Decision variables are generated for all years (states) or sub-periods (events) defined by the YEARS parameter, see Appendix B.2. For the naming of decision variables for optimization problems, see **mdl** type files in Appendix C.2.

Notice that the values of the decision variables represent the whole management units, not per hectare values.

> NOTE: The variables of the decision data record are called x variables in JLP terms. For JLP x variables, see Lappi (1992).

Structure

Decision data records are compressed floating-point vectors that are processed by MELA routines. A decision data record contains the selected decision variables (see the variables below and the MSD_VARIABLES parameter in Appendix B.2) for the sub-periods (see the YEARS parameter in Appendix B.2) of a management schedule in a management unit (see initial data (**rsd** type) files in Appendix C.2).

Variables

> NOTE: The variables below are for timberland if not mentioned otherwise. See the TIMBER_PRODUCTION_LAND parameter in Appendix B.2 and the sample plot variable (30) of the initial data record in Appendix D.1.

001-007 Cutting area by cutting method (7), ha/a

001	thinnings, total
002	clear cutting
003	(first) thinning (number of stems/ha instructions)
004	over story removal
005	seed tree cutting (natural regeneration for pine)
006	shelterwood cutting (natural regeneration for spruce)
007	TOTAL

008 Tending of young stands, ha/a
009 Clearing of regeneration areas, ha/a
010 Soil surface preparation, ha/a

011-015 Artificial regeneration area by tree species categories (5), ha/a

011	pine
012	spruce
013	birch
014	other deciduous
015	TOTAL

016-020 Seeding area by tree species categories (5), ha/a

016	pine
017	spruce
018	birch
019	other deciduous
020	TOTAL

021-025 Planting area by tree species categories (5), ha/a

021	pine
022	spruce
023	birch
024	other deciduous
025	TOTAL

026 Supplementary planting area, ha/a
027 Pruning area, ha/a
028 - not used -
029 Fertilization area, ha/a
030 Natural regeneration area, ha/a

031-035 Regeneration area by tree species categories (5), ha/a

031	pine
032	spruce
033	birch
034	other deciduous
035	TOTAL

036-038 Drainage area, ha/a

036	new drainage
037	re-drainage
038	TOTAL

039 Increment of the dominant story, m^3/a

040-047 Costs by owner categories (4) and cutting methods (2), FIM/a

private	company	state	TOTAL	
040	041	042	043	thinnings
044	045	046	047	regeneration cuttings

048-055 Manpower by owner categories (4) and cutting methods (2), d/a

private	company	state	TOTAL	
048	049	050	051	thinnings
052	053	054	055	regeneration cuttings

056-060 Increment of trees generated during simulation by tree species categories (5), m^3/a

056	pine
057	spruce
058	birch
059	other deciduous
060	TOTAL

061-065 Removal of trees generated during simulation by tree species categories (5), m^3/a

061	pine
062	spruce
063	birch
064	other deciduous
065	TOTAL

066-090 Increment by diameter classes (5) and tree species categories (5), m^3/a

diameter, cm	-10	11-20	21-30	31-	TOTAL	
	066	071	076	081	086	pine
	067	072	077	082	087	spruce
	068	073	078	083	088	birch
	069	074	079	084	089	other deciduous
	070	075	080	085	090	TOTAL

091-100 Increment on forest land by age classes (10), m^3/a

	age, a
091	0
092	1-20
093	21-40
094	41-60
095	61-80
096	81-100
097	101-120
098	121-140
099	141-
100	TOTAL

101-110 Total drain by forest management categories (see the MANAGEMENT_CATEGORY_GROUPS parameter in Appendix B.2 and the sample plot variable (30) of initial data in Appendix D.1) (10), m^3/a

111-120 Cutting removal by forest management categories (see the MANAGEMENT_CATEGORY_GROUPS parameter in Appendix B.2 and the sample plot variable (30) of initial data in Appendix D.1) (10), m^3/a

121-195 Cutting removal by diameter classes (5), timber assortments (3) and tree species categories (5), m^3/a (see the D_CLASSES_IN_REMOVAL parameter in Appendix B.2)

diameter,cm -10	11-20	21-30	31-	TOTAL	
121	136	151	166	181	saw log, pine
122	137	152	167	182	pulpwood, pine
123	138	153	168	183	TOTAL, pine
124	139	154	169	184	saw log, spruce
125	140	155	170	185	pulpwood, spruce
126	141	156	171	186	TOTAL, spruce
127	142	157	172	187	saw log, birch
128	143	158	173	188	pulpwood, birch
129	144	159	174	189	TOTAL, birch
130	145	160	175	190	saw log, other deciduous
131	146	161	176	191	pulpwood, other deciduous
132	147	162	177	192	TOTAL, other deciduous
133	148	163	178	193	saw log
134	149	164	179	194	pulpwood
135	150	165	180	195	TOTAL

196-255 Cutting removal by owner categories (4), timber assortments (3) and tree species categories (5), m^3/a

private	company	state	TOTAL	
196	211	226	241	saw log, pine
197	212	227	242	pulpwood, pine
198	213	228	243	TOTAL, pine
199	214	229	244	saw log, spruce
200	215	230	245	pulpwood, spruce
201	216	231	246	TOTAL, spruce
202	217	232	247	saw log, birch
203	218	233	248	pulpwood, birch
204	219	234	249	TOTAL, birch
205	220	235	250	saw log, other deciduous
206	221	236	251	pulpwood, other deciduous
207	222	237	252	TOTAL, other deciduous
208	223	238	253	saw log
209	224	239	254	pulpwood
210	225	240	255	TOTAL

256-275 Cutting removal by tree species categories (5) and cutting methods (4), m^3/a

thinning	regeneration cutting	over story removal	TOTAL	
256	261	266	271	pine
257	262	267	272	spruce
258	263	268	273	birch
259	264	269	274	other deciduous
260	265	270	275	TOTAL

276-285 Cutting removal by tree species categories (5) and soil types (2), m^3/a

mineral soil	peatland	
276	281	pine
277	282	spruce
278	283	birch
279	284	other deciduous
280	285	TOTAL

286-290 Total drain on forestry land by tree species categories (5), m^3/a

286	pine
287	spruce
288	birch
289	other deciduous
290	TOTAL

291-325 Cutting removal by tree species categories (5) and soil fertility categories (7) (see the sample plot variable (15) of initial data record in Appendix D.1), m^3/a

-rich sites	damp sites	sub-dry sites	dry sites	barren sites	scrub land	TOTAL	
291	296	301	306	311	316	321	pine
292	297	302	307	312	317	322	spruce
293	298	303	308	313	318	323	birch
294	299	304	309	314	319	324	other deciduous
295	300	305	310	315	320	325	TOTAL

326 Increment of saw log volume, m^3/a
327 Increment of pulpwood volume, m^3/a
328 Increment of logging residue, m^3/a
329 Increment of commercial timber, m^3/a
330 Increment of basal area, m^2/a

331-335 Logging residue by tree species categories (5), m^3/a

331	pine
332	spruce
333	birch
334	other deciduous
335	TOTAL

336-340 Cutting drain by tree species categories (5), m^3/a

336	pine
337	spruce
338	birch
339	other deciduous
340	TOTAL

341-345 Waste wood by tree species categories (5), m^3/a

341	pine
342	spruce
343	birch
344	other deciduous
345	TOTAL

346-350 Total drain by tree species categories (5), m^3/a

346	pine
347	spruce
348	birch
349	other deciduous
350	TOTAL

351-360 Mortality by forest management categories (see the MANAGEMENT_CATEGORY_GROUPS parameter in Appendix B.2 and the sample plot variable (30) of initial data in Appendix D.1) (10), m^3/a

361-365 Mortality by tree species categories (5), m3/a

361	pine
362	spruce
363	birch
364	other deciduous
365	TOTAL

366 Silviculture costs, FIM/a
367 Forest improvement costs, FIM/a
368 Silviculture manpower, d/a
369 Forest improvement manpower, d/a
370 Net revenues, FIM/a (for details, see Appendix E)
371-380 Increment by forest management categories (see the MANAGEMENT_CATEGORY_GROUPS parameter in Appendix B.2 and the sample plot variable (30) of initial data in Appendix D.1) (10), m^3/a

381-384 Increment by owner categories (4), m^3/a

381	private
382	company
383	state
384	TOTAL

385 Increment of secondary story, m^3/a

386-390 Net increment by tree species categories (5), m^3/a

386	pine
387	spruce
388	birch
389	other deciduous
390	TOTAL

391-400 Increment by tree species categories (5) and soil types (2), m^3/a

mineral soil	peatland	
391	396	pine
392	397	spruce
393	398	birch
394	399	other deciduous
395	400	TOTAL

401-405 Total increment on forestry land by tree species categories (5), m^3/a

401	pine
402	spruce
403	birch
404	other deciduous
405	TOTAL

406-440 Increment by tree species categories (5) and soil fertility categories (7) (see the sample plot variable (15) of initial data record in Appendix D.1), m^3/a

-rich sites	damp sites	sub-dry sites	dry sites	barren sites	scrub land	TOTAL	
406	411	416	421	426	431	436	pine
407	412	417	422	427	432	437	spruce
408	413	418	423	428	433	438	birch
409	414	419	424	429	434	439	other deciduous
410	415	420	425	430	435	440	TOTAL

441-445 Saw log removal of the trees generated during simulation by tree species categories (5), m^3/a

441	pine
442	spruce
443	birch
444	other deciduous
445	TOTAL

446-450 Net value increment by tree species categories (5), FIM/a (for details, see Appendix E)

446	pine
447	spruce
448	birch
449	other deciduous
450	TOTAL

451-474 Costs by owner categories (4) and forest management activities (6), FIM/a

private	company	state	TOTAL	
451	452	453	454	logging
455	456	457	458	regeneration
459	460	461	462	tending and pruning
463	464	465	466	drainage
467	468	469	470	fertilization
471	472	473	474	TOTAL

475-494 Manpower by owner categories (4) and forest management activities (6), d/a

private	company	state	TOTAL	
475	476	477	478	logging
479	480	481	482	regeneration
483	484	485	486	tending and pruning
487	488	489	490	drainage
491	492	493	494	fertilization
495	496	497	498	TOTAL

499 Gross income (roadside prices), FIM/a (for details, see Appendix E)

500 Gross income (stumpage prices), FIM/a (for details, see Appendix E)

501-510 Forest land area by age classes (10), ha

	age, a
501	0
502	1-20
503	21-40
504	41-60
505	61-80
506	81-100
507	101-120
508	121-140
509	141-
510	TOTAL

511-516 Area by owner categories (6), ha

511	private
512	company
513	state
514	municipality
515	community
516	TOTAL

517-537 Area by soil fertility categories (7) (see the sample plot variable (15) of initial data record in Appendix D.1) and soil types (3), ha

mineral soil	peatland	TOTAL	
517	524	531	-rich sites
518	525	532	damp sites
519	526	533	sub-dry sites
520	527	534	dry sites
521	528	535	barren sites
522	529	536	scrub land
523	530	537	TOTAL

538-540 - not used -

541-550 Forestry land area by forest management categories (see the MANAGEMENT_CATEGORY_GROUPS parameter in Appendix B.2 and the sample plot variable (30) of initial data in Appendix D.1) (10), ha

551-555 Total volume on forestry land by tree species categories (5), m^3

551	pine
552	spruce
553	birch
554	other deciduous
555	TOTAL

556-593 - not used -

594-599 Area by dominant tree species categories (5), ha

594	open area
595	pine
596	spruce
597	birch
598	other deciduous
599	TOTAL

600 Area of stands generated during simulation, ha

601-700 Volume by diameter classes (5), timber assortments (4) and tree species categories (5), m^3

diameter, cm -10	11-20	21-30	31-	TOTAL	
601	621	641	661	681	saw log, pine
602	622	642	662	682	pulpwood, pine
603	623	643	663	683	waste wood, pine
604	624	644	664	684	TOTAL, pine
605	625	645	665	685	saw log, spruce
606	626	646	666	686	pulpwood, spruce
607	627	647	667	687	waste wood, spruce
608	628	648	668	688	TOTAL, spruce
609	629	649	669	689	saw log, birch
610	630	650	670	690	pulpwood, birch
611	631	651	671	691	waste wood, birch
612	632	652	672	692	TOTAL, birch
613	633	653	673	693	saw log, other deciduous
614	634	654	674	694	pulpwood, other deciduous
615	635	655	675	695	waste wood, other deciduous
616	636	656	676	696	TOTAL, other deciduous
617	637	657	677	697	saw log
618	638	658	678	698	pulpwood
619	639	659	679	699	waste wood
620	640	660	680	700	TOTAL

701-730 Volume by tree species categories (5) and owner categories (6), m^3

private	company	state	municip.	community	TOTAL	
701	706	711	716	721	726	pine
702	707	712	717	722	727	spruce
703	708	713	718	723	728	birch
704	709	714	719	724	729	other deciduous
705	710	715	720	725	730	TOTAL

731-765 Volume by site types (7) and tree species categories (5), m^3

-rich sites	damp sites	sub-dry sites	dry sites	barren sites	scrub land	TOTAL	
731	736	741	746	751	756	761	pine
732	737	742	747	752	757	762	spruce
733	738	743	748	753	758	763	birch
734	739	744	749	754	759	764	other deciduous
735	740	745	750	755	760	765	TOTAL

766-770 - not used -

771-785 Volume by soil types (3) and tree species categories (5), m^3

mineral soil	peatland	TOTAL	
771	776	781	pine
772	777	782	spruce
773	778	783	birch
774	779	784	other deciduous
775	780	785	TOTAL

786-795 Volume by forest management categories (see the MANAGEMENT_ CATEGORY_GROUPS parameter in Appendix B.2 and the sample plot variable (30) of initial data in Appendix D.1) (10), m^3

796-800 Value of the growing stock (roadside prices) by tree species categories (5), FIM (for details, see Appendix E)

796	pine
797	spruce
798	birch
799	other deciduous
800	TOTAL

801-805 Net present value from actual subperiod by discount factors (5), FIM (for details, see Appendix E)

NOTE: Net present values (801, 802, etc.) can be calculated only if the variables (801) and (806), (802) and (807), etc. are pairwise present for each desired discount factor in a decision data record. The default discount factors are 1, 2, 3, 4 and 5 %. For user-supplied discount factors, see the DISCOUNT_RATES parameter in Appendix B.2.

801	1 %
802	2 %
803	3 %
804	4 %
805	5 %

806-810 Discounted net income on each subperiod by discount factors (5), FIM

NOTE: The variables (806 - 810) are auxiliary information only for the calculation of the net present value, see the NOTE above. They are not intended for direct user purposes. The default discount factors are 1, 2, 3, 4 and 5 %. For user-supplied discount factors, see the DISCOUNT_RATES parameter in Appendix B.2.

806	1 %
807	2 %
808	3 %
809	4 %
810	5 %

811-815 Land value by discount factors (5), FIM (in specific applications only, see the item (17) of the SIMULATION_CONTROL parameter in Appendix B.2)

811	1 %
812	2 %
813	3 %
814	4 %
815	5 %

816 Total yield, m^3 (for details, see Appendix E)
817 Total returns, FIM (for details, see Appendix E)
818 Summarized costs over the calculation period, FIM
819 Summarized net revenues over the calculation period, FIM
820 Summarized revenues (stumpage prices) over the calculation period, FIM
821 Summarized manpower over the calculation period, d
822 Returns per sub-period, FIM (for details, see Appendix E)
823 Cutting value of the growing stock, FIM (for details, see Appendix E)
824-830 - not used -

831-835 Basal area by tree species categories (5), m^2

831	pine
832	spruce
833	birch
834	other deciduous
835	TOTAL

836-840 Summarized saw log removal over calculation period by tree species categories (5), m^3

836	pine
837	spruce
838	birch
839	other deciduous
840	TOTAL

841-845 Saw log volume of trees generated during simulation by tree species categories (5), m^3

841	pine
842	spruce
843	birch
844	other deciduous
845	TOTAL

846-850 Stumpage price value of the growing stock by tree species categories (5), FIM

846	pine
847	spruce
848	birch
849	other deciduous
850	TOTAL

851-900 Volume on forest land by tree species categories (5) and age classes (10), m^3

pine	spruce	birch	other deciduous	TOTAL	age, a
851	852	853	854	855	0
856	857	858	859	860	1-20
861	862	863	864	865	21-40
866	867	868	869	870	41-60
871	872	873	874	875	61-80
876	877	878	879	880	81-100
881	882	883	884	885	101-120
886	887	888	889	890	121-140
891	892	893	894	895	141-
896	897	898	899	900	TOTAL

901-905 Initial volume of trees existing in initial data, m^3

901	pine
902	spruce
903	birch
904	other deciduous
905	TOTAL

906-910 Actual volume of trees existing in initial data, m^3

906	pine
907	spruce
908	birch
909	other deciduous
910	TOTAL

911-915 Summarized increment over the calculation period by tree species categories (5), m^3

911	pine
912	spruce
913	birch
914	other deciduous
915	TOTAL

916-920 Summarized total drain over the calculation period by tree species categories (5), m^3

916	pine
917	spruce
918	birch
919	other deciduous
920	TOTAL

921-925 Summarized cutting removal over the calculation period by tree species categories (5), m^3

921	pine
922	spruce
923	birch
924	other deciduous
925	TOTAL

926-930 Summarized value increment over the calculation period by tree species categories (5), FIM

926	pine
927	spruce
928	birch
929	other deciduous
930	TOTAL

931-935 Summarized net revenues over the calculation period by tree species categories (5), FIM

931	pine
932	spruce
933	birch
934	other deciduous
935	TOTAL

936-940 Volume of the trees generated during simulation by tree species categories (5), m^3

936	pine
937	spruce
938	birch
939	other deciduous
940	TOTAL

941-970 - not used -

971-975 Volume of dominant story by tree species categories (5), m^3

971	pine
972	spruce
973	birch
974	other deciduous
975	TOTAL

976-980 Volume of secondary story by tree species categories (5), m^3

976	pine
977	spruce
978	birch
979	other deciduous
980	TOTAL

981-985 Saw log volume of dominant story by tree species category (5), m^3

981	pine
982	spruce
983	birch
984	other deciduous
985	TOTAL

986-990 Saw log volume of secondary story by tree species category (5), m^3

986	pine
987	spruce
988	birch
989	other deciduous
990	TOTAL

991-1000 Random numbers from even distribution (values 0.0 - 1.0)

Generation

Decision data records are generated by MELA routines.

Instructions

The variables of decision data records represent the whole management units. They are not per hectare values. In further processing, the variables are as such summarized over the whole forestry unit.

Only a limited number of decision variables can be usually stored in **msd** type files. Users should select the variables of their MELA applications according to the actual analysis and reporting needs.

Decision data records and **msd** type files should be processed using MELA routines only because of the double compressed internal structure of the decision data record.

D.5 Management Schedule Record (selected simulation variables in msc and msd type files)

Functions

The management schedule record is a collection of management unit or sample plot variables from simulation records (see Appendix D.3) at selected points of time for further use in user routines.

Structure

The management schedule record is a fixed-length floating-point vector, see Figure D.4.

management_schedule_data (1...number_of_variables)

Figure D.4. The structure of the management schedule record.

The logical record type of management schedule records in MSB format files is 3 (see Appendix G).

Variables

A management schedule record consists of user-defined management unit variables from the simulation record, see the MSR_VARIABLES parameter in Appendix B.2.

Generation

Management schedule records are generated and stored in MELASIM (see the MSR_VARIABLES parameter and the item (1) of the OUTPUT parameter in Appendix B.2) in **msc** and **msd** type files (see Appendix C.2).

Instructions

The variables in management schedule records are expressed in per hectare values in the beginning of each year in question (before any events). See the parameters MSR_VARIABLES and YEARS in Appendix B.2.

The variables of the management schedule records are often transferred via MELAOPT to management report records (see Appendix D.6) of the selected management schedules and further to **mps** type files (see Appendix C.2, the MPS_VARIABLES parameter in Appendix B.2 and the MELAOPT command REPORT SUMMARY in Chapter 3.5.2.2).

Management schedule records can be generated also in the re-simulation of the selected management schedules. Notice that **msc** and **msd** type files will get in the re-simulation the same names as in the simulation of optional management schedules; rename existing **msc** and **msd** type files before the re-simulation, if they should be saved.

D.6 Management Report Record (management unit variables in mps type files)

Functions

The management report record is a collection of variables from decision data records (see Appendix D.4) and management schedule records (see Appendix D.5) for the management schedules selected in a MELAOPT solution. Management report records are stored by request in **mps** type files for further processing in user routines, for example for transferring into the forest database.

Structure

The management report record is a fixed-length floating-point vector, see Figure D.5.

management_report_data (1...number_of_variables)

Figure D.5. The structure of the management report record.

The logical record type of management report records in MSB format files is 4 (see Appendix G).

Variables

A management report record consists of user-defined selection of simulation and decision variables, see the MPS_VARIABLES parameter in Appendix B.2.

Generation

Management report records are generated and stored by MELAOPT in **mps** type files (see Appendix C.2).

Instructions

For the variables of management report records stored in **mps** type files, see Appendix C.2 and the MELAOPT command REPORT SUMMARY in Chapter 3.5.2.2.

The variables in management schedule records are expressed in per hectare values while the variables in decision data records are expressed in absolute values for each management unit. All the values to the management schedule records are collected in the beginning of each year in question (before any events).

D.7 Simulation Instruction Record (for individual management units in sms type files)

Functions

Several kinds of detailed simulation instructions can be provided for each individual management unit in MELASIM, besides the general event definitions for simulation. These instructions are stored in simulation instruction records of **sms** type files. The general event definitions in **par** type files control the automated simulation of management schedules.

Where found, the simulation instructions are obeyed instead or before the general event definitions. By means of the simulation instructions, user can also control how simulation instructions and general event definitions are combined.

Simulation instructions for individual management units are needed, for example

- to simulate the management proposals provided in field inventory, and
- to control the re-simulation of the selected management schedules.

simulation_instruction_data (1...number_of_variables)
(1) validity of the instruction record
'0' temporary, instructions are valid for the actual management unit only
'1' continuous, instructions are valid for all the following management units until a new simulation instruction record is found
(2) instruction category
'0'
(3) record type
'0'

repeated section(s) for each event to be simulated

(1) number of the items in this section (this item excluded)
(2) event_identification code, see the event definitions of the simulation application
(3) branching instruction for this event
'-1' branching or options for this event are not allowed
'0' branching instruction obtained from actual event definition being called
'1' branching or options for this event are allowed

For an introduction to the branching concept in the simulation of management schedules, see the item (4) of the EVENT parameter in Appendix B.2. Notice also the different definitions here.

Figure D.6. The structure of the simulation instruction record.

Structure

The MELA simulation instruction record is a variable-length floating-point vector, see Figure D.6.

> NOTE: Simulation instruction records may contain also some experimental instructions not described here.

The logical record type of simulation instruction records in MSB format files is 5 (see Appendix G).

Variables

Simulation instruction records for each management unit consist of user-defined information, see Figure D.6.

Generation

Re-simulation instructions

In the simulation of management schedules, the simulation instructions for each management schedule are automatically generated and stored by request in **msd** type files (see the RE_SIMULATION_INSTRUCTIONS parameter). The simulation instructions for the selected management schedules in each MELAOPT solution are transferred from MELAOPT (see the REPORT SUMMARY command) via **sms** type files to the re-simulation in MELASIM (see the **instructions** argument of the SIMULATE command in Chapter 3.4.2.1).

Instructions to simulate standwise management proposals

The instructions to simulate the management proposals provided in field inventory are generated by dedicated user programs (see also Appendix C.2 for the naming of **sms** type files and the argument instructions of the SIMULATE command in Chapter 3.4.2.1). Contact the MELA Team for auxiliary routines.

Instructions

Simulation instruction records can be provided also for some of the management units only. The order of the simulation instruction records in a **sms** type file must follow the order of the management units in a **rsd** type file.

In simulation instruction records, all the events appearing in the actual event definitions can be called, also those temporarily excluded from automatically controlled simulation. As well, users may define dedicated events available via simulation instruction records only, for example, specific management operations for user-specified management units.

D.8 Summary Report Definition Record (row generation instructions in tab type files)

Functions

Summary report definition records are used in **tab** type files to select decision variables and to describe the rows of MELA summary reports generated into **sum** type files (see Appendix C.2).

Structure

The MELA summary report definition record is a character string with the following structure.

```
VVVVEEEETTTTtext
```

VVVV the row type and the identification of the decision variable is a right justified integer (four characters) having one of the following values:

- -9 a pager row containing text '<>MELA<>'
- -4 a heading containing the names of the forestry unit and the optimization problem, if available
- -2 a row showing the years of the calculation period and its sub-periods defined by the YEARS parameter in the original simulation, see Appendix B.2
- -1 a row filled with the first character of **text**
- 0 a row containing **text** only
- 1 to 1000 a row containing the values of a decision variable (1) - (1000) over the calculation period, see Appendix D.4
- >1000 the end of a **tab** type file

EEEE the expression type is a right justified integer (four characters) having one of the following values:

- 0 a value of the decision variable (VVVV) is expressed in absolute terms (or as such)

-1 to -1000 the value of the decision variable (VVVV) is expressed in relative terms (or percentages) compared with the value of the decision variable (EEEE) on the same sub-period

1 to 1000 the value of the decision variable (VVVV) is expressed in relative terms (or percentages) compared with the value of the decision variable (EEEE) in the beginning of the calculation period or on the first sub-period

>1000 the value of the decision variable (VVVV) is expressed in relative terms (or percentages) compared with the value of the same decision variable at the end of the calculation period or on the last sub-period

TTTT the variable type is a right justified integer (four characters) having one of the following values:

decision variables describing states

1 a decision variable (VVVV) in absolute terms

2 a decision variable (VVVV) in relative terms

3 years for decision variables in relative terms

4 years for decision variables in absolute terms

NOTE: Decision variables describing states appear exactly below their respective years at the columns of a report.

decision variables describing events

-1 a decision variable (VVVV) in absolute terms

-2 a decision variable (VVVV) in relative terms

-3 years for decision variables in relative terms

-4 years for decision variables in absolute terms

NOTE: Decision variables describing events appear between their respective years in the columns of report.

`text` user-supplied character string appearing in the beginning of row, the maximum is 60 characters

See Examples H.3 and H.4.

Notice the specific exponential expressions in MELA solution and summary reports. Bigger values than 7 digits are expressed by the notation *a*n* where *a* is a numerical value and *n* is 3 to 9 referring to the number of zeros to be added to the value *a*. For example, 12345*4 should be interpreted as 123 450 000.

Variables

See the structure definitions above.

Generation

Summary report definition records are generated by a text editor or user routines.

Instructions

Design summary reports in accordance with the actual needs in order to facilitate the interpretation of the results. Existing **tab** type files may serve a starting point.

For the actual availability of decision variables, see the MSD_VARIABLES parameter in Appendix B.2. See also Chapter 4.6.7.

D.9 Optimum Solution Record (selected management schedules in mps type files)

Functions

Optimum solution records contain information about the management schedules selected in a MELAOPT solution for management units. Optimum solution records are stored by request in **mps** type files for further processing in user routines, for example, for transferring into the forest database.

Structure

The optimum solution is a fixed-length floating-point vector, see Figure D.7.

optimum_solution_data (1...2)

Figure D.7. The structure of the optimum solution record.

The logical record type of optimum solution records in MSB format files is 6 (see Appendix G).

Variables

(1) number of the selected management schedule (in the **msd** type file)
(2) proportion of the selected management schedule in the solution

Generation

Management report records are generated and stored by MELAOPT in **mps** type files (see Appendix C.2).

Instructions

For storing of the optimum solution records into **mps** type files, see Appendix C.2 and the MELAOPT command REPORT SUMMARY in Chapter 3.5.2.2.

Appendix E

Some MELA Decision Variables

Appendix E provides an introduction to a selection of MELA decision variables.

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Appendix E

Some MELA Decision Variables

NOTE: The linear combinations of MELA decision variables can be used in a JLP problem formulation, consider, for example, the calculation of such integrated decision variables over the calculation period as (801) - (805), (816) and (817).

NOTE: Numbers in the brackets refer to the MELA decision variables introduced in Appendix D.4.

(370) Net revenues

Average annual net incomes earned during each sub-period, i.e. incomes from timber sales (decision variable (499), gross income applying roadside prices) minus total costs (decision variable (474), costs of logging, costs of silviculture and costs of forest improvement) occurred during the sub-period in question.

(446) - (450) Net value increment

The average net value increment per year during a sub-period is summarized by tree species. The net value increment is calculated as the value of the growth of trees minus the value of the trees died during the sub-period. The net value increment is calculated using roadside prices.

The net value increment is comparable with the decision variables (796) - (800), value of the growing stock and (499), gross income (roadside prices). See also the parameters ROADSIDE_PRICES and ROADSIDE_LOG_PRICE_ADJUSTMENT in Appendix B.2.

(499) Gross income (roadside prices)

The average gross incomes from timber sales per year during a sub-period. The variable consists of the value of timber and implicitly the value of logging and hauling this timber, i.e. the gross value of cutting removal at the road side.

Gross income (roadside prices) is comparable with

- decision variables (796) - (800), values of the growing stock, and (450), net value increment, and
- sample plot and management unit variables (39), (49), values of the tree, and (62), net value increment, of the simulation record, and
- tree variable (12), stem value, of the simulation record.

See also the ROADSIDE_PRICES and ROADSIDE_LOG_PRICE_ADJUSTMENT parameters in Appendix B.2.

(500) Gross income (stumpage prices)

The average gross value of cutting removal per year on stumpage is calculated during a sub-period. The variable gives the "pure" value of timber.

The gross income (stumpage prices) is comparable with the decision variables (846) - (850), the stumpage value of the growing stock. See also the STUMPAGE_PRICES parameter in Appendix B.2.

(796) - (800) Value of the growing stock

The gross value of the growing stock by tree species in the beginning of a sub-period is evaluated from the trees of the simulation record (see Appendix D.3) using roadside prices (see the ROADSIDE_PRICES and ROADSIDE_LOG_PRICE_ADJUSTMENT parameters in Appendix B.2).

The value of the growing stock (roadside prices) is comparable with

- decision variables (499), gross income (roadside prices), and (450), net value increment, and
- sample plot and management unit variables (39) and (49), values of the tree, and (62), net value increment, of the simulation record, and
- tree variable (12), stem value, of the simulation record.

(801) - (805) Net present value

Discounted future net revenues from the beginning of each sub-period are calculated using five optional interest rates.

Timber production process comprises a set of sequential actions, though the time interval between these actions can be long. A generally accepted way to manage time in forestry is to apply the net present value (NPV) method. In the calculation of the net present value, all predicted future incomes and costs are discounted to the present, compressing the whole future of the management schedule into one figure temporally weighted by the discount rate.

In the MELA system, the NPV is calculated for each management schedule applying the principles of the formula E.1. The NPV of the whole forestry unit is the sum of the management units. The net present value is sensitive to interest rate. In the MELA simulation, the NPV is calculated using five optional interest rates for easy comparisons, see the DISCOUNT_RATES parameter in Appendix B.2.

$$NPV = \frac{\sum_{t=q+1}^{T} R_t(1+i)^{T-t} - \sum_{t=q+1}^{T} C_t(1+i)^{T-t} + LV}{(1+i)^{T-q}}$$

NPV = net present value of future revenues
t = time
q = the present time of calculations
T = minimum rotation of a stand after the planning period or maximum time horizon, whichever is shorter
R_t = incomes at time *t* (road - side prices)
C_t = costs at time *t*
i = interest rate (*p* % / 100)
LV = value of bare land (soil expectation value)

Formula E.1. The principle of the calculation of the net present value.

The NPV in MELA consists of the following three components in order to take into account the infinite time horizon presumed by the NPV method:

- The revenues from cuttings (gross income with roadside prices) and costs due to silviculture, forest improvement and harvesting (see the decision variable (370)) during the calculation period

- The revenues and costs from the end of the calculation period until the end of the on-going rotation period. The simulation of each management schedule is continued by automatically selecting the first feasible event for each new state without alternatives until the regeneration criterion (either minimum rotation period or minimum mean diameter before regeneration, see the parameters MIN_REGENERATION_AGE and MIN_REGENERATION_DIAMETER in Appendix B.2) or the unconditional finish of the simulation period is met, see the item (15) of the SIMULATION_CONTROL parameter in Appendix B.2. In the latter case, the cutting value of the stand (see the decision variable (823)) is calculated instead of the regeneration of the forest.

- The value of bare land represents the revenues and the costs from the rotation periods after the simulation period, see the LAND_VALUES parameter in Appendix B.2.

Both in MELASIM and in MELAOPT, the NPV's or the decision variables (801) - (805) are calculated for the beginning of each sub-period on the basis of the decision variables (806) - (810), see Appendix D.4.

The NPV figures for the sub-periods refer to the future from the beginning of each sub-period on; the total NPV figure for the entire future is found at the beginning of the first sub-period.

> NOTE: Due to the simulation practice explained above, the NPV at the end of the calculation period is conceptually not fully compatible with the NPV in the beginning of the calculation period. This limits the validity of direct NPV comparisons over the calculation period.

(816) Total yield

Cumulative cutting removal (decision variable (195)) plus change of the volume of commercial timber from the beginning of the calculation period until the year in question. Commercial timber is the sum of saw log volume (decision variable (697)) and pulpwood volume (decision variable (698)). The total figure for the calculation period is found at the end of the last sub-period.

Total yield is comparable with all components of the cutting removal (for example, decision variable (195)), of saw log volume (for example, decision variable (697)) and of pulpwood volume (for example, decision variable (698)).

(817) Total returns

Total return is equal to cumulative net revenues (decision variable (370)) plus change of the cutting value (decision variable (823)) from the beginning of the calculation period until the year in question. The total figure for the calculation period is found at the end of the last sub-period.

(822) Returns per sub-period

This variable is a sum of the annual net revenues (decision variable (370)) and the change of the cutting value of growing stock (decision variable (823)) during each preceding sub-period.

Returns per period is comparable with the decision variable (817), cumulative total returns during the calculation period.

(823) Cutting value of growing stock

The value of the growing stock in the beginning of each sub-period is evaluated from the trees of the simulation record (see Appendix D.3) using roadside prices (see the parameters ROADSIDE_PRICES and ROADSIDE_LOG_PRICE_ADJUSTMENT in Appendix B.2) subtracted by the cost of clearcutting and the cost of clearing (see the SILVICULTURAL_COSTS parameter in Appendix B.2). The cutting value of the growing stock describes the current "net value" of forest excluding both land and future potentials.

The cutting value of the growing stock is comparable with the decision variable (800), value of the growing stock, and the decision variable (454), logging costs.

Appendix F

Selection of Trees in Treatments

Appendix F provides the details of the tree selection procedure applied in MELASIM.

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Appendix F

Selection of Trees in Treatments

F.1 Tree Selection Routine

Functions

In MELA, there is a general routine to select trees in treatments, for example, to be removed in cuttings or to be saved for the reason of biodiversity. The stepwise tree selection procedure is controlled by selection instructions. Selection instructions make it possible to define several details of the tree selection for different kinds of treatments. The default values for selection instructions are preset in the routines calling the tree selection, for example in cutting and pruning routines. In some cases, for example in thinnings, users can define also their own selection instructions via the EVENT_CALL item of the EVENT parameter in the user-supplied event definitions (see Appendix B.2). The user-supplied selection instructions for each event override the preset defaults.

Tree selection procedure

Trees are selected separately on each sample plot of a management unit (see the simulation data record in Appendix D.3) in the current MELA simulator. Selection instructions may be provided for one or several selection groups on a sample plot. The selection routine returns the number of stems selected for each tree of a sample plot to the calling routine for further processing.

The tree selection procedure on a sample plot proceeds by selection groups in the order of the actual selection instructions. In each selection group, the convergative iteration tries to reach the requested selection quantity (see specific EVENT_CALL arguments of the EVENT parameter for each basic event in Appendix B.2). The selection procedure stops immediately when the requested total quantity on the sample plot is reached, omitting the trees left in current selection group as well as the selection groups still left. If the selection routine fails to reach the requested quantity completely, a warning message is given and the current, more or less faulty selection is returned as a final result to the calling routine.

The selection priority of the trees in a selection group is determined by the selection factor (y) which depends on the value (x) of the actual priority variable in the priority function

$$y = ax + b$$

where a is the slope of the priority function, and b is determined iteratively by the selection routine on the basis of the requested selection quantity and the actual trees in the selection group. The value of slope in the priority function defines the selection principle, for example in thinnings, low thinning or high thinning if tree size is the actual priority variable (for details, see the selection instructions in Appendix F.2).

F.2 Selection Instructions

Selection instructions consist of

- overall selection range definitions for the whole sample plot, and
- a section for each different selection group on a sample plot.

The overall selection range is a set of trees which is determined by one or more overall selection criteria. If more than one criterion is given, the logical operator AND is applied between the given criteria. Furthermore, trees are selected from the overall selection range only.

Selection groups are sets of trees with their own selection instructions. Selection groups are defined via the tree variables of tree records, such as diameter, age, etc. The order of the groups in the selection instruction determines also the priority of the groups in the selection of the requested quantity.

The selection instructions for each selection group consist of two types of parameters:

- selection group definition (range variable and bounds), and
- selection parameters (priority variable, slope of the priority function and maximum intensity).

The selection instruction is a floating point vector having the following structure:

(1) number of following overall selection range criteria (i.e. groups of items (2) - (4))

parameters repeated for each overall selection range, items (2) - (4)

(2) index of the overall selection range variable in the tree record, see the tree variables in the simulation data record in Appendix D.3.

(3) lower bound for the overall selection range variable (lower and upper bounds define the interval from which the trees are selected)

(4) upper bound for the overall selection range variable (lower and upper bounds define the interval from which the trees are selected)

(5) number of following selection groups

selection instructions repeated for each selection group, items (6) - (11)

(6) index of the range variable of the selection group, see the tree variables in the simulation record in Appendix D.3.

'0' trees in the overall selection range and still left untouched in the previous selection groups (for the last selection group only)

(7) lower bound for the range variable of the selection group

- < 0 others than the absolute value of the lower bound are included in the selection process
- > 0 all values between the lower and upper bound (excluding bounds) are included in the selection process

(8) upper bound for the range variable of the selection group

- < 0 others than the absolute value of the upper bound are included in the selection process
- > 0 all values between the lower and upper bound (excluding bounds) are included in the selection process

Notice the exceptional interpretations of the following item combinations:

(6)	(7)	(8)	
2	-1	1	refers to the dominant tree species and
2	-1	-1	others than the dominant tree species,

see the sample plot variable (32) of the simulation record in Appendix D.3.

(9) index of the priority variable in the tree record

(10) slope of the priority function

- < 0 trees with a lower value of the priority variable have a higher selection priority, for example, low thinnings. A low value means that the selection proceeds from the smallest values of the priority variable until the requested selection quantity is reached.
- = 0 all trees have equal priority (regardless the value of the selection variable)
- > 0 trees with a higher value of the priority variable have a higher selection priority, for example, high thinnings. A high value means that the selection proceeds from the highest values of the priority variable until the requested selection quantity is reached.

(11) maximum selection intensity for the individual selection group, for the expression of the selection quantity, see specific EVENT_CALL arguments of the EVENT parameter for each basic event in Appendix B.2

- <= 1 refers to the maximum proportion to be selected from the group in the selection, for example 0.5
- > 1 refers to the minimum absolute quantity to be left in the group in the selection

NOTE: All trees not included in the selection group definitions are excluded from the selection and left untouched.

NOTE: The maximum number of trees in the selection routine is 1 000 for each sample plot. The calling routine may put additional limits.

The upper and lower bounds (items (7) and (8)) for the limiting variable for the selection group can be interpreted as the following combinations, see the exceptions of the selection instructions above and Example F.1:

combination	interpretation
lower bound > 0 and upper bound > 0	trees with the value of the limiting variable between lower and upper bounds, except the bounds themselves, constitute the selection group (from which the trees are selected)
lower bound < 0 and upper bound < 0	trees with the value of the limiting variable other than the absolute value of the lower or upper bound constitute the selection group
lower bound < 0 and upper bound > 0	trees with the value of the limiting variable less than upper bound, except the absolute value of the lower bound, constitute the selection group
lower bound > 0 and upper bound < 0	trees with the value of the limiting variable greater than lower bound, except the absolute value of the upper bound, constitute the selection group

Example F.1. Interpretations of some bound values in the tree selection.

```
lower bound 2          upper bound 4
------------++++++++++----------------------------------
0     1     2     3     4     5     6     7     8     9

lower bound -2         upper bound -4
++++++++++++++++++++++++++++++++++++++++++++++++++++++++
0     1     2     3     4     5     6     7     8     9

lower bound -2         upper bound 4
++++++++++++++++++++++----------------------------------
0     1     2     3     4     5     6     7     8     9

lower bound 2          upper bound -4
------------++++++++++++++++++++++++++++++++++++++++++++
0     1     2     3     4     5     6     7     8     9

lower bound 2          upper bound 10
------------++++++++++++++++++++++++++++++++++++++++++
0     1     2     3     4     5     6     7     8     9

lower bound 0          upper bound 4
-++++++++++++++++++++++----------------------------------
0     1     2     3     4     5     6     7     8     9

The character '-' on the explanation rows refers to
values outside of the selection range and '+' to
values included in the selection range.
```

A high absolute value of the slope (item (10) of selection instructions) generates more strict dependence of the selection priority on the value of the selection variable or, for example, different size trees have different selection priorities. A low absolute value of the slope means less dependence on the selection variable, or all trees have almost the same selection priority. There are no universal rules of slope value for different treatments.

Example F.2. A tree selection instruction with interpretation.

```
A selection instruction (items 1-23, cf. the EVENT_CALL arguments
16-38 in Example B.15):

1 3 3 99 3 3 15 99 3 1 1 2 -1 -1 8 -0.5 0.6 0 0 0 8 -0.5 1

Interpretation of the items 1-23:

items value explanation

1     1     number of overall selection criteria

2-4         first overall selection criterion
      3     - overall selection range variable
      3     - lower bound for overall range variable
      99    - upper bound for overall range variable
            (trees with diameter 3-99 cm are
             included in the overall selection range)

5     3     number of selection groups

6-11        first selection group
      3     - range variable of selection group
      15    - lower bound for range variable
      99    - upper bound for range variable
      3     - priority variable
      1     - slope of priority variable
      1     - maximum intensity
            (trees with diameter 15-99 cm starting
             from bigger ones in terms of diameter,
             all trees in group can be selected)

12-17       second selection group
      2     - range variable of selection group
     -1     - lower bound for range variable
     -1     - upper bound for range variable
      8     - priority variable
     -0.5   - slope of priority variable
      0.6   - maximum intensity
            (others than dominant tree species starting
             from smaller ones in terms of stem volume,
             up to 60 % of trees in group can be selected
             in terms of event specific selection
             quantity)

18-23       third selection group
      0     - range variable of selection group
      0     - lower bound for range variable
      0     - upper bound for range variable
      8     - priority variable
     -0.5   - slope of priority variable
      1     - maximum intensity
            (all trees in overall selection range left
             untouched in previous groups starting from
             smaller ones, all trees in group can be
             selected)
```

F.3 Instructions

The validity of any new applications of selection routine, for example, new event definitions, should be carefully tested with sufficient tree and sample plot material.

Appendix G

MELA Standard Binary Records

Appendix G is an introduction to MELA standard binary (MSB) records and how to write and read them in user routines.

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Appendix G

MELA Standard Binary Records

G.1 Introduction

MELA standard binary (MSB) records provide the standardized structure for some MELA records in sequential MELA system files (see Appendix D).

MSB format makes it possible to store several logical records in one physical record of the file as well as to store several types of records in the same file. The same basic i/o procedure can be used for all MSB type records.

A user-supplied unique management unit identifier (UID) is attached to each of the physical MSB type records. See Appendix G.2 and Example H.51.

G.2 Unique Management Unit Identifier

The unique management unit identifier (UID) is a user-supplied double precision datum attached to each of the physical MSB type records in the MELA system files.

UID can be used, for example, as a management unit level linkage to user's forest database when transporting data between MELA and user programs. See Figure G.1 and Examples G.1 and H.51.

G.3 MSB Format

The general structure of MSB records is shown in Figure G.1. For the files and the logical records stored in the MSB format, see Appendices C and D.

UID - double precision
number_of_words_in_physical_record - integer

repeated part(s)

logical_record_type - floating point (see Appendix D)
number_of_words_in_logical_record - floating point
logical_record (1...number_of_words_in_logical_record) - floating point

Figure G.1. The structure of the MSB (MELA standard binary) record.

Notice that a logical record in Figure G.1 corresponds to any MSB type record in Appendix D.

G.4 How to Process MSB Records in User Routines

MSB records should be written and read by user routines according to the principles presented in Example G.1.

Example G.1. How to write and read MSB records.

```
* write logical records into one MSB record

* introduction to sample data:
*   logical records           data1   data2   data3
*   respective record types     r1      r2      r3
*   number of words
*     in logical records       d1      d2      d3

* calculation of the length of the physical record (nwp):
* number_of_words_in_physical_record =
* number_of_words_in_logical_records +
* number_of_logical_records * 2

      parameter (mfp=1000)
      double precision uid

* logical records
      real data1(mfp),data2(mfp),data3(mfp)

* respective record types
      real d1,d2,d3

* number of words in logical records
      real r1,r2,r3

      integer nw1,nw2,nw3
      integer io

* NOTE: user have to define values for d1, d2 and d3
      nw1=d1
      nw2=d2
      nw3=d3

* write one logical record into one
* physical MSB record
      nwp=r1+2
      write(io) uid,nwp,r1,d1,(data1(i),i=1,nw1)

* write three logical records into one
* physical MSB record
      nwp=r1+r2+r3+6
      write(io) uid,nwp,
     - r1,d1,(data1(i),i=1,nw1),
     - r2,d2,(data2(i),i=1,nw2),
     - r3,d3,(data3(i),i=1,nw3)

* read and write again a MSB record

      parameter (mfp=10000)
      double precision uid
      integer nwp,io,ip
      real fp(mfp)

* read one MSB record
      read (io) uid,nwp,(fp(i),i=1,nwp)
      if (nwp.gt.mfp) stop '--increase fp length'

* write one MSB record
      write(ip) uid,nwp,(fp(i),i=1,nwp)
```

Appendix H
Sample Files, Runs and Results

Appendix H contains the demonstration material of the MELA Handbook in the framework of the MELA analysis steps.

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Appendix H

Sample Files, Runs and Results

H.1 Introduction

Appendix H provides a collection of MELA files, runs and results. These examples should illustrate the analysis process from the user's point of view - also without a computer at hand - complementing the material presented elsewhere in the MELA Handbook.

The demonstration material is grouped by the steps of typical MELA tasks (see Chapter 2.1 and Figures 1.2 and 4.1). The tasks, commands, parameters and results are shown side by side. Study the parameters and the corresponding results in order to understand the functions of the MELA programs; compare also the results of different runs for their substance and interpretation. Notice the connections of the examples to the main text.

The approach of the examples is to provide a starter package - the demonstration of the basic calculations. However, the simple examples may be characterized by the computation aspects more than the complete coverage of the substance for all potential decision situations.

> NOTE: On some operating systems, the length of file names must not override eight digits. In such cases, the file names of actual runs may deviate from the names presented here resulting conflicts in the use of the MELA files. See Chapter 3.2.3.1 and the MAX_LENGTH_OF_FILENAME and FILE_NAMING parameters in Appendix B.2.

H.2 Forest Resource Data

Initial data

The small demonstration data referred in the MELA Handbook was made using some real sample plots of the Finnish National Forest Inventory. Sample plots were compiled into the initial data and further grouped into management units, which can be interpreted also as stands in the case of forest holding analyses. The small number of stands and sample plots in the stands of the demonstration data is for the convenience only; true data sets are much larger, of course.

Management units were grouped further into six hypothetical forestry units F1 - F5 and WR and corresponding initial data (**rsd** type) files, see Appendices C.2 and D.1. The forestry units are shortly characterized below.

Forestry unit	Number of management units (stands)	Short characterization of forestry units
F1	16	old, spruce dominated
F2	13	middle aged, pine dominated
F3	11	shortage of middle aged stands, coniferous dominated
F4	21	young stands, even tree species distribution
F5	17	middle aged with some very old stands, pine dominated
WR	14	middle aged, clearly pine dominated

The demonstration data can be used for exercises consisting of a single stand (standwise analysis), a simple forestry unit (forest level analysis with individual initial data files) or several sub-unit units (hierarchical forest level analysis). A hierarchical forestry unit can be interpreted here as well a set of individual forest holdings as a sample of forests over a large forest area consisting of regions and districts.

In the examples in Appendix H, the demonstration files are used as lowest level members (or sub-units) of the hierarchical forestry unit FX (see Chapter 3.3.2, Example 3.11 and Figure 2.1). F1, F2 and F3 are districts of the region SR and F4 and F5 districts of the region NR.

The sub-unit WR is used also for an example how to import an existing MELAOPT solution (a given forest level summary from MELAOPT) as such into a new MELAOPT optimization problem (see Examples H.34 - H.38).

Users are encouraged to try other kinds of exercises than the ones presented in the MELA Handbook. Notice that different hierarchical forestry units can be generated from the demonstration material by simply combining initial data files into a new order in new decision hierarchy description files.

C variables

The following c variables (see Appendix D.2) are found in the management unit records of the initial data (**rsd** type) files (see Appendix C.2):

C variable	Explanation	Possible values
UNIT	Identification number of management unit	1 - 21
AREA	Area, ha	0.5 - 5
SITE	Site type category	1 - 8
MANAGEMENT	Forest management category	1,2,3,6,7
OWNER	Owner category	0 and 2

For the explanation of the category values, see Appendix D.1.

Notice the following introduction of the c variables in the **MELA_SET.PAR** file, see Example H.1:

```
C_VARIABLES#UNIT#AREA#SITE#MANAGEMENT#OWNER
```

Statistics about the demonstration data

Table H.1. Age class distribution in the sample data (% of the forest land area).

Age class	F1	F2	F3	F4	F5	WR
0	0.0	0.0	0.0	3.6	3.8	0.0
1 - 20	7.3	13.3	30.5	11.7	1.8	10.8
21 - 40	22.1	9.1	23.2	14.5	0.0	8.4
41 - 60	3.8	20.7	0.0	45.4	18.7	34.1
61 - 80	19.9	36.5	8.6	15.9	43.2	33.1
81 - 100	27.4	6.6	0.0	0.0	8.2	6.8
101 - 121	19.6	13.7	37.7	8.9	0.0	0.0
121 +	0.0	0.0	0.0	0.0	24.3	6.8
	100.0	100.0	100.0	100.0	100.0	100.0

Table H.2. Diameter class distribution in the sample data (% of the volume of the growing stock).

Diameter class	F1	F2	F3	F4	F5	WR
- 10	7.1	6.1	4.7	26.4	9.4	9.8
11 - 20	22.9	36.3	32.4	50.7	50.2	53.9
21 - 30	34.3	50.3	41.0	18.3	30.9	18.6
31 +	35.7	7.4	21.9	4.6	9.4	17.7
	100.0	100.0	100.0	100.0	100.0	100.0

Table H.3. Tree species distribution in the sample data (% of the volume of the growing stock).

Species	F1	F2	F3	F4	F5	WR
Pine	24.0	63.3	50.2	34.4	75.3	80.9
Spruce	59.1	34.3	43.9	25.1	16.7	15.4
Birch	16.2	1.9	5.9	31.4	8.0	2.5
Other deciduous	0.7	0.5	0.0	9.1	0.0	1.2
	100.0	100.0	100.0	100.0	100.0	100.0

H.3 Some Common Parameter and Definition Files

MELA_SET.PAR

For an introduction to the **MELA_SET.PAR** file and common parameter definitions, see Chapter 3.2.3.2 and Appendix C.2. The MELA programs will stop if the **MELA_SET.PAR** file is missing. See Example H.1.

Example H.1. The common parameter definition file.

```
* MELA_SET.PAR *

* Default value for the FORESTRY_UNIT parameter

FORESTRY_UNIT#FX

* Names of the c variables in the demonstration data

C_VARIABLES#UNIT#AREA#SITE#MANAGEMENT#OWNER

* Remove following '*' signs for shorter file names than defaults
*
*FILE_NAMING
*#01 SUM _ FORESTRY_UNIT SUB_UNIT PROBLEM
*#20 MSC _ FORESTRY_UNIT SUB_UNIT PROBLEM
*#21 MSD _ FORESTRY_UNIT SUB_UNIT PROBLEM

COMMANDS
#SIMULATE APPLICATION FORESTRY_UNIT PROBLEM
#SOLVE PROBLEM FORESTRY_UNIT
```

Decision hierarchy definition

For an introduction to the decision hierarchy concept and its use for hierarchical forestry units consisting of several sub-units, see Chapter 3.3.2 and Example 3.11.

SYMBOL.SYM

For an introduction to the **SYMBOL.SYM** file and symbol definitions, see Chapter 3.2.3.2 and Appendix C.2. The MELA programs will stop if the **SYMBOL.SYM** file is missing. See Example H.2.

Example H.2. The default symbol definition file.

```
* SYMBOL.SYM * (excerpts)

* The file is read sequentially, therefore the definitions needed at
* first and the most common ones should appear in the beginning of
* the file.

* Syntax: generic name in Finnish = translation in English

* - MELA-commands
SIMULOI=SIMULATE
RATKAISE=SOLVE
NAYTA=SHOW

* <clip> ... Part of the file was cut out ... <clip>

* Options of the SHOW command
KOMENNOT=COMMANDS
TULKINTA=INTERPRETATION
PARAMETRI_C=PARAMETER_C

* <clip> ... Part of the file was cut out ... <clip>

* Options of the REPORT command
RATKAISU=SOLUTION
VALITUT=SCHEDULES
TAULUKKO=SUMMARY

* <clip> ... Part of the file was cut out ... <clip>

* - MELA file naming components
METSATALOUS_YKSIKKO=FORESTRY_UNIT
PERUSALUE=SUB_UNIT
TEHTAVA=PROBLEM
SOVELLUS=APPLICATION

* - MELA event definitions
TAPAHTUMA=EVENT
TAPAHTUMA_OLETUSARVOT=EVENT_DEFAULTS
TAPAHTUMAVUODET=EVENT_YEARS

* <clip> ... Part of the file was cut out ... <clip>

* - MELA paramer names
_TASOT=_LEVELS
ALIN_TASO=LOWEST_LEVEL
KANTOHINNAT=STUMPAGE_PRICES

* <clip> ... Part of the file was cut out ... <clip>

* - MELA run-time messages
f_get_1 Clearing parameters from earlier commands
f_gtp_1 The given EVENT-definitions:
f_gtr/c Symbol in: #C1#

* <clip> ... Part of the file was cut out ... <clip>

* for the complete SYMBOL.SYM file, see the delivery package
```

Default summary report definitions

For an introduction to forest level summary report definitions, see Chapters 4.1.3.1 and 4.1.4.1 and Appendices D.2 and D.8. For the default summary report definition, see Example H.3, and for the corresponding report, see e.g. Example H.8.

Example H.3. The default summary report definition.

```
* TABLE.TAB * (excerpts)

  -9    0    0
  -1    0   -1=
  -4    0    1  (Title from the problem definition file)
  -1    0   -1-
  -2    0   -4
  -1    0   -1-
 537    0    1FORESTRY LAND AREA, ha
   0    0    1
 700    0    1TOTAL VOLUME, m3
 684    0    1  Pine

* <clip> ... Part of the file was cut out ... <clip>

 697    0    1  Saw log
 698    0    1  Pulpwood
  -1    0   -1-
 800    0    1VALUE (roadside prices), FIM
 803    0    1NET PRESENT VALUE (NPV) 3%
  -1    0   -1-
  -2    0   -4
  -1    0   -1-
  90    0   -1INCREMENT, m3/a
  86    0   -1  Pine

* <clip> ... Part of the file was cut out ... <clip>

 350    0   -1TOTAL DRAIN, m3/a
 365    0   -1  Mortality
 340    0   -1  Cutting drain
  -1    0   -1-
 195    0   -1CUTTING REMOVAL, m3/a
 270    0   -1 Shelterwood cuttings

* <clip> ... Part of the file was cut out ... <clip> etc.

   7    0   -1TOTAL CUTTING AREA, ha/a
   1    0   -1 Thinnings

* <clip> ... Part of the file was cut out ... <clip>

  35    0   -1REGENERATION AREA, ha/a
  15    0   -1 Artificial regeneration
  30    0   -1 Natural regeneration
   0    0    1
   8    0   -1TENDING YOUNG STANDS, ha/a
  -1    0   -1-
 499    0   -1GROSS REVENUES, FIM/a
 474    0   -1TOTAL COSTS, FIM/a
 370    0   -1NET REVENUES, FIM/a
  -1    0   -1=
9999

* for the complete TABLE.TAB file, see the delivery package
```

User-defined summary report definitions

For an introduction to user-defined summary reports, see Chapter 4.6.7 and Appendices D.2 and D.8. For a user-defined summary report definition, see Example H.4, and for the corresponding report, see Example H.48.

Example H.4. A user-defined summary report definition.

```
* USER.TAB * (excerpts)

  -9    0    0
  -1    0   -1=
  -4    0    1  (Title from the problem definition file)
  -1    0   -1-
  -2    0   -4 CUTTING REMOVALS, m³/a
  -1    0   -1-
 195    0   -1TOTAL CUTTING REMOVAL
 193    0   -1  Saw logs
 194    0   -1  Pulpwood
   0    0    1
 183    0   -1 PINE
 123    0   -1        ... 10 cm
 138    0   -1    11 ... 20 cm
 153    0   -1    21 ... 30 cm
 168    0   -1    31 ...    cm
   0    0    1
 181    0   -1   Saw logs
 182    0   -1   Pulpwood
   0    0    1
 186    0   -1 SPRUCE
 126    0   -1        ... 10 cm

*  <clip> ... Part of the file was cut out ... <clip>

   0    0    1
 192    0   -1 OTHER DECIDUOUS
 132    0   -1        ... 10 cm
 147    0   -1    11 ... 20 cm
 162    0   -1    21 ... 30 cm
 177    0   -1    31 ...    cm
   0    0    1
 190    0   -1   Saw logs
 191    0   -1   Pulpwood
  -1    0   -1-
 260    0   -1 THINNINGS
 256    0   -1  Pine
 257    0   -1  Spruce
 258    0   -1  Birch
 259    0   -1  Other deciduous
  -1    0   -1
 265    0   -1 REGENERATION CUTTINGS
 266    0   -1  Pine
 267    0   -1  Spruce
 268    0   -1  Birch
 269    0   -1  Other deciduous
  -1    0   -1
 270    0   -1 OVERSTORY CUTTINGS
 266    0   -1  Pine
 267    0   -1  Spruce
 268    0   -1  Birch
 269    0   -1  Other deciduous
  -1    0   -1=

* for the complete USER.TAB file, see the delivery package
```

H.4 Simulation of Alternative Management Schedules

A MELASIM session for alternative management schedules

Commands

```
>MELASIM
MELASIM>SIMULATE MS FX
MELASIM>EXIT
```

Arguments

MS	see MS.PAR
FX	see FX.PAR

Input files

FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
MS.PAR	see Example H.5
MS_EVENT.PAR	see Example H.6
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3
VOLUME.VOL	see Appendix C.2

Output files

MELASIM session log	see Example H.7
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule files, see FX.PAR
FX_sub_unit_S.SUM	see Example H.8 ('sub_unit' stands for F1 to WR in turn)

Notice

OUTPUT (1) = 1 enables management schedule files, see Example H.5.
OUTPUT (2) = 1 enables forest level summary reports, see Examples H.3, H.5 and H.8.

The MELASIM session log should be always checked for warnings and error messages.

Example H.5. A parameter definition file for the simulation of alternative management schedules.

```
* MS.PAR *

YEARS                1 11 21 31 41

OUTPUT               1 1 0 0 0 0 0 0 0 0

SIMULATION_CONTROL 41 50 0 0 1000 0 1 999 0 0 500 0 0 0 151 0 0

INCLUDE MS_EVENT.PAR
```

Example H.6. An event definition file for the simulation of alternative management schedules.

```
* MS_EVENT.PAR * (excerpts)

*====================================
* DEFAULT VALUES FOR EVENT PARAMETER
*====================================

EVENT_DEFAULTS
#EVENT_YEARS                        6 10
#EVENT_INTERVALS                    10
#EVENT_BRANCHING                    1
#FEASIBLE_PRECEDESSORS              99
#FOREST_CATEGORIES                  0
#EVENT_PROBABILITY                  1

*==================
* EVENT DEFINITIONS
*==================

EVENT
#10 FIRST THINNING - NUMBER OF STEMS/HA INSTRUCTIONS
*-----------------------------------------------------
#COMPARABLE_EVENTS        20 25 28 29 50
#FEASIBLE_PRECEDESSORS    70 71 99
#FEASIBLE_MANAGEMENT_CATEGORIES  3 30 0 -6.99999
#EVENT_CALL  2 1  3 1 0 800 800 8 12 0.6 1500 1 0.5 0 0 0 0
*            A B  1 2 3  4   5  6  7  8    9  0  1  2 3 4 5

EVENT
#20 THINNING - BASAL AREA INSTRUCTIONS
*-------------------------------------
#COMPARABLE_EVENTS        10 20 25 28 29 30
#FEASIBLE_PRECEDESSORS    70 71 99
#FOREST_CATEGORIES  3 30 0 -6.99999
#EVENT_CALL  2 1  1 1 0 4 2 10 1.5 0.85 1.5 0.9 0.35 0 0 0 0

EVENT
#25 OVER STORY REMOVAL
*---------------------
#EVENT_BRANCHING          0
#COMPARABLE_EVENTS        20 30

*<clip> ... The rest of the file was cut out ... <clip>

* for the complete MS_EVENT.PAR file, see the MELA delivery package
```

Example H.7. The log of the MELASIM session.

```
 * MELASIM session log * (excerpts)

 MELA-100496-S1

 .. Reading user information from the file USER.PAR ..

 .. Welcome to use MELA-programs ! ..

 MELASIM> SIMULATE MS FX
 .. Original command: SIMULATE MS FX ..
 .. Command to be returned: SIMULATE MS FX ..
 .. Parameters to be removed: ..

 .. Clearing parameters from earlier commands ..

 .. <MELASIM> starting to execute the command: MS FX  ..
 .. Symbol in: METSATALOUS_YKSIKKO <> FORESTRY_UNIT ..
 .. f_get: INCLUDE MELA_SET.PAR
 .. Symbol definition not found: FORESTRY_UNIT#FX ..
 .. Parameter in: METSATALOUS_YKSIKKO ..
 .. Files of the FORESTRY_UNIT definition: ..
 .. f_get: INCLUDE FX.PAR
 .. f_get: include MS.PAR
 .. f_get: INCLUDE MS_EVENT.PAR
=====================================================================
 .. FX -> basic_units (files): ..
 .. Symbol in: ALIN_TASO <> LOWEST_LEVEL ..
 .. Parameter ALIN_TASO was not found ..
 .. in MELA forest resource data (rsd) F1.RSD

* <clip>... Part of the report was cut out ... <clip>

 .. The management schedule file (MSD) was written ..
 .. The following  133 variables were stored: ..

      1    2    4    5    6    7    8    9   10   11   12   13   14
     15   20   25   26   27   29   30   35   36   37   38   60   65
     86   87   88   89   90  100  181  182  183  184  185  186  187
    188  189  190  191  192  193  194  195  210  225  240  260  265
    270  340  346  347  348  349  350  365  370  445  454  458  462
    466  470  474  478  482  486  490  494  498  499  500  501  502
    503  504  505  506  507  508  509  510  537  600  620  640  660
    680  684  688  692  696  697  698  699  700  705  710  715  720
    725  800  801  802  803  804  805  806  807  808  809  810  816
    817  818  819  820  821  822  823  840  845  850  900  915  920
    925  940 1000

 .. Summary of the simulation: ..

    1      1.  1 1.00    2      2.  6 1.00    3      3.  8 1.00
    4      4. 27 1.00    5      5. 28 1.00    6      6.  6 1.00
    7      7. 39 1.00    8      8. 16 1.00    9      9.  9 1.00
   10     10.  2 1.00   11     11.  1 1.00   12     12. 53 1.00
   13     13. 24 1.00   14     14. 22 1.00

 .. ** TOTAL: ..
 .. ** CALCULATION UNITS        14 ..
 .. ** MANAGEMENT SCHEDULES    242 ..
 =====================================================================

 .. <MELASIM> end of execution of the command: MS FX  ..
```

Example H.8. A forest level summary report from the simulation of alternative management schedules.

*** FX_F2_S.SUM ***

<>mela<> 270996 100608

MS FX F2

	1996	2006	2016	2026	2036
FORESTRY LAND AREA, ha	24.1	24.1	24.1	24.1	24.1
TOTAL VOLUME, m3	2829.4	3627.0	3179.6	2282.4	3051.6
Pine	1790.9	2466.4	2288.6	1329.7	1481.1
Spruce	969.6	1008.2	625.3	730.4	1185.2
Birch	53.6	117.9	201.0	147.4	221.6
Other deciduous	15.3	34.6	64.6	74.9	163.7
Saw log	1224.6	1702.3	1595.8	1264.4	1641.0
Pulpwood	1472.8	1793.1	1495.8	929.9	1196.7
VALUE (roadside prices), FIM	525340	707241	627410	463105	606777
NET PRESENT VALUE (NPV) 3%	639222	785488	752084	667065	818241

	1996	2006	2016	2026	2036
INCREMENT, m3/a		126.3	120.8	103.7	113.4
Pine		75.8	74.4	56.4	49.8
Spruce		41.7	34.0	32.7	46.4
Birch		6.7	9.5	9.1	8.3
Other deciduous		2.0	3.1	5.5	9.0
TOTAL DRAIN, m3/a		46.5	165.6	193.5	36.5
Mortality		3.0	4.3	4.2	3.4
Cutting drain		43.5	161.3	189.3	33.1
CUTTING REMOVAL, m3/a		42.8	157.2	185.9	33.0
Shelterwood cuttings		20.2	5.7	22.3	33.0
Thinnings		22.6	15.4	36.8	0.0
Regeneration cuttings		0.0	136.1	126.8	0.0
Pine		5.8	88.9	149.1	33.0
Spruce		37.0	68.3	21.1	0.0
Birch		0.0	0.0	11.6	0.0
Other deciduous		0.0	0.0	4.1	0.0
Saw log		26.9	94.2	104.5	24.7
Pulpwood		15.8	63.0	81.4	8.3
TOTAL CUTTING AREA, ha/a		0.5	0.9	1.5	0.6
Thinnings		0.3	0.2	0.4	0.0
Clear cuttings		0.0	0.2	0.0	0.0
Over story cuttings		0.1	0.1	0.5	0.6
Seed tree cuttings		0.0	0.5	0.6	0.0
Shelterwood cuttings		0.0	0.0	0.0	0.0
REGENERATION AREA, ha/a		0.0	0.6	0.6	0.0
Artificial regeneration		0.0	0.2	0.0	0.0
Natural regeneration		0.0	0.5	0.6	0.0
TENDING YOUNG STANDS, ha/a		0.3	0.1	0.5	0.6
GROSS REVENUES, FIM/a		8810.0	34723.7	39758.0	8699.9
TOTAL COSTS, FIM/a		2463.4	8539.6	10112.5	1951.0
NET REVENUES, FIM/a		6346.5	26184.1	29645.5	6748.9

Management schedule summary in MELASIM

Commands

```
>MELASIM
MELASIM>SIMULATE SS F2
MELASIM>EXIT
```

Arguments

SS	see SS.PAR
F2	forestry unit F2

Input files

MELA_SET.PAR	see Example H.1
SS.PAR	see Example H.9
MS_EVENT.PAR	see Example H.6
F2.RSD	initial data file
SYMBOL.SYM	see Example H.2
VOLUME.VOL	see Appendix C.2

Output files

MELASIM session log	see Example H.10

Notice

OUTPUT (1) = 0 disables management schedule files.
OUTPUT (2) = 0 disables forest level summary reports.
OUTPUT (3) = 3 enables management schedule summaries in a MELASIM session log.

The length of the management schedule summary is 5 to 10 rows for each management schedule or several 60-row pages for each management unit.

Example H.9. A parameter definition file for the management schedule summary.

```
* SS.PAR * see also Example H.3
YEARS                1 11 21 31 41
OUTPUT               0 0 3 0 0 0 0 0 0 0
SIMULATION_CONTROL 41 50 0 0 1000 0 1 999 0 0 50 0 0 0 151 0 0
INCLUDE MS_EVENT.PAR
```

Example H.10. A management schedule summary report.

```
* MELASIM session log (page 1/2) *

 MELASIM> SIMULATE MS F2

* <clip> ... Part of the file was cut out ... <clip>

 .. <>    3.0000 ..
 -----------------
    M_unit  year     area        Y   X  nr  alt   TS   o u l s t t d d     dt   ft   st  n  clt dc   at   tt   pt   ct fbd cat lc
 >>    3.0<<1996.    2.10 2.1          0. 150. 1160. 0.1.1.3.0.3.0.0.0.   0.   0.   0. 0.   0. 6.1961.   0.1992.1992.  5. 1. 3.
 -----------------
 >>>>    1<<    1>   (1.000)   241279.    96505.    56146.    37830.    27427.
  row  year  cat  dc      ns  sp  ba    vol psbo value age    d    h     fel psbo cut  cl s a c t p d f  mort ivol ival    revs  costs
    1> 1996 1.00   6 0  1096. 1. 17.3 103.9 6400 17905. 47. 15.3 11.9   38.5 0X00 1.020 0.0.0.0.0.0.0.0. 0.15  7.4 1264.   6700.  2525.
    2> 2006 1.00   7 0   754. 1. 18.9 137.7 8200 23941. 55. 18.9 14.7   32.9 0X00 1.020 0.0.0.0.0.0.0.0. 0.19  6.9 1418.   5640.  1952.
    3> 2016 1.00   7 0   586. 1. 20.4 171.9 X000 32589. 63. 22.0 17.3    0.0       0.000 0.0.0.0.0.0.0.0. 0.25  6.5 1639.      0.     0.
    4> 2026 1.00   7 0   577. 1. 25.5 234.1 X000 49098. 73. 24.5 19.3   74.1 X000 1.020 0.0.0.0.0.0.0.0. 0.24  5.9 1894.  16159.  3833.
    5> 2036 1.00   8 0   398. 1. 22.2 216.2 X000 52000. 84. 27.5 21.0    0.0       0.000 0.0.0.0.0.0.0.0. 0.16  5.2 1398.      0.     0.
    6> 2041 1.00   8 0   396. 1. 24.2 241.2 X000 59019. 89. 28.7 21.7    0.0       0.000 0.0.0.0.0.0.0.0. 0.00  0.0    0.      0.     0.

* <clip> ... Part of the file was cut out ... <clip>

>>>>   26<<  148>   (1.000)   249728.    96655.    51683.    30945.    19408.
  row  year  cat  dc      ns  sp  ba    vol psbo value age    d    h     fel psbo cut  cl s a c t p d f  mort ivol ival    revs  costs
  151> 1996 1.00   6 0  1096. 1. 17.3 103.9 6400 17905. 47. 15.3 11.9    0.0       0.000 0.0.0.0.0.0.0.0. 0.22  8.2 1405.      0.     0.
  152> 2006 1.00   7 0  1073. 1. 25.9 184.2 6400 32090. 56. 18.3 14.4    0.0       0.000 0.0.0.0.0.0.0.0. 0.56  9.2 1671.      0.     0.
  153> 2016 1.00   7 0  1040. 1. 33.4 270.2 6400 49055. 66. 20.8 16.7    0.0       0.000 0.0.0.0.0.0.0.0. 1.13  9.1 1849.      0.     0.
  154> 2026 1.00   7 0   996. 1. 39.2 349.5 5500 67933. 76. 22.9 18.6    0.0       0.000 0.0.0.0.0.0.0.0. 1.80  8.2 1777.      0.     0.
  155> 2036 1.00   7 0   941. 2. 43.2 413.9 5500 86187. 86. 24.7 20.2    0.0       0.000 0.0.0.0.0.0.0.0. 2.25  7.9 1931.      0.     0.
  156> 2041 1.00   8 0   911. 2. 44.9 442.2 5500 96156. 92. 25.6 20.9    0.0       0.000 0.0.0.0.0.0.0.0. 0.00  0.0    0.      0.     0.
    <>      3       3.000    26 1.000 <>

* <clip> ... Part of the file was cut out ... <clip>

 .. <>   13.0000 ..
 -----------------
    M_unit  year     area        Y   X  nr  alt   TS   o u l s t t d d     dt   ft   st  n  clt dc   at   tt   pt   ct fbd cat lc
 >>   13.0<<1996.    1.70 1.7          0.  90. 1175. 2.1.2.3.0.2.0.0.0.   0.   0.   0. 0.   0. 6.   0.   0.   0.1992. 5.  1. 3.
 -----------------
 >>>>    1<<  247>   (1.000)   221400.    96740.    58957.    40569.    29621.
  row  year  cat  dc      ns  sp  ba    vol psbo value age    d    h     fel psbo cut  cl s a c t p d f  mort ivol ival    revs  costs
    1> 1996 1.00   6 0  1139. 2. 16.0 115.4 0X00 20466. 45. 15.6 14.3   31.2 0X00 1.020 0.0.0.0.0.0.0.0. 0.12  9.0 1819.   5426.  2111.
    2> 2006 1.00   7 0   835. 2. 20.7 173.0 0X00 33325. 56. 20.0 17.0   58.4 0X00 1.020 0.0.0.0.0.0.0.0. 0.13  9.1 1996.  10772.  3376.
    3> 2016 1.00   8 0   538. 2. 21.7 203.9 0X00 42593. 66. 25.1 19.8   59.2 0X00 1.020 0.0.0.0.0.0.0.0. 0.11  8.3 2237.  11273.  3582.
    4> 2026 1.00   8 0   349. 2. 22.2 226.6 0X00 53745. 78. 31.1 22.5   54.4 0X00 1.020 0.0.0.0.0.0.0.0. 0.08  7.4 2252.  11562.  3193.
    5> 2036 1.00   8 0   237. 2. 22.9 245.5 0X00 64740. 89. 37.7 25.0    0.0       0.000 0.0.0.0.0.0.0.0. 0.06  7.1 2233.      0.     0.
    6> 2041 1.00   8 0   236. 2. 26.2 280.8 0X00 75923. 94. 40.1 25.7    0.0       0.000 0.0.0.0.0.0.0.0. 0.00  0.0    0.      0.     0.

* <clip> ... Part of the file was cut out ... <clip>
```

```
* MELASIM session log (page 2/2) *

 >>>>    8<<   38>   (1.000)   228399.   100741.    60918.    41164.    29321.
  row  year  cat  dc      ns  sp  ba    vol psbo value age    d   h     fel psbo cut  cl s a c t p d f  mort ivol ival    revs  costs
   43> 1996 1.00  6 0  1139. 2. 16.0 115.4 0X00 20466. 45. 15.6 14.3  31.2 0X00 1.020 0.0.0.0.0.0.0.0. 0.12  9.0 1819.   5426.  2111.
   44> 2006 1.00  7 0   835. 2. 20.7 173.0 0X00 33325. 56. 20.0 17.0   0.0       0.000 0.0.0.0.0.0.0.0. 0.19 10.3 2224.      0.     0.
   45> 2016 1.00  7 0   820. 2. 29.8 273.7 0X00 55678. 65. 23.7 19.1 109.0 0X00 1.020 0.0.0.0.0.0.0.0. 0.23 10.3 2626.  20873.  6264.
   46> 2026 1.00  8 0   464. 2. 26.3 265.6 0X00 61176. 77. 29.5 22.0 103.2 0X00 1.020 0.0.0.0.0.0.0.0. 0.11  8.1 2402.  21867.  5764.
   47> 2036 1.00  8 0   247. 2. 22.6 242.7 0X00 63386. 89. 36.9 24.9   0.0       0.000 0.0.0.0.0.0.0.0. 0.07  7.2 2291.      0.     0.
   48> 2041 1.00  8 0   246. 2. 25.8 278.2 0X00 74856. 94. 39.3 25.6   0.0       0.000 0.0.0.0.0.0.0.0. 0.00  0.0    0.      0.     0.

* <clip> ... Part of the file was cut out ... <clip>

 >>>>   23<<  130>   (1.000)   213501.   100972.    63129.    42696.    29861.
  row  year  cat  dc      ns  sp  ba    vol psbo value age    d   h     fel psbo cut  cl s a c t p d f  mort ivol ival    revs  costs
  133> 1996 1.00  6 0  1139. 2. 16.0 115.4 0X00 20466. 45. 15.6 14.3   0.0       0.000 0.0.0.0.0.0.0.0. 0.15  9.6 1935.      0.     0.
  134> 2006 1.00  7 0  1117. 2. 25.5 210.3 0X00 39930. 55. 19.1 16.7   0.0       0.000 0.0.0.0.0.0.0.0. 0.34 12.1 2561.      0.     0.
  135> 2016 1.00  7 0  1090. 2. 35.9 328.2 0X00 65728. 65. 22.5 18.8 125.8 0X00 1.020 0.0.0.0.0.0.0.0. 0.42 12.0 2925.  23729.  7091.
  136> 2026 1.00  8 0   629. 2. 31.5 317.9 0X00 71440. 76. 27.8 21.6 243.4 0X00 6.029 1.0.0.0.0.0.0.0. 0.16  7.5 2201.  51067.  9479.
  137> 2036 1.00  8 0    90. 2. 12.8 148.4 0X00 42467. 93. 42.8 27.9 431.7 0X00 1.020 0.0.0.0.1.0.0.0. 0.09  6.6 1311.  99498. 24293.
  138> 2111 1.00  8 0   867. 2. 20.1 202.3 0X00 41844. 73. 25.0 21.2   0.0       0.000 0.0.0.0.0.0.0.0. 0.00  0.0    0.      0.     0.

* <clip> ... Part of the file was cut out ... <clip>

 >>>>   28<<  160>   (1.000)   239153.   101989.    57146.    34961.    22154.
  row  year  cat  dc      ns  sp  ba    vol psbo value age    d   h     fel psbo cut  cl s a c t p d f  mort ivol ival    revs  costs
  163> 1996 1.00  6 0  1139. 2. 16.0 115.4 0X00 20466. 45. 15.6 14.3   0.0       0.000 0.0.0.0.0.0.0.0. 0.15  9.6 1935.      0.     0.
  164> 2006 1.00  7 0  1117. 2. 25.5 210.3 0X00 39930. 55. 19.1 16.7   0.0       0.000 0.0.0.0.0.0.0.0. 0.34 12.1 2561.      0.     0.
  165> 2016 1.00  7 0  1090. 2. 35.9 328.2 0X00 65728. 65. 22.5 18.8   0.0       0.000 0.0.0.0.0.0.0.0. 0.75 13.1 3058.      0.     0.
  166> 2026 1.00  8 0  1052. 2. 45.6 451.5 0X00 96614. 75. 25.5 20.7   0.0       0.000 0.0.0.0.0.0.0.0. 1.40 10.5 2523.      0.     0.
  167> 2036 1.00  8 0  1002. 2. 50.8 542.1 0X00122240. 85. 27.6 22.5   0.0       0.000 0.0.0.0.0.0.0.0. 1.80  9.4 2501.      0.     0.
  168> 2041 1.00  8 0   975. 2. 52.7 580.1 0X00134970. 90. 28.4 23.2   0.0       0.000 0.0.0.0.0.0.0.0. 0.00  0.0    0.      0.     0.
    <>    13      13.000    28 1.000 <>

 .. Summary of the simulation: ..
    1      1.  1 1.00    2      2.  1 1.00    3      3. 26 1.00
    4      4. 11 1.00    5      5. 11 1.00    6      6. 38 1.00
    7      7. 17 1.00    8      8. 25 1.00    9      9.  2 1.00
   10     10.  1 1.00   11     11. 19 1.00   12     12. 42 1.00
   13     13. 28 1.00

 .. ** TOTAL: ..
 .. ** CALCULATION UNITS        13 ..
 .. ** SIMULATED SCHEDULES     222 ..

 ================================================================================
 .. <MELASIM> end of execution of the command: MS F2  ..

 MELASIM>
```

Interpretation of the management schedule summary report

The summary report for the monitoring of the generation of the management schedules consists of three parts for each management schedule:

- an identification of the management unit and a selection of management unit variables (see Appendix D.3),
- a row for the identification of the management schedule, its proportion (in the solution) and the net present values for the management schedule by the given discount rates (see the DISCOUNT_RATES parameter in Appendix B.2), and
- a row for each sub-period with a selection of variables from the simulation and decision data records describing the state of the growing stock in the beginning of the sub-period and the events during the sub-period.

state in the beginning of sub-period		events during sub-period	
row	line number	fel	cutting drain, m³/ha/a
year	year	psbo	proportion of pine, spruce,
cat	forest management category		birch and other deciduous sp.
dc	development class	cut	cutting method
ns	number of trees/ha	cl	clearing - 0 (no) /1 (yes)
sp	dominant tree species	s	soil surface preparation - 0/1
ba	basal area, m²/ha	a	artificial regeneration - 0/1
vol	volume, m³/ha	c	supplementary planting - 0/1
psbo	proportion of pine, spruce,	t	tending of young stands - 0/1
	birch and other deciduous sp.	p	pruning - 0/1
value	value, FIM/ha	d	drainage - 0/1
age	mean stand age, a	f	fertilization - 0/1
d	mean stand diameter, cm	mort	mortality, m³/ha/a
h	mean stand height, m	ivol	increment, m³/ha/a
		ival	value increment, FIM/ha/a
		revs	gross income, FIM/ha/a
		costs	costs, FIM/ha/a

Notice, however, that the event variables on the second last row represent the development of the growing stock after the calculation period until the simulation period. The last row shows the final state of the growing stock at the end of the simulation period. No events are simulated after that.

NOTE: The compact 132 character lines of the management schedule summary report should never be broken on several lines while displaying or printing them.

Simulation data (sample plot and sample tree) report in MELASIM

Commands

```
>MELASIM
MELASIM>SIMULATE SP F2
MELASIM>EXIT
```

Arguments

SP	see SP.PAR
F2	forestry unit F2

Input files

MELA_SET.PAR	see Example H.1
MS_EVENT.PAR	see Example H.6
SP.PAR	see Example H.11
F2.RSD	initial data file
SYMBOL.SYM	see Example H.2
VOLUME.VOL	see Appendix C.2

Output files

MELASIM session log	see Example H.12

Notice

OUTPUT (1) = 0 disables management schedule files.
OUTPUT (2) = 0 disables forest level summary reports.
OUTPUT (3) = 0 disables management schedule summaries in a MELASIM session log.
OUTPUT (4) = 1 enables simulation data (sample plot and sample tree) reports of the initial state into the session log.

The variables in the simulation data report, e.g. in Example H.12, refer to the structure of the simulation record in Appendix D.3.

The length of the simulation data (sample plot and sample tree) report is tens or hundreds of rows for each individual state of each management schedule.

Example H.11. A parameter definition file for the simulation data report.

```
* SP.PAR * see also Examples H.3 and H.9
YEARS                1
OUTPUT               0 0 0 1 0 0 0 0 0 0
SIMULATION_CONTROL 1 50 0 0 1000 0 1 999 0 0 50 0 0 0 151 0 0
INCLUDE MS_EVENT.PAR
```

Example H.12. A simulation data (sample plot and sample tree) report.

```
* MELASIM session log *

MELASIM> SIMULATE SP F2

* <clip> ... Part of the file was cut out ... <clip>

-----
>>    13<<
     13.0 1996.0     1.7     1.7 6825.2  357.0     0.0    90.0  1175.0    2.00
        1.0     2.0     3.0     0.0    2.0     0.0     0.0     0.0    0.00
        0.0     0.0     3.0     0.0    2.0     0.0     0.0     0.0    0.00
        0.0     0.0     0.0     6.0    0.0     0.0  1992.0     5.0    1.00
     1138.6     2.0    45.4   115.4   16.0    15.6    14.3    24.8 17722.6  109.41
        0.0     0.0     0.0     0.0    0.0     0.0    18.9     0.0     0.0    0.00
        0.0    16.0     0.0     0.0    0.0     0.0     0.0     0.0     0.0    0.00
        0.0     0.0     0.0     0.0    0.0     0.0     0.0     0.0     0.0    3.00
        0.0   730.0     0.0  1980.0    0.0     0.0   115.4     0.0     0.0  115.42
        0.0     0.0     0.0     0.0    0.0     0.0     0.0     0.0     0.0    0.00
>>        1
     13.0 1996.0     1.7     1.7 6825.2  357.0     0.0    90.0  1175.0    2.00
        1.0     2.0     3.0     0.0    2.0     5.0     2.0     0.0     0.0    0.00
        0.0     0.0     0.0     6.0    0.0     0.0     0.0  1992.0     5.0    1.00
     1138.6     2.0    45.4   115.4   16.0    15.6    14.3    24.8 17722.6  109.41
        0.0     0.0     0.0     0.0    0.0     0.0     0.0     0.0     0.0    0.00
        0.0    16.0     0.0     0.0    0.0     0.0    18.9     0.0     0.0    3.00
        0.0   730.0     0.0  1980.0    0.0     0.0   115.4     0.0     0.0  115.42
        0.0     0.0     0.0     0.0    0.0     0.0     0.0     0.0     0.0    0.00

tree    n  sp   d     h      ba                vol  age   st     pw   value
   1  113.  2 15.0  14.7  0.018   30  0.13  0.133   45 0.00   0.13    19.3  0.2  1   0  35  0.0  0  0.13
   2  177.  2 12.0  12.2  0.011   26  0.07  0.071   41 0.00   0.07     9.9  0.2  1   0  37  0.0  0  0.07
   3  210.  2 11.0  11.2  0.010   25  0.06  0.055   40 0.00   0.05     7.5  0.2  1   0  38  0.0  0  0.05
   4  255.  2 10.0  10.1  0.008   24  0.04  0.042   39 0.00   0.04     5.4  0.2  1   0   0  0.0  0  0.04
   5   88.  2 17.0  16.3  0.023   32  0.19  0.188   47 0.00   0.18    27.6  0.2  1   0  34  0.0  0  0.18
   6  210.  2 11.0  11.2  0.010   25  0.06  0.055   40 0.00   0.05     7.5  0.2  1   0  38  0.0  0  0.05
   7   44.  2 24.0  19.3  0.045   38  0.42  0.421   53 0.28   0.14    77.3  0.2  1   0  31  0.0  0  0.42
   8   41.  2 25.0  19.5  0.049   39  0.46  0.456   54 0.31   0.15    84.1  0.2  1   0  30  0.0  0  0.45
  -----

* <clip> ... The rest of the file was cut out ... <clip>
```

tree	id	ih	if			
1	0.0	0.00	0.0	1.	0.	0.00	0.00
2	0.0	0.00	0.0	2.	0.	0.00	0.00
3	0.0	0.00	0.0	3.	0.	0.00	0.00
4	0.0	0.00	0.0	4.	0.	0.00	0.00
5	0.0	0.00	0.0	5.	0.	0.00	0.00
6	0.0	0.00	0.0	6.	0.	0.00	0.00
7	0.0	0.00	0.0	7.	0.	0.00	0.00
8	0.0	0.00	0.0	8.	0.	0.00	0.00

Growth updating by presimulation in MELASIM

Commands

```
>MELASIM
MELASIM>SIMULATE UD F2
MELASIM>EXIT
```

Arguments

UD	see UD.PAR
F2	forestry unit F2

Input files

MELA_SET.PAR	see Example H.1
MS_EVENT.PAR	see Example H.6
UD.PAR	see Example H.13
F2.RSD	initial data file
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3
VOLUME.VOL	see Appendix C.2

Output files

F2.MSC	management schedule files
F2.MSD	management schedule files
F2_F2_S.SUM	see Example H.14

Notice

OUTPUT (1) = 1 enables management schedule files.
OUTPUT (2) = 1 enables forest level summary reports.
OUTPUT (3) = 0 disables management schedule summaries.
OUTPUT (4) = 0 disables simulation data (sample plot and sample tree) reports.

The absolute values for the YEARS parameter enable the presimulation for the growth updating of the initial data, cf. Examples H.5 to H.8.

Example H.13. A parameter definition file for the integrated updating of the initial data and the simulation of alternative management schedules.

```
* UD.PAR *
YEARS                1997 2007 2017 2027 2037
OUTPUT               1 1 0 0 0 0 0 0 0 0
SIMULATION_CONTROL 41 50 0 0 1000 0 1 999 0 0 50 0 0 0 151 0 0
INCLUDE MS_EVENT.PAR
```

Example H.14. A forest level summary report from the integrated updating of the initial data and the simulation of alternative management schedules.

*** F2_F2_S.SUM ***

<>mela<> 270996 160048

UD F2 F2

	1997	2007	2017	2027	2037
FORESTRY LAND AREA, ha	24.1	24.1	24.1	24.1	24.1
TOTAL VOLUME, m3	2951.6	3751.2	2121.0	2037.3	3157.8
Pine	1861.5	2540.1	1192.8	1082.5	1648.6
Spruce	1013.8	1048.3	653.1	751.1	1196.2
Birch	59.3	125.8	209.5	154.5	232.9
Other deciduous	17.0	37.0	65.6	49.4	80.1
Saw log	1314.6	1800.8	990.6	1094.5	1723.9
Pulpwood	1503.6	1819.3	1056.1	879.2	1265.0
VALUE (roadside prices), FIM	550341	734890	413295	404083	639783
NET PRESENT VALUE (NPV) 3%	642081	787104	586496	626725	843098

	1997	2007	2017	2027	2037
INCREMENT, m3/a	128.2	108.7	86.0	115.9	
Pine	76.6	61.2	40.6	58.3	
Spruce	42.5	34.8	32.7	45.6	
Birch	7.0	9.8	9.6	8.8	
Other deciduous	2.1	2.9	3.1	3.2	
TOTAL DRAIN, m3/a	48.3	271.7	94.4	3.8	
Mortality	3.4	4.1	3.6	3.8	
Cutting drain	44.8	267.6	90.8	0.0	
CUTTING REMOVAL, m3/a	44.1	261.9	88.7	0.0	
Shelterwood cuttings	20.8	5.8	50.6	0.0	
Thinnings	23.2	16.0	38.1	0.0	
Regeneration cuttings	0.0	240.1	0.0	0.0	
Pine	6.0	191.8	50.6	0.0	
Spruce	38.1	70.1	21.7	0.0	
Birch	0.0	0.0	12.0	0.0	
Other deciduous	0.0	0.0	4.3	0.0	
Saw log	27.8	162.7	51.0	0.0	
Pulpwood	16.3	99.2	37.7	0.0	
TOTAL CUTTING AREA, ha/a	0.5	1.6	1.5	0.0	
Thinnings	0.3	0.2	0.4	0.0	
Clear cuttings	0.0	0.2	0.0	0.0	
Over story cuttings	0.1	0.1	1.1	0.0	
Seed tree cuttings	0.0	1.1	0.0	0.0	
Shelterwood cuttings	0.0	0.0	0.0	0.0	
REGENERATION AREA, ha/a	0.0	1.3	0.0	0.0	
Artificial regeneration	0.0	0.2	0.0	0.0	
Natural regeneration	0.0	1.1	0.0	0.0	
TENDING YOUNG STANDS, ha/a	0.3	0.2	1.1	0.1	
GROSS REVENUES, FIM/a	9181.7	56023.5	20028.6	0.0	
TOTAL COSTS, FIM/a	2447.1	14148.5	5681.7	73.9	
NET REVENUES, FIM/a	6734.6	41875.0	14346.9	-73.9	

Storing of simulation records in MELASIM for further use

Commands

```
>MELASIM
MELASIM>SIMULATE MF F2
MELASIM>EXIT
```

Arguments

MF	see MF.PAR
F2	forestry unit F2

Input files

MELA_SET.PAR	see Example H.1
MS_EVENT.PAR	see Example H.6
MF.PAR	see Example H.15
F2.RSD	initial data file
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3
VOLUME.VOL	see Appendix C.2

Output files

F2.SMR	see Appendix C.2

Notice

OUTPUT (9) = 1.2 enables the generation of simulation record (**smr** type) files.
SIMULATION_CONTROL (1) = 1 provides the relative year (initial state) for finishing the simulation.
SIMULATION_CONTROL (12) = 1 provides the relative year (initial state) for storing simulation records.
UNUSED_GROWTH_ESTIMATES = 1 clears unused growth estimates before storing simulation records.

The absolute value for the YEARS parameter enables the presimulation for the growth updating of the initial data.

For the processing of **smr** type files by user routines, see Appendices C.2 and G.

Example H.15. A parameter definition file for the storing of simulation records.

```
* MF.PAR *
YEARS                1996
OUTPUT               0 0 0 0 0 0 0 0 1.2 0
SIMULATION_CONTROL 1 50 0 0 1000 0 1 0 0 0 50 1 0 0 1 0 0
UNUSED_GROWTH_ESTIMATES 1
INCLUDE MS_EVENT.PAR
```

H.5 Selection of Forest and Stand Level Solutions

A MELAOPT session for cutting potential

Commands

```
>MELAOPT
MELAOPT>SOLVE P5 FX
MELAOPT>REPORT SUMMARY
MELAOPT>EXIT
```

Arguments

P5	see P5.MDL
FX	see FX.PAR

Input files

P5.MDL	see Example H.16
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule files, see FX.PAR
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3

Output files

MELAOPT session log	see Example H.17
FX_sub_unit_P5_O.MSC	forest level summary files, see Appendix C.2
FX_sub_unit_P5_O.MSD	forest level summary files, see Appendix C.2
FX_sub_unit_P5.SMS	standwise simulation instruction files, see Appendix C.2
FX_FX_P5_O.SUM	see Example H.18
	('sub_unit' stands for F1 to WR in turn)

Notice

For an introduction to the optimization problem, see Chapter 4.2.2.1. In fact, the maximization of the net present value without forest level constraints in Example H.16 is a typical stand level optimization problem.

The MELAOPT session log should be always checked for warnings and error messages.

Example H.16. A JLP problem definition for the cutting potential.

```
* P5.MDL *

* CUTTING POTENTIAL
* 'xvar' section is obligatory:
* at least variables of the 'prob' section have to be mentioned
* 'xvar' section defines also decision variables for SOLUTION report

xvar x0805,x0537>
,x0700,x1700,x2700,x3700,x4700>
,x0697,x1697,x2697,x3697,x4697>
,x1090,x2090,x3090,x4090>
,x1195,x2195,x3195,x4195>
,x1193,x2193,x3193,x4193>
,x1370,x2370,x3370,x4370>
,x0800,x4800,x0803,x4803

* 'prob' section is obligatory
prob P5 - CUTTING POTENTIAL - NPV 5 %

* maximize net present value using 5 % interest rate
x0805 max
/
```

Example H.17. A MELAOPT session log report for the cutting potential problem.

```
* MELAOPT session log * (excerpts)

 MELAOPT> SOLVE P5 FX

* <clip>... Part of the report was cut out ... <clip>

============================================================
 <>MELA<>   FX  - all:
            P5-max 5 % NPV-no constraints   solution is optimum
------------------------------------------------------------
                           1996    2006    2016    2026    2036
------------------------------------------------------------
 805 NPV 5 %             2390033
 537 Forestry land area    195.4
 700 Volume, m3          18472.0 14345.4 13476.4 13385.1 17618.2
 697 -saw log             7503.8  4494.8  4084.6  3535.7  4656.2
 090 Increment, m3/a           726.1   629.5   678.3   833.6
 195 Cutting removal, m3/a    1075.2   675.1   636.6   371.9
 193 -saw log                  601.6   304.2   284.0   165.2
 370 Net revenues, FIM/a      159424 88203.8 87491.7 49957.1
 800 Roadside value,FIM  3413323                         2948357
 803 NPV 3 %             3939953                         4577281
 ============================================================

 MELAOPT>
```

Example H.18. A MELAOPT summary report for the cutting potential problem.

```
* FX_FX_P5_O.SUM *

 <>mela<> 300996  85510
=====================================================================
FX - P5-max 5 % NPV-no constraints - all:
---------------------------------------------------------------------
                                1996    2006    2016    2026    2036
---------------------------------------------------------------------
FORESTRY LAND AREA, ha         195.4   195.4   195.4   195.4   195.4

TOTAL VOLUME, m3             18472.0 14345.4 13476.4 13385.1 17618.2
  Pine                        9597.5  9000.8  8592.2  7912.6  9308.7
  Spruce                      6490.1  3211.3  2810.1  3238.3  5054.7
  Birch                       2073.7  1819.2  1730.3  1993.7  2877.4
  Other deciduous              310.6   314.2   343.8   240.5   377.4

  Saw log                     7503.8  4494.8  4084.6  3535.7  4656.2
  Pulpwood                    9772.1  8871.8  8448.6  8938.1 11696.3
---------------------------------------------------------------------
VALUE (roadside prices),FIM  3413322 2481888 2311535 2249744 2948357
NET PRESENT VALUE (NPV) 3%   3939953 3446808 3609698 3836862 4577281
---------------------------------------------------------------------
                                1996    2006    2016    2026    2036
---------------------------------------------------------------------
INCREMENT, m3/a                726.1   629.5   678.3   833.6
  Pine                         417.3   392.0   385.2   418.8
  Spruce                       186.6   130.4   164.7   260.1
  Birch                        103.0    87.6   109.0   134.6
  Other deciduous               19.2    19.5    19.3    20.1

TOTAL DRAIN, m3/a             1138.8   716.4   687.4   410.3
  Mortality                     17.0    16.0    16.3    18.1
  Cutting drain               1121.8   700.4   671.1   392.2
---------------------------------------------------------------------
CUTTING REMOVAL, m3/a         1075.2   675.1   636.6   371.9
 Shelterwood cuttings           35.7   143.5    67.9    54.3
 Thinnings                     234.1   210.8   217.8   186.4
 Regeneration cuttings         805.4   320.8   350.9   131.2

 Pine                          447.3   409.9   430.1   263.5
 Spruce                        498.2   162.4   117.9    74.4
 Birch                         116.9    87.4    68.6    28.8
 Other deciduous                12.8    15.4    20.0     5.3

 Saw log                       601.6   304.2   284.0   165.2
 Pulpwood                      473.6   370.9   352.6   206.7
---------------------------------------------------------------------
TOTAL CUTTING AREA, ha/a         9.8     8.6     7.0     4.9
 Thinnings                       4.8     3.8     3.3     3.1
 Clear cuttings                  2.4     0.7     0.8     0.3
 Over story cuttings             0.4     2.4     1.7     1.2
 Seed tree cuttings              0.9     1.7     1.0     0.3
 Shelterwood cuttings            1.2     0.0     0.2     0.0

REGENERATION AREA, ha/a          4.5     2.4     2.0     0.7
 Artificial regeneration         2.4     0.7     0.8     0.3
 Natural regeneration            2.1     1.7     1.2     0.3

TENDING YOUNG STANDS, ha/a       2.8     3.7     4.1     2.6
---------------------------------------------------------------------
GROSS REVENUES, FIM/a          229736  131976  127563 73160.2
TOTAL COSTS, FIM/a            70312.0 43772.2 40071.1 23203.1
NET REVENUES, FIM/a            159424 88203.8 87491.7 49957.1
```

A MELAOPT session for maximum sustained yield

Commands

```
>MELAOPT
MELAOPT>SOLVE S4 FX
MELAOPT>REPORT SUMMARY
MELAOPT>EXIT
```

Arguments

S4	see S4.MDL
FX	see FX.PAR

Input files

S4.MDL	see Example H.19
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule files, see FX.PAR
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3

Output files

MELAOPT session log	see Example H.20
FX_sub_unit_S4_O.MSC	forest level summary files, see Appendix C.2
FX_sub_unit_S4_O.MSD	forest level summary files, see Appendix C.2
FX_sub_unit_S4.SMS	standwise simulation instruction files, see Appendix C.2
FX_FX_S4_O.SUM	see Example H.21
	('sub_unit' stands for F1 to WR in turn)

Notice

For an introduction to the optimization problem, see Chapter 4.2.2.2.

Evaluate the result with regard to the future sustainability and adjust the constraints for net present values if necessary.

The MELAOPT session log should be always checked for warnings and error messages.

Example H.19. A JLP problem definition for the maximum sustained yield.

```
* S4.MDL *

* MAXIMUM SUSTAINED YIELD

xvar x0804,x4804,x0537>
,x0700,x1700,x2700,x3700,x4700>
,x0697,x1697,x2697,x3697,x4697>
,x1090,x2090,x3090,x4090>
,x1195,x2195,x3195,x4195>
,x1193,x2193,x3193,x4193>
,x1370,x2370,x3370,x4370>
,x0800,x4800

prob S4 - MAX. SUSTAINED YIELD - NPV 4 %

* maximize net present value using 4 % interest rate
x0804 max

* non-declining cutting removals
x2195-x1195>0
x3195-x2195>0
x4195-x3195>0

* non-declining saw timber removals compared with first sub-period
x2193-x1193>0
x3193-x2193>0
x4193-x3193>0

* non-declining net revenues
x2370-x1370>0
x3370-x2370>0
x4370-x3370>0

* 20 % higher net present value at the end of the calculation period
* is assumed here to guarantee the sustainable yield level
* after the calculation period

x4804-1.2*x0804>0
/
```

Example H.20. A MELAOPT session log report for the problem of the maximum sustained yield.

```
* MELAOPT session log *

 MELAOPT> SOLVE S4 FX

* <clip>... Part of the report was cut out ... <clip>

================================================================
 <>MELA<>    FX  - all:
             S4-MAXIMUM SUSTAINED YIELD,4%  solution is optimum
----------------------------------------------------------------
                            1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %              2917768                         3501322
 537 Forestry land area     195.4
 700 Volume, m3          18472.0 18903.3 18728.5 18333.3 18724.2
 697 -saw log             7503.8  7085.6  6752.4  6343.6  5971.5
 090 Increment, m3/a           785.9   756.0   766.6   824.9
 195 Cutting removal, m3/a     685.3   732.8   744.1   747.4
 193 -saw log                  387.3   387.3   387.3   390.2
 370 Net revenues, FIM/a      101863  114144  114144  114144
 800 Roadside value,FIM  3413323                         3276647
 ================================================================

 MELAOPT>
```

Example H.21. A MELAOPT summary report for the problem of the maximum sustained yield.

```
* FX_FX_S4_O.SUM *

<>mela<> 300996  92607
=========================================================================
FX - SK5-MAXIMUM SUSTAINED YIELD,4% - all:
-------------------------------------------------------------------------
                              1996    2006    2016    2026    2036
-------------------------------------------------------------------------
FORESTRY LAND AREA, ha        195.4   195.4   195.4   195.4   195.4

TOTAL VOLUME, m3            18472.0 18903.3 18728.5 18333.3 18724.2
  Pine                       9597.5 11317.5 12141.1 11816.8 10556.3
  Spruce                     6490.1  4517.6  4045.1  4230.6  5251.0
  Birch                      2073.7  2688.9  2180.7  2010.8  2480.1
  Other deciduous             310.6   379.3   361.6   275.0   436.8

  Saw log                    7503.8  7085.6  6752.4  6343.6  5971.5
  Pulpwood                   9772.1 10765.6 10938.6 11118.7 11701.0
-------------------------------------------------------------------------
VALUE (roadside prices),FIM 3413322 3468710 3376879 3290281 3276646
NET PRESENT VALUE (NPV) 3%  4036690 4244096 4380464 4563731 4810028
-------------------------------------------------------------------------
                              1996    2006    2016    2026    2036
-------------------------------------------------------------------------
INCREMENT, m3/a                785.9   756.0   766.6   824.9
  Pine                         446.5   464.3   468.9   451.7
  Spruce                       204.1   166.7   189.0   255.3
  Birch                        114.3   103.2    88.5    96.5
  Other deciduous               21.0    21.7    20.2    21.4

TOTAL DRAIN, m3/a              742.8   773.4   806.1   785.8
  Mortality                     19.2    22.7    25.1    23.1
  Cutting drain                723.6   750.7   781.1   762.7
-------------------------------------------------------------------------
CUTTING REMOVAL, m3/a          685.3   732.8   744.1   747.4
 Shelterwood cuttings           35.7    96.3    88.7    69.5
 Thinnings                     208.4   156.6   200.2   338.5
 Regeneration cuttings         441.2   479.9   455.2   339.3

 Pine                          247.0   359.0   475.2   554.5
 Spruce                        386.6   207.3   161.1   148.8
 Birch                          43.0   144.8    89.0    40.1
 Other deciduous                 8.7    21.6    18.8     3.9

 Saw log                       387.3   387.3   387.3   390.2
 Pulpwood                      298.0   345.4   356.7   357.2
-------------------------------------------------------------------------
TOTAL CUTTING AREA, ha/a         6.5     6.7     6.8     6.8
 Thinnings                       3.7     2.9     3.0     4.2
 Clear cuttings                  1.4     0.7     0.8     0.7
 Over story cuttings             0.4     1.4     1.7     1.2
 Seed tree cuttings              0.4     1.2     1.1     0.5
 Shelterwood cuttings            0.6     0.5     0.1     0.2

REGENERATION AREA, ha/a          2.4     2.4     2.1     1.4
 Artificial regeneration         1.4     0.7     0.8     0.7
 Natural regeneration            1.0     1.7     1.2     0.7

TENDING YOUNG STANDS, ha/a       2.8     2.3     2.9     2.2
-------------------------------------------------------------------------
GROSS REVENUES, FIM/a          147167  156595  157539  154908
TOTAL COSTS, FIM/a           45303.5 42450.3 43394.3 40764.0
NET REVENUES, FIM/a            101863  114144  114144  114144
```

A MELAOPT session for assumed harvests

Commands

```
>MELAOPT
MELAOPT>SOLVE A3 FX
MELAOPT>REPORT SUMMARY
MELAOPT>EXIT
```

Arguments

S4	see A3.MDL
FX	see FX.PAR

Input files

A3.MDL	see Example H.22
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule files, see FX.PAR
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3

Output files

MELAOPT session log	see Example H.23
FX_sub_unit_A3_O.MSC	forest level summary files, see Appendix C.2
FX_sub_unit_A3_O.MSD	forest level summary files, see Appendix C.2
FX_sub_unit_A3.SMS	standwise simulation instruction files, see Appendix C.2
FX_FX_A3_O.SUM	see Example H.24
	('sub_unit' stands for F1 to WR in turn)

Notice

For an introduction to the optimization problem, see Chapter 4.2.2.3.

There would be infeasibilities in solving problems of this kind. In those cases, change or remove the constraints until the feasible solution is achieved. Try different interest rates and compare results.

The MELAOPT session log should be always checked for warnings and error messages.

Example H.22. A JLP problem definition for the assumed harvests.

```
* A3.MDL *

* CUTTINGS BASED ON THE ASSUMED REMOVALS

xvar   x0803,x4803,x0537>
,x0700,x1700,x2700,x3700,x4700>
,x0697,x1697,x2697,x3697,x4697>
,x1090,x2090,x3090,x4090>
,x1195,x2195,x3195,x4195>
,x1193,x2193,x3193,x4193>
,x1183,x2183,x3183,x4183>
,x1181,x2181,x3181,x4181>
,x1186,x2186,x3186,x4186>
,x1184,x2184,x3184,x4184>
,x1189,x2189,x3189,x4189>
,x1192,x2192,x3192,x4192>
,x1370,x2370,x3370,x4370>
,x0800,x4800

prob A3 - ASSUMED CUTTINGS 3 % NPV
x0803 max

* total removals
x1195=460
x2195=460
x3195=460
x4195=460

* saw timber removals
x1193=245
x2193=245
x3193=245
x4193=245

* pine removals
x1183<195
x2183<195
x3183<195
x4183<195

* removals of pine saw logs
x1181>105
x2181>105
x3181>105
x4181>105

* spruce removals
x1186>230
x2186>230
x3186>230

* removals of spruce saw logs
x1184>135
x2184>135
x3184>135

* deciduous removals
x1189+x1192<35
x2189+x2192<35
x3189+x3192<35
/
```

Example H.23. A MELAOPT session log report for the problem of the assumed harvests.

```
* MELAOPT session log *

 MELAOPT> SOLVE A3 FX

* <clip> ... Part of the report was cut out ... <clip>

================================================================
 <>MELA<>   FX  - all:
            A3-ASSUMED CUTTINGS, 3 % NPV    solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 803 NPV 3 %             3732200                         6915071
 537 Forestry land area    195.4
 700 Volume, m3          18472.0 21486.6 24780.5 28265.0 32388.2
 697 -saw log             7503.8  8781.8 10547.5 12476.0 14934.9
 090 Increment, m3/a          814.4   836.0   869.3   941.2
 195 Cutting removal, m3/a    460.0   460.0   460.0   460.0
 193 -saw log                 245.0   245.0   245.0   245.0
 183 -pine, m3/a              195.0   195.0   195.0   195.0
 181 --pine saw log           105.0   105.0   105.0   105.0
 186 -spruce, m3/a            230.0   230.0   230.0   109.6
 184 --spruce saw log         135.0   137.2   136.2   102.8
 189 -birch, m3/a              31.0    24.5    34.8   123.2
 192 -other deciduous, m3/a     4.0    10.5     0.2    32.2
 370 Net revenues, FIM/a    65383.4 68665.7 71395.6 75018.6
 800 Roadside value,FIM  3413323                         6431101
================================================================

 MELAOPT>
```

Example H.24. A MELAOPT summary report for the problem of the assumed harvests.

*** FX_FX_A3_O.SUM ***

<>mela<> 300996 141615

FX - A3-ASSUMED CUTTINGS 3 % NPV - all:

	1996	2006	2016	2026	2036
FORESTRY LAND AREA, ha	195.4	195.4	195.4	195.4	195.4
TOTAL VOLUME, m3	18472.0	21486.6	24780.5	28265.0	32388.2
Pine	9597.5	11878.3	14572.1	17510.7	20837.7
Spruce	6490.1	6323.0	5928.8	5417.6	6391.2
Birch	2073.7	2834.3	3708.7	4470.3	4270.1
Other deciduous	310.6	451.0	570.9	866.4	889.2
Saw log	7503.8	8781.8	10547.5	12476.0	14934.9
Pulpwood	9772.1	11598.8	13148.3	14680.2	16243.6
VALUE (roadside prices),FIM	3413322	4047531	4769140	5528714	6431101
NET PRESENT VALUE (NPV) 3%	3732200	4257791	4926089	5792581	6915072

	1996	2006	2016	2026	2036
INCREMENT, m3/a		814.4	836.0	869.3	941.2
Pine		452.1	489.0	521.9	572.7
Spruce		223.6	199.1	188.3	212.2
Birch		115.9	121.8	127.2	118.5
Other deciduous		22.8	26.1	31.9	37.9
TOTAL DRAIN, m3/a		512.9	506.6	520.9	528.9
Mortality		22.3	32.5	43.5	55.1
Cutting drain		490.6	474.1	477.3	473.8
CUTTING REMOVAL, m3/a		460.0	460.0	460.0	460.0
Shelterwood cuttings		35.7	68.3	9.6	22.4
Thinnings		149.8	216.7	146.5	226.6
Regeneration cuttings		274.5	175.0	303.8	211.0
Pine		195.0	195.0	195.0	195.0
Spruce		230.0	230.0	230.0	109.6
Birch		31.0	24.5	34.8	123.2
Other deciduous		4.0	10.5	0.2	32.2
Saw log		245.0	245.0	245.0	245.0
Pulpwood		215.0	215.0	215.0	215.0
TOTAL CUTTING AREA, ha/a		5.2	5.4	4.1	3.1
Thinnings		3.0	3.5	2.6	2.3
Clear cuttings		0.9	0.5	0.7	0.3
Over story cuttings		0.4	1.1	0.2	0.2
Seed tree cuttings		0.4	0.2	0.0	0.4
Shelterwood cuttings		0.5	0.0	0.5	0.0
REGENERATION AREA, ha/a		1.8	0.8	1.2	0.7
Artificial regeneration		0.9	0.5	0.7	0.3
Natural regeneration		0.8	0.2	0.5	0.4
TENDING YOUNG STANDS, ha/a		2.8	2.5	1.7	1.1
GROSS REVENUES, FIM/a		97065.4	98268.2	100907	99403.4
TOTAL COSTS, FIM/a		31682.1	29602.5	29511.3	24384.7
NET REVENUES, FIM/a		65383.4	68665.7	71395.6	75018.6

A MELAOPT session for harvests bound to increment

Commands

```
>MELAOPT
MELAOPT>SOLVE D4 FX
MELAOPT>REPORT SUMMARY
MELAOPT>EXIT
```

Arguments

D4	see D4.MDL
FX	see FX.PAR

Input files

D4.MDL	see Example H.25
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule files, see FX.PAR
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3

Output files

MELAOPT session log	see Example H.26
FX_sub_unit_D4_O.MSC	forest level summary files, see Appendix C.2
FX_sub_unit_D4_O.MSD	forest level summary files, see Appendix C.2
FX_sub_unit_D4.SMS	standwise simulation instruction files, see Appendix C.2
FX_FX_D4_O.SUM	see Example H.27
	('sub_unit' stands for F1 to WR in turn)

Notice

For an introduction to the optimization problem, see Chapter 4.2.2.3.

The MELAOPT session log should be always checked for warnings and error messages.

Example H.25. A JLP problem definition for harvests bound to increment.

```
* D4.MDL *

* HARVESTS BOUND TO INCREMENT, SAW LOG REMOVALS, AND
* REGENERATION AREA

xvar x0804,x4804,x0537>
,x0700,x1700,x2700,x3700,x4700>
,x0697,x1697,x2697,x3697,x4697>
,x1090,x2090,x3090,x4090>
,x1195,x2195,x3195,x4195>
,x1193,x2193,x3193,x4193>
,x1035,x2035,x3035,x4035>
,x1370,x2370,x3370,x4370>
,x0800,x4800

prob D4 - INCREMENT REGULATION - 4 % NPV

* maximize net present value using 4 % interest rate
x0804 max

* total removal during each sub-period
* equals to 90 % of total increment
x1195-0.9*x1090=0
x2195-0.9*x2090=0
x3195-0.9*x3090=0
x4195-0.9*x4090=0

* minimum saw log removal during each sub-period
* greater than 45 % of total removal
x1193-0.45*x1195>0
x2193-0.45*x2195>0
x3193-0.45*x3195>0
x4193-0.45*x4195>0

* annual regeneration area less than 1.5 % of forestry land area
x1035-0.015*x0537<0
x2035-0.015*x0537<0
x3035-0.015*x0537<0
x4035-0.015*x0537<0
/
```

Example H.26. A MELAOPT session log report for the problem of harvests bound to increment.

```
* MELAOPT session log *

 MELAOPT> SOLVE D4 FX

* <clip> ... Part of the report was cut out ... <clip>

================================================================
 <>MELA<>    FX  - all:
             D4-INCREMENT REGULATION-4 % NPV  solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %             2918426                         3649481
 537 Forestry land area    195.4
 700 Volume, m3          18472.0 18690.4 18996.8 19146.8 19616.7
 697 -saw log             7503.8  6486.8  6660.3  6563.0  6220.2
 090 Increment, m3/a           780.1   753.0   801.5   864.3
 195 Cutting removal, m3/a     702.1   677.7   721.4   777.9
 193 -saw log                  445.1   326.1   352.5   386.5
 035 Regeneration area, ha/a     2.8     2.1     1.8     1.5
 370 Net revenues, FIM/a      111208  100409  104963  115603
 800 Roadside value,FIM  3413323                         3444336
================================================================

 MELAOPT>
```

Example H.27. A MELAOPT summary report for the problem of harvests bound to increment.

```
* FX_FX_D4_0.SUM *

<>mela<> 300996 151743
=============================================================================
FX - D4-INCREMENT REGULATION-4 % NPV - all:
-----------------------------------------------------------------------------
                              1996    2006    2016    2026    2036
-----------------------------------------------------------------------------
FORESTRY LAND AREA, ha        195.4   195.4   195.4   195.4   195.4

TOTAL VOLUME, m3            18472.0 18690.4 18996.8 19146.8 19616.7
  Pine                       9597.5 11918.9 12321.1 12284.1 10905.8
  Spruce                     6490.1  3740.4  4009.6  4319.9  5301.7
  Birch                      2073.7  2682.0  2271.4  2286.8  3039.8
  Other deciduous             310.6   349.2   394.7   256.0   369.3

  Saw log                    7503.8  6486.8  6660.3  6563.0  6220.2
  Pulpwood                   9772.1 11125.6 11247.5 11700.2 12298.9
-----------------------------------------------------------------------------
VALUE (roadside prices),FIM 3413322 3338013 3374781 3442900 3444335
NET PRESENT VALUE (NPV) 3%  4041149 4141754 4402151 4699318 4975330
-----------------------------------------------------------------------------
                              1996    2006    2016    2026    2036
-----------------------------------------------------------------------------
INCREMENT, m3/a                780.1   753.0   801.5   864.3
  Pine                         452.3   470.0   475.3   460.4
  Spruce                       193.5   155.2   189.2   257.4
  Birch                        114.3   106.4   116.9   126.7
  Other deciduous               20.1    21.4    20.2    19.8

TOTAL DRAIN, m3/a              758.3   722.4   786.5   817.3
  Mortality                     21.3    26.7    26.0    22.8
  Cutting drain                737.0   695.7   760.6   794.5
-----------------------------------------------------------------------------
CUTTING REMOVAL, m3/a          702.1   677.7   721.4   777.9
 Shelterwood cuttings           35.7    96.3    81.9    61.3
 Thinnings                     119.9   179.0   254.1   357.5
 Regeneration cuttings         546.5   402.4   385.4   359.1

 Pine                          192.3   402.7   451.2   574.6
 Spruce                        453.9   122.5   148.9   154.0
 Birch                          45.2   137.3    97.7    41.7
 Other deciduous                10.7    15.2    23.6     7.5

 Saw log                       445.1   326.1   352.5   386.5
 Pulpwood                      257.0   351.6   368.9   391.4
-----------------------------------------------------------------------------
TOTAL CUTTING AREA, ha/a         5.7     5.9     6.9     7.3
 Thinnings                       2.5     2.5     3.6     4.8
 Clear cuttings                  1.9     0.5     0.8     0.6
 Over story cuttings             0.4     1.4     1.5     1.1
 Seed tree cuttings              0.4     1.0     1.0     0.7
 Shelterwood cuttings            0.6     0.5     0.1     0.2

REGENERATION AREA, ha/a          2.8     2.1     1.8     1.5
 Artificial regeneration         1.9     0.5     0.8     0.6
 Natural regeneration            1.0     1.5     1.1     0.9

TENDING YOUNG STANDS, ha/a       2.8     2.4     2.8     2.4
-----------------------------------------------------------------------------
GROSS REVENUES, FIM/a          157335  140212  146714  159075
TOTAL COSTS, FIM/a             46126.6 39802.9 41751.6 43471.7
NET REVENUES, FIM/a             111208  100409  104963  115603
```

Reports for domains in MELAOPT

Commands

```
>MELAOPT
MELAOPT>SOLVE SQ FX
MELAOPT>REPORT SUMMARY
MELAOPT>REPORT SOLUTION REGION=SR:
MELAOPT>EXIT
```

Arguments

SQ	see SQ.MDL
FX	see FX.PAR

Input files

SQ.MDL	see Example H.28
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule files, see FX.PAR
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3

Output files

MELAOPT session log	see Example H.29
FX_sub_unit_SQ_O.MSC	forest level summary files, see Appendix C.2
FX_sub_unit_SQ_O.MSD	forest level summary files, see Appendix C.2
FX_sub_unit_SQ.SMS	standwise simulation instruction files, see Appendix C.2
FX_SR_SQ.SOL	see Example H.21
FX_FX_SQ_O.SUM	forest level summary report ('sub-unit' stands for F1 to WR in turn)

Notice

The 'show/domain' paragraph in Example H.28 is for automatic reporting.

See Chapter 3.5.2.2 for the report requesting for domains.

The MELAOPT session log should be always checked for warnings and error messages.

Example H.28. A JLP problem definition with a report request for domains.

```
* SQ.MDL *

* MAXIMUM SUSTAINED YIELD
*  - using domain definition for reporting

xvar   x0804,x4804,x0537>
,x0700,x1700,x2700,x3700,x4700>
,x0697,x1697,x2697,x3697,x4697>
,x1090,x2090,x3090,x4090>
,x1195,x2195,x3195,x4195>
,x1193,x2193,x3193,x4193>
,x1370,x2370,x3370,x4370>
,x0800,x4800

prob SQ - MAXIMUM SUSTAINED YIELD, 4%

x0804 max
* non-declining cutting removals
x2195-x1195>0
x3195-x2195>0
x4195-x3195>0

* non-declining saw timber removals compared to first sub-period
x2193-x1193>0
x3193-x1193>0
x4193-x1193>0

* non-declining net revenues
x2370-x1370>0
x3370-x2370>0
x4370-x3370>0

* 20 % higher net present value at the end of the calculation period
* is assumed here to guarantee the sustainable yield level beyond
* the calculation period
x4804-1.2*x0804>0
/

* domains for reporting
show/domain
REGION=WR:
DISTRICT=F2:
/
```

Example H.29. A MELAOPT session log report for domains defined in the problem definition file.

```
* MELAOPT session log *

 MELAOPT> SOLVE SQ FX

* <clip> ... Part of the report was cut out ... <clip>

================================================================
 <>MELA<>    FX  - all:
             SQ-MAXIMUM SUSTAINED YIELD,4%   solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %             2917768                         3501322
 537 Forestry land area    195.4
 700 Volume, m3          18472.0 18903.3 18728.5 18333.3 18724.2
 697 -saw log             7503.8  7085.6  6752.4  6343.6  5971.5
 090 Increment, m3/a           785.9   756.0   766.6   824.9
 195 Cutting removal, m3/a     685.3   732.8   744.1   747.4
 193 -saw log                  387.3   387.3   387.3   390.2
 370 Net revenues, FIM/a      101863  114144  114144  114144
 800 Roadside value,FIM  3413323                         3276647

================================================================
 <>MELA<>    FX  - REGION=WR:
             SQ-MAXIMUM SUSTAINED YIELD,4%   solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %              531284                          558606
 537 Forestry land area     29.6
 700 Volume, m3           3285.0  3546.3  2690.5  2712.7  3042.8
 697 -saw log             1009.3  1200.0   832.2   848.6  1096.6
 090 Increment, m3/a           159.4   140.2   124.9   148.0
 195 Cutting removal, m3/a     121.8   213.1   108.6   108.3
 193 -saw log                   44.5   102.2    62.0    48.9
 370 Net revenues, FIM/a      16224.8 32641.6 16781.7 14749.5
 800 Roadside value,FIM   592238                          525811

================================================================
 <>MELA<>    FX  - SUB_REGION=F2:
             SQ-MAXIMUM SUSTAINED YIELD,4%   solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %              463063                          419482
 537 Forestry land area     24.1
 700 Volume, m3           2829.4  3420.3  3224.3  2357.1  1777.3
 697 -saw log             1224.6  1620.2  1626.7  1306.6   629.5
 090 Increment, m3/a           123.1   118.5   107.0   100.9
 195 Cutting removal, m3/a      60.0   130.5   185.9   155.2
 193 -saw log                   34.2    85.1   104.5   113.8
 370 Net revenues, FIM/a       8870.8 22043.0 29657.5 27279.5
 800 Roadside value,FIM   525340                          322931
================================================================

* <clip> ... Part of the report was cut out ... <clip>

MELAOPT>
```

Example H.30. A MELAOPT solution report for the domain defined by the REPORT command.

```
* FX_SR_SQ.SOL *

 SQ FX
================================================================
 <>MELA<>    FX  - REGION=SR:
             SQ-MAXIMUM SUSTAINED YIELD,4%      ratkaisu on optimi
----------------------------------------------------------------
                            1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %              1871186                          1745271
 537 Forestry land area      82.4
 700 Volume, m3           10066.0  8659.0  8280.6  7654.2  7616.9
 697 -saw log              5271.4  4051.3  3595.3  2817.2  1622.1
 090 Increment, m3/a            386.7   366.3   405.3   459.0
 195 Cutting removal, m3/a      502.2   389.6   449.9   447.8
 193 -saw log                   335.5   239.4   251.8   264.5
 370 Net revenues, FIM/a     81694.6 66203.7 73973.9 75409.5
 800 Roadside value,FIM   2012435                          1282113
----------------------------------------------------------------
```

Constraints for domains in MELAOPT

Commands

```
>MELAOPT
MELAOPT>SOLVE SD FX
MELAOPT>REPORT SUMMARY
MELAOPT>REPORT SOLUTION DISTRICT=F2.or.DISTRICT=F3:
MELAOPT>EXIT
```

Arguments

SD	see SD.MDL
FX	see FX.PAR

Input files

SD.MDL	see Example H.31
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule files, see FX.PAR
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3

Output files

MELAOPT session log	see Example H.32
FX_sub_unit_SD_O.MSC	forest level summary files, see Appendix C.2
FX_sub_unit_SD_O.MSD	forest level summary files, see Appendix C.2
FX_sub_unit_SD.SMS	standwise simulation instruction files, see Appendix C.2
FX_SD.SOL	see Example H.33
FX_FX_SD_O.SUM	forest level summary report
	('sub_unit' stands for F1 to WR in turn)

Notice

Each domain definition is valid for constraints until the next domain definition (or until the end of the 'prob' section). In Example H.31, sustainability constraints (non-declining cutting removals, saw timber removals and net revenues and final state) are for the forestry unit FX as a whole (i.e. all:) and for the district F2 separately. Clear cutting restrictions are for the district F3 only. - Notice that in the absence of domain definitions the constraints are for the whole forestry unit. See also problem definition (**mdl** type) files in Appendix C.2.

The MELAOPT session log should be always checked for warnings and error messages.

Example H.31. A JLP problem definition with constraints for domains.

```
* SD.MDL *

* MAXIMUM SUSTAINED YIELD
*  - with domain constraints

xvar x0804,x4804,x0537>
,x0700,x1700,x2700,x3700,x4700>
,x0697,x1697,x2697,x3697,x4697>
,x1090,x2090,x3090,x4090>
,x1002,x2002,x3002,x4002>
,x1195,x2195,x3195,x4195>
,x1193,x2193,x3193,x4193>
,x1370,x2370,x3370,x4370>
,x0800,x4800

prob SD - MAXIMUM SUSTAINED YIELD/SD, 4%

* maximize overall NPV (4 %)
x0804 max

* CONSTRAINTS FOR DOMAINS all: (i.e. FX) and DISTRICT=F2:
all: DISRICT=F2:

* non-declining cutting removals
x2195-x1195>0
x3195-x2195>0
x4195-x3195>0

* non-declining saw timber removals compared with first sub-period
x2193-x1193>0
x3193-x1193>0
x4193-x1193>0

* non-declining net revenues
x2370-x1370>0
x3370-x2370>0
x4370-x3370>0

* 20 % higher net present value at the end of the calculation period
* is assumed here to guarantee the sustainable yield level beyond
* the calculation period
x4804-1.2*x0804>0

* CONSTRAINTS FOR DOMAIN DISTRICT=F3:

DISTRICT=F3:

* maximum annual clear cutting area for sub-periods (0.5 %)
x1002-0.005*x0537>0
x2002-0.005*x0537>0
x3002-0.005*x0537>0
x4002-0.005*x0537>0

* minimum clear cutting area for whole calculation period (3.5 %)
x1002+x2002+x3002+x4002-0.035*x0537<0
/
```

Example H.32. A MELAOPT session log report for domains defined by the problem formulation.

```
* MELAOPT session log *

 MELAOPT> SOLVE SD FX

* <clip> ... Part of the report was cut out ... <clip>

================================================================
 <>MELA<>   FX  - all:
            SD -MAXIMUM SUSTAINED YIELD,4%  solution is optimum
----------------------------------------------------------------
                          1996    2006    2016    2026    2036
----------------------------------------------------------------
804 NPV 4 %             2913863                         3496636
 537 Forestry land area    195.4
 700 Volume, m3         18472.0 18806.8 18698.5 18349.3 18600.0
 697 -saw log            7503.8  7092.3  6770.9  6395.0  6073.9
 090 Increment, m3/a           785.7   756.0   766.9   821.7
 002 -clear cutting              1.3     0.8     0.9     0.5
 195 Cutting removal, m3/a     692.8   727.5   741.4   757.4
 193 -saw log                  388.1   388.1   388.1   388.7
 370 Net revenues, FIM/a      101734  113987  113987  113987
 800 Roadside value,FIM  3413323                         3285402
================================================================

* <clip> ... Part of the report was cut out ... <clip>

================================================================
 <>MELA<>   FX  - SUB_REGION=F2:
            SD -MAXIMUM SUSTAINED YIELD,4%  solution is optimum
----------------------------------------------------------------
                          1996    2006    2016    2026    2036
----------------------------------------------------------------
804 NPV 4 %              462233                          554679
 537 Forestry land area     24.1
 700 Volume, m3          2829.4  3289.7  3033.3  2731.5  2487.1
 697 -saw log            1224.6  1555.1  1554.3  1504.6  1180.3
 090 Increment, m3/a           121.1   113.8   110.7   115.0
 002 -clear cutting              0.1     0.1     0.0     0.0
 195 Cutting removal, m3/a      69.1   132.6   134.9   134.9
 193 -saw log                   40.3    84.1    79.9    88.6
 370 Net revenues, FIM/a     10319.6 21923.3 21923.3 22851.2
 800 Roadside value,FIM   525340                          491042
================================================================

 <>MELA<>   FX  - DISTRICT=F3:
            SD -MAXIMUM SUSTAINED YIELD,4%  solution is optimum
----------------------------------------------------------------
                          1996    2006    2016    2026    2036
----------------------------------------------------------------
804 NPV 4 %              432568                          478027
 537 Forestry land area     22.0
 700 Volume, m3          2119.4  1902.0  1971.5  2303.8  2180.9
 697 -saw log            1157.5   895.8   710.1   690.4   357.2
 090 Increment, m3/a           92.1   104.9   124.1   141.5
 002 -clear cutting             0.1     0.1     0.1     0.2
 195 Cutting removal, m3/a     107.9    94.7    86.3   147.1
 193 -saw log                   70.1    61.7    41.1    76.0
 370 Net revenues, FIM/a     16506.3 15643.2 12468.6 25135.5
 800 Roadside value,FIM   417273                          347125
================================================================

 MELAOPT>
```

Example H.33. A MELAOPT solution report for the domains defined by the REPORT command.

```
* FX_SD.SOL *

 SD FX
================================================================
 <>MELA<>    FX  - DISTRICT=F2.or.DISTRICT=F3:
             SD -MAXIMUM SUSTAINED YIELD,4%  solution is optimum
----------------------------------------------------------------
                            1996    2006    2016    2026    2036
----------------------------------------------------------------
804 NPV 4 %               894801                          1032706
 537 Forestry land area     46.1
 700 Volume, m3           4948.8  5191.7  5004.9  5035.3  4668.0
 697 -saw log             2382.1  2451.0  2264.4  2195.0  1537.5
 090 Increment, m3/a           213.3   218.6   234.8   256.6
 002 -clear cutting              0.2     0.2     0.1     0.2
 195 Cutting removal, m3/a     177.0   227.4   221.3   282.0
 193 -saw log                  110.3   145.9   121.0   164.5
 370 Net revenues, FIM/a     26825.9 37566.5 34391.9 47986.7
 800 Roadside value,FIM   942614                           838167
----------------------------------------------------------------
```

Forest level summary data as a part of MELAOPT solution

Commands

Step I: generate the P5 solution for the sub-unit WR

```
>MELAOPT
MELAOPT>SOLVE P5 WR
MELAOPT>REPORT SUMMARY
```

Step II: import the solution P5 instead of the management schedules for the sub-unit WR in a new optimization problem

```
MELAOPT>FORESTRY_UNIT#FZ
MELAOPT>SOLVE S4 FZ
MELAOPT>REPORT SUMMARY
MELAOPT>REPORT SOLUTION DISTRICT=F2:
MELAOPT>REPORT SOLUTION REGION=WR_WR_P5_O:
MELAOPT>EXIT
```

Arguments

P5	see P5.MDL
WR	forestry unit WR
S4	see S4.MDL
FZ	see FZ.PAR

Input files

Step I:

P5.MDL	see Example H.16
WR.MSC	management schedule file
WR.MSD	management schedule file
WR.RSD	initial data file

Step II:

S4.MDL	see Example H.19
F1.MSC-F5.MSC	management schedule files, see FZ.PAR
F1.MSD-F5.MSD	management schedule files, see FZ.PAR
WR_WR_P5_O.MSC	forest level summary file
WR_WR_P5_O.MSD	forest level summary file
FZ.PAR	see Example H.34

Steps I and II:

F1.RSD-F5.RSD	initial data files, see FZ.PAR
MELA_SET.PAR	see Example H.1
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3

Output files

Step I:

WR_WR_P5_O.MSC	forest level summary file
WR_WR_P5_O.MSD	forest level summary file
WR_WR_P5.SMS	standwise simulation instruction file
WR_WR_P5_O.SUM	see Example H.35

Step II:

FZ_sub_unit_S4_O.MSC	forest level summary file
FZ_sub_unit_S4_O.MSD	forest level summary file
FZ_sub_unit_S4.SMS	standwise simulation instruction files
FZ_F2_S4.SOL	see Example H.37
FZ_WR_WR.SOL	see Example H.38
FZ_FZ_S4_O.SUM	see Example H.36
	('sub_unit' stands for F1 to WR in turn)

Notice

In step II, the optimization problem and the forest level summary files **WR_WR_P5_O.MSC** and **WR_WR_P5_O.MSD** from step I are used for the sub-unit WR with the conventional management schedule files for the sub-units F1 - F5 (see Example H.34).

In the definition of the forestry unit FZ (see Example H.34), the sub-unit WR is substituted by the name of the forest level summary files, compared with the definition of the forestry unit FX (see Example 3.11).

Consider potential applications for this type of optimization problem.

Example H.34. A decision hierarchy definition for the problem dealing with the lower level solution as a part of the problem formulation.

```
* FZ.PAR *

* decision hierarchy levels for the forestry unit FZ

 FZ_LEVELS
#FZ
#REGION
#DISTRICT

 FZ
#SR Southern Region
#NR Northern Region
#WR_WR_P5_O imported solution for Western region

 SR
#F1 District F1
#F2 District F2
#F3 District F3

 NR
#F4 District F4
#F5 District F5
```

Example H.35. The import of a lower level solution into the upper level optimization problem.

```
* WR_WR_P5_O.SUM *

 <>mela<>  11096 155633
=========================================================================
WR - P5-max 5 % NPV-no constraints - all:
-------------------------------------------------------------------------
                                1996    2006    2016    2026    2036
-------------------------------------------------------------------------
FORESTRY LAND AREA, ha          29.6    29.6    29.6    29.6    29.6

TOTAL VOLUME, m3              3285.0  2592.9  2374.0  2528.7  3186.9
  Pine                        2658.5  2484.3  2246.3  2048.2  2216.2
  Spruce                       506.5    51.5     0.0     0.3     1.5
  Birch                         81.8    35.6    48.4   317.4   697.1
  Other deciduous               38.1    21.5    79.3   162.9   272.1

  Saw log                     1009.3   611.4   793.4   681.3   932.4
  Pulpwood                    2065.8  1808.9  1429.0  1702.4  2038.7
-------------------------------------------------------------------------
VALUE (roadside prices),FIM   592238  428666  409799  419367  529134
NET PRESENT VALUE (NPV) 3%    704484  610718  648016  673366  766776
-------------------------------------------------------------------------
                                1996    2006    2016    2026    2036
-------------------------------------------------------------------------
INCREMENT, m3/a                146.0   123.9   134.3   158.5
  Pine                         126.3   109.5    98.1   106.0
  Spruce                        12.0     1.7     0.0     0.1
  Birch                          4.5     6.3    27.0    40.7
  Other deciduous                3.3     6.4     9.1    11.7

TOTAL DRAIN, m3/a              215.2   145.8   118.8    92.7
  Mortality                      5.2     4.8     4.4     4.6
  Cutting drain                210.0   141.0   114.4    88.1
-------------------------------------------------------------------------
CUTTING REMOVAL, m3/a          202.9   132.0   109.5    86.3
 Shelterwood cuttings            0.0     1.8    25.2    13.6
 Thinnings                      99.0    38.9    18.9    60.9
 Regeneration cuttings         103.9    91.3    65.3    11.8

 Pine                          136.3   125.0   109.5    85.5
 Spruce                         56.0     4.1     0.0     0.0
 Birch                           7.0     2.9     0.0     0.8
 Other deciduous                 3.6     0.0     0.0     0.0

 Saw log                        92.8    36.5    64.9    39.5
 Pulpwood                      110.2    95.5    44.5    46.8
-------------------------------------------------------------------------
TOTAL CUTTING AREA, ha/a         2.2     1.7     1.3     1.3
 Thinnings                       1.6     0.9     0.2     0.8
 Clear cuttings                  0.6     0.0     0.0     0.0
 Over story cuttings             0.0     0.1     0.7     0.3
 Seed tree cuttings              0.0     0.7     0.3     0.1
 Shelterwood cuttings            0.0     0.0     0.0     0.0

REGENERATION AREA, ha/a          0.6     0.7     0.3     0.1
 Artificial regeneration         0.6     0.0     0.0     0.0
 Natural regeneration            0.0     0.7     0.3     0.1

TENDING YOUNG STANDS, ha/a       0.3     0.6     0.9     0.3
-------------------------------------------------------------------------
GROSS REVENUES, FIM/a        42701.2 23645.8 23068.5 16737.9
TOTAL COSTS, FIM/a           13713.2  8745.3  6030.9  4819.1
NET REVENUES, FIM/a          28988.0 14900.5 17037.6 11918.8
```

Example H.36. A MELAOPT summary report for the whole forestry unit in the problem dealing with the imported summary data as a part of the solution.

```
* FZ_FZ_S4_O.SUM *

=====================================================================
FX - S4 -MAXIMUM SUSTAINED YIELD,4% - all:
---------------------------------------------------------------------
                                1996    2006    2016    2026    2036
---------------------------------------------------------------------
FORESTRY LAND AREA, ha         195.4   195.4   195.4   195.4   195.4

TOTAL VOLUME, m3             18472.0 18790.3 18493.6 18240.0 18620.5
  Pine                        9597.5 11436.1 11766.9 11246.1 10139.9
  Spruce                      6490.1  4384.3  4138.1  4435.9  5272.6
  Birch                       2073.7  2654.1  2239.8  2282.3  2771.9
  Other deciduous              310.6   315.9   348.7   275.7   436.1

  Saw log                     7503.8  7063.6  6727.7  6283.0  5834.2
  Pulpwood                    9772.1 10677.0 10765.7 11091.9 11699.6
---------------------------------------------------------------------
VALUE (roadside prices),FIM  3413323 3435647 3338261 3267989 3246270
NET PRESENT VALUE (NPV) 3%   4026478 4218920 4360208 4550087 4805270
---------------------------------------------------------------------
                                1996    2006    2016    2026    2036
---------------------------------------------------------------------
INCREMENT, m3/a                782.6   749.9   769.2   823.9
  Pine                         446.9   458.8   448.4   431.4
  Spruce                       202.1   165.9   193.5   260.5
  Birch                        114.3   105.5   107.3   110.7
  Other deciduous               19.3    19.6    19.9    21.4

TOTAL DRAIN, m3/a              750.7   779.5   794.5   785.9
  Mortality                     19.1    22.3    24.4    23.6
  Cutting drain                731.6   757.3   770.2   762.3
---------------------------------------------------------------------
CUTTING REMOVAL, m3/a          693.5   735.8   737.7   746.1
 Shelterwood cuttings           35.7    96.3    92.4    69.5
 Thinnings                     201.9   174.7   203.9   349.7
 Regeneration cuttings         455.9   464.7   441.4   327.0

 Pine                          235.5   402.4   475.7   519.1
 Spruce                        398.4   181.3   158.2   172.0
 Birch                          46.8   136.8    86.4    51.0
 Other deciduous                12.7    15.2    17.4     4.0

 Saw log                       387.2   387.2   387.2   387.2
 Pulpwood                      306.3   348.6   350.5   359.0
---------------------------------------------------------------------
TOTAL CUTTING AREA, ha/a         6.7     6.6     6.9     7.1
 Thinnings                       3.9     2.8     3.0     4.5
 Clear cuttings                  1.5     0.6     0.8     0.7
 Over story cuttings             0.4     1.4     1.9     1.2
 Seed tree cuttings              0.4     1.4     1.1     0.5
 Shelterwood cuttings            0.6     0.5     0.1     0.2

REGENERATION AREA, ha/a          2.4     2.5     2.0     1.4
 Artificial regeneration         1.5     0.6     0.8     0.7
 Natural regeneration            1.0     1.9     1.2     0.7

TENDING YOUNG STANDS, ha/a       2.8     2.2     3.0     2.3
---------------------------------------------------------------------
GROSS REVENUES, FIM/a          149516  155723  155796  154170
TOTAL COSTS, FIM/a            46664.7 42749.8 42822.8 41197.5
NET REVENUES, FIM/a            102851  112973  112973  112973
```

Example H.37. A MELAOPT solution report for a sub-unit in the problem dealing with the imported summary data as a part of the solution.

```
* FZ_F2_S4.SOL *

================================================================
 <>MELA<>    FZ  - DISTRICT=F2:
             S4 -MAXIMUM SUSTAINED YIELD,4%   solution is optimum
----------------------------------------------------------------
                            1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %               462269                            432637
 537 Forestry land area      24.1
 700 Volume, m3            2829.4  3529.5  3200.0  2304.9  1811.1
 697 -saw log              1224.6  1705.1  1614.7  1294.1   695.4
 090 Increment, m3/a            124.4   119.3   104.1    98.8
 195 Cutting removal, m3/a       50.6   144.3   185.9   144.7
 193 -saw log                    26.9    95.6   104.5   106.6
 370 Net revenues, FIM/a       7223.1 24641.3 29645.5 25553.2
 800 Roadside value,FIM    525340                            335741
----------------------------------------------------------------
```

Example H.38. A MELAOPT solution report for the imported sub-unit.

```
* FZ_WR_WR.SOL *

 S4 FX
================================================================
 <>MELA<>    FX  - DISTRICT=WR_WR_P5:
             S4 -MAXIMUM SUSTAINED YIELD,4%   solution is optimum
----------------------------------------------------------------
                            1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %               434579                            483596
 537 Forestry land area      22.0
 700 Volume, m3            2119.4  1975.1  1821.6  2324.7  2234.0
 697 -saw log              1157.5   908.1   615.8   690.4   357.2
 090 Increment, m3/a            92.8   104.0   124.4   144.5
 195 Cutting removal, m3/a      101.0   115.5    69.8   147.1
 193 -saw log                    69.2    71.7    30.3    76.0
 370 Net revenues, FIM/a       15785.2 18620.8  9758.6 25297.0
 800 Roadside value,FIM    417273                            353892
----------------------------------------------------------------
```

JLP mode in MELAOPT

Commands

```
>MELAOPT
MELAOPT>SOLVE SD FX
MELAOPT>JLP
jlp>include cc.prb
jlp>solve
jlp>mrep SOLUTION
jlp>end
MELAOPT>
```

Arguments

SD	see SD.MDL
FX	see FX.PAR
cc.prb	see cc.prb
SOLUTION	SOLUTION report request

Input files

SD.MDL	Example H.31
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule files, see FX.PAR
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
cc.prb	see Example H.39
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2

Output files

JLP session log	see Example H.40

Notice

The MELAOPT command SOLVE is used here to introduce the decision hierarchy for the forestry unit FX and to read the corresponding management schedule data for the subsequent JLP session. JLP can process directly single forestry units only, see the JLP command 'xform' in Lappi (1992).

In the JLP mode, the same management unit data can be used (without reading the data for each problem again) for several subsequent JLP 'solve' commands and problems if the MELA decision variables are not changed in the 'xvar' section of the problem definition (**mdl** type) file.

Example H.39. A JLP problem definition for the maximum sustained yield with the prohibition of clear cuttings for one domain.

```
* cc.prb *

* MAXIMUM SUSTAINED YIELD - NO CLEAR CUTTINGS IF OWNER = 2
* exclude management schedules with clear cuttins if OWNER = 2

xtran
clearcut=x1002+x2002+x3002+x4002
if OWNER.eq.2.and.clearcut>0 then reject
/
prob CC - MAXIMUM SUSTAINED YIELD, 4%
x0804 max

* non-declining cutting removals
x2195-x1195>0
x3195-x2195>0
x4195-x3195>0

* non-declining saw timber removals compared with first sub-period
x2193-x1193>0
x3193-x1193>0
x4193-x1193>0

* non-declining net revenues
x2370-x1370>0
x3370-x2370>0
x4370-x3370>0

* 20 % higher net present value at the end of the calculation period
* is assumed here to guarantee the sustainable yield level
* after the calculation period
x4804-1.2*x0804>0
/

* domains for reporting
show/domain
OWNER=0:
OWNER=2:
/
```

Example H.40. A JLP session log in the JLP mode of MELAOPT.

```
* JLP session log (page 1/3) *

 MELAOPT> JLP

jlp>include cc.prb
> * cc.prb *
> xtran
> clearcut=x1002+x2002+x3002+x4002
> if OWNER.eq.2.and.clearcut>0 then reject
> /
> prob S4 - MAXIMUM SUSTAINED YIELD, 4%
making x-variables: clearcut,reject
number of rejected schedules:  . . . . . . . . . .    204
> x0804 max
> * non-declining cutting removals
> x2195-x1195>0
> x3195-x2195>0

* <clip> ... Part of the report was cut out ... <clip>

>/
number of domains, domain combinations: . . . . .       1      1
number of z-variables, temporary x-variables . . .      0     10
_____________________________________________________________________
domain:                                          # of units
row    tolerance       min              max
_____________________________________________________________________
all:                                                   92
   1   2.937341       1829286.       2702353.
   2  0.1516997E-02  -679.2604       1395.637
   3  0.2304673E-02  -1369.901       2120.299
   4  0.3022611E-02  -1936.465       2780.802
   5  0.6813204E-03  -270.2923       626.8148
   6  0.1128032E-02  -393.3161       1037.789
   7  0.1666255E-02  -393.3161       1532.954
   8  0.2115919      -83767.08       194664.5
   9  0.3421583      -187679.3       314785.6
  10  0.4881125      -282374.0       449063.5
  11   7.282064       12647.56       6699499.
> show/domain
> OWNER=0:
> OWNER=2:
> /
```

*** JLP session log (page 2/3) ***

```
 jlp>solve
starting optimization...
 ok(1)  constr.   2:  48.060426    w+z basics:   0   0
 ok(0)  constr.   4:  279.59028    w+z basics:   0   0

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 ok(0)  constr.  11:  2358017.9    w+z basics:   0   0
 ok(2)  constr.   3:  24.018460    w+z basics:   0   0
 ok(2)  constr.   5:  10.844893    w+z basics:   1   0
**FEASIBLE
 **OBJECT VARIABLE:   2320513.6    w+z basics:   1   0
 unit=    1, OBJ VAR= 2635006.6    w+z basics:   1   0
 unit=    1, OBJ VAR= 2672832.5    w+z basics:   2   0

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 unit=    1, OBJ VAR= 2692649.2    w+z basics:   5   0
 unit=    1, OBJ VAR= 2692650.5    w+z basics:   6   0
 **SOLUTION, OBJ VAR= 2692650.5    w+z basics:   6   0 unit=    2
*s* solution,
```

DOMAIN all: 92 units

row	value	shadow price	lower bound	upper bound
1) x0804 . . .	2692650.54	1.00000000	max	
2) x2195-x1195 . . .	0.00000000	-18.020837	0.000000	L
3) x3195-x2195 . . .	0.00000000	-23.879584	0.000000	L
4) x4195-x3195	6.07470534	0.00000000	0.000000	
5) x2193-x1193	8.90876734	0.00000000	0.000000	
6) x3193-x1193 . . .	0.00000000	-31.838604	0.000000	L
7) x4193-x1193 . . .	0.00000000	-1.4932742	0.000000	L
8) x2370-x1370	8072.11004	0.00000000	0.000000	
9) x3370-x2370 . . .	0.00000000	-0.1111726	0.000000	L
10) x4370-x3370 . . .	0.00000000	-0.2534630	0.000000	L
11) x4804-1.2*x0804	856846.284	0.00000000	0.000000	

x-variable	value	shadow price	cost of decrease	cost of increase
x0804	2692650.54	1.00000000	1.00000000	INF
x4804	4088027.06	0.00000000	0.00004970	0.00007170
x0537	195.398999		INF	INF
x0700	18471.9526		INF	INF
x1700	19346.2576		0.04515379	0.06167802

* <clip> ... Part of the report was cut out ... <clip>

show/domain OWNER=0: 34 units

x-variable	value	cost of decrease	cost of increase
x0804	1065359.68	0.01149753	0.21800045
x4804	1109189.30	0.00042184	0.00425988
x0537	72.2099992	INF	INF
x0700	6845.22051	INF	INF
x1700	7545.95460	0.43286799	0.04236043

* <clip> ... Part of the report was cut out ... <clip>

```
* JLP session log (page 3/3) *

 jlp>mrep SOLUTION

================================================================
 <>MELA<>   FX  - all:
            CC-MAXIMUM SUSTAINED YIELD,4%    solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %             2692651                          4088027
 537 Forestry land area    195.4
 700 Volume, m3          18472.0 19346.3 20177.0 20779.5 21659.8
 697 -saw log             7503.8  7854.7  8267.7  8715.3  9355.5
 090 Increment, m3/a           786.8   762.3   748.6   772.7
 195 Cutting removal, m3/a     641.6   641.6   641.6   647.7
 193 -saw log                  314.2   323.2   314.2   314.2
 002 Clear cutting area          0.5     0.0     0.4     0.5
 370 Net revenues, FIM/a     87030.9 95103.0 95103.0 95103.0
 800 Roadside value,FIM  3413323                          4210115
----------------------------------------------------------------
================================================================
 <>MELA<>   FX  - OWNER=0:
            CC-MAXIMUM SUSTAINED YIELD,4%    solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %             1065360                          1109189
 537 Forestry land area     72.2
 700 Volume, m3           6845.2  7546.0  6955.8  6636.8  5693.5
 697 -saw log             2451.9  2813.5  2918.0  2275.4  1466.3
 090 Increment, m3/a           302.0   285.2   269.5   277.3
 195 Cutting removal, m3/a     215.8   324.7   284.7   352.3
 193 -saw log                  119.5   147.4   191.3   173.8
 002 Clear cutting area          0.5     0.0     0.4     0.5
 370 Net revenues, FIM/a     32412.7 43807.7 50635.9 53164.0
 800 Roadside value,FIM  1249014                           962226
----------------------------------------------------------------

================================================================
 <>MELA<>   FX  - OWNER=2:
            CC-MAXIMUM SUSTAINED YIELD,4%    solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
 804 NPV 4 %             1627291                          2978838
 537 Forestry land area    123.2
 700 Volume, m3          11626.7 11800.3 13221.3 14142.7 15966.3
 697 -saw log             5051.9  5041.2  5349.6  6439.9  7889.1
 090 Increment, m3/a           484.8   477.1   479.1   495.4
 195 Cutting removal, m3/a     425.8   316.9   356.9   295.4
 193 -saw log                  194.8   175.7   123.0   140.4
 002 Clear cutting area          0.0     0.0     0.0     0.0
 370 Net revenues, FIM/a     54618.2 51295.3 44467.1 41939.0
 800 Roadside value,FIM  2164309                          3247889
----------------------------------------------------------------
 jlp>end
```

MELAOPT REPORT options

Commands

```
>MELAOPT
MELAOPT>SOLVE S4 FX
MELAOPT>REPORT JLP_SOLUTION
MELAOPT>REPORT MARGINALS
MELAOPT>REPORT SCHEDULES
MELAOPT>REPORT SHADOW_PRICES
MELAOPT>REPORT SOLUTION
MELAOPT>REPORT SUMMARY
MELAOPT>EXIT
```

Arguments

S4	see S4.MDL
FX	see FX.PAR
JLP_SOLUTION	see MELAOPT session log
MARGINALS	see FX_FX_S4.MRG
SCHEDULES	see FX_FX_S4.SCH
SHADOW_PRICES	see FX_FX_S4.SHP
SOLUTION	see FX_FX_S4.SOL
SUMMARY	see FX_FX_S4_O.SUM

Input files

S4.MDL	see Example H.19
F1.MSC-F5.MSC, WR.MSC	management schedule files, see FX.PAR
F1.MSD-F5.MSD, WR.MSD	management schedule data files, see FX.PAR
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3

Output files

MELAOPT session log	see Example H.41
FX_FX_S4.MRG	see Example H.42
FX_sub_unit_S4.MSC	forest level summary files
FX_sub_unit_S4.MSD	forest level summary files
FX_FX_S4.SCH	see Example H.43
FX_FX_S4.SHP	see Example H.44
FX_sub_unit_S4.SMS	standwise simulation instruction files
FX_FX_S4.SOL	solution report file, see e.g. Examples H.20 and H.37
FX_FX_S4_O.SUM	see Example H.21
	('sub_unit' stands for F1 to WR in turn)

Example H.41. A MELAOPT JLP_SOLUTION report in the MELAOPT session log.

```
* MELAOPT session log *

 MELAOPT> REPORT JLP_SOLUTION

* <clip> ... Part of the report was cut out ... <clip>

DOMAIN all:                                                  92 units

row                              value       shadow    lower     upper
                                            price     bound     bound

  1) x0804          . . .  2917767.81 1.00000000          max
  2) x2195-x1195    . . .  47.4560368 0.00000000   0.000000
  3) x3195-x2195    . . .  11.3157754 0.00000000   0.000000
  4) x4195-x3195    . . .  3.31351274 0.00000000   0.000000
  5) x2193-x1193    . . .  0.00000000 -104.28626   0.000000          L
  6) x3193-x1193    . . .  0.00000000 -64.885590   0.000000          L
  7) x4193-x1193    . . .  2.85134280 0.00000000   0.000000
  8) x2370-x1370    . . .  12280.8516 0.00000000   0.000000
  9) x3370-x2370    . . .  0.00000000 -0.4665153   0.000000          L
 10) x4370-x3370    . . .  0.00000000 -0.4604046   0.000000          L
 11) x4804-1.2*x0804    .  0.00000000 -0.0338469   0.000000          L

x-variable                   value       shadow    cost of   cost of
                                         price     decrease  increase

     x0804  . . . . . .  2917767.81 0.95938363 1.00000000    INF
     x4804  . . . . . .  3501321.50 0.03384696 0.83326657 0.03527991
     x0537  . . . . . .  195.398999               INF        INF
     x0700  . . . . . .  18471.9526               INF        INF
     x1700  . . . . . .  18903.2603            0.30019175 1.11570486
     x2700  . . . . . .  18728.4801            0.19601904 0.89446002
     x3700  . . . . . .  18333.2743            0.71180048 0.16476113
     x4700  . . . . . .  18724.2503            1.28080700 2.68516779
     x0697  . . . . . .  7503.83358               INF        INF
     x1697  . . . . . .  7085.56664            0.92310000 7.74104677
     x2697  . . . . . .  6752.41178            0.61902963 1.01156566
     x3697  . . . . . .  6343.57948            0.52061912 0.42531525
     x4697  . . . . . .  5971.47924            2.37611699 0.45513364
     x1090  . . . . . .  785.909935            13.8337557 43.5662226
     x2090  . . . . . .  755.952092            14.2976811 23.6947089
     x3090  . . . . . .  766.621463            8.80189468 8.46522741
     x4090  . . . . . .  824.894712            6.72074826 8.21663053
     x1195  . . . . . .  685.300275 0.00000000 15.8491745 4.09821748
     x2195  . . . . . .  732.756306 0.00000000 2.72130976 2.50310975
     x3195  . . . . . .  744.072074 0.00000000 1.40779916 3.80020222
     x4195  . . . . . .  747.385585 0.00000000 5.82376049 1.40428378
     x1193  . . . . . .  387.338824 -169.17185 169.317454 13.0283747
     x2193  . . . . . .  387.338824 104.286264 183.040867 13.0283791
     x3193  . . . . . .  387.338824 64.8855900 169.317461 13.0283753
     x4193  . . . . . .  390.190168 0.00000000 1.86266963 9.75497022
     x1370  . . . . . .  101863.385 0.00000000 0.09272875 0.02454570
     x2370  . . . . . .  114144.236 -0.4665153 0.03527345 0.13469426
     x3370  . . . . . .  114144.234 0.00611071 0.03527344 0.13469417
     x4370  . . . . . .  114144.235 0.46040463 0.03527345 0.13469422
     x0800  . . . . . .  3413322.43               INF        INF
     x4800  . . . . . .  3276646.84            0.01264793 0.00272064

>
```

Example H.42. A MELAOPT MARGINALS report.

```
* FX_FX_S4.MRG *

================================================================
 <>MELA<>    FX  - all:
             S4 -MAXIMUM SUSTAINED YIELD,4%   solution is optimum
----------------------------------------------------------------
                           1996    2006    2016    2026    2036
----------------------------------------------------------------
     - cost of incr.     ********                          0.035
 804 NPV 4 %              2917768                         3501322
     - cost of decr.        1.000                           0.833
----------------------------------------------------------------
     - cost of incr.     ********
 537 Forestry land area     195.4
     - cost of decr.     ********
----------------------------------------------------------------
     - cost of incr.     ********   1.116   0.894   0.165   2.685
 700 Volume, m3           18472.0 18903.3 18728.5 18333.3 18724.2
     - cost of decr.     ********   0.300   0.196   0.712   1.281
----------------------------------------------------------------
     - cost of incr.     ********   7.741   1.012   0.425   0.455
 697 -saw log              7503.8  7085.6  6752.4  6343.6  5971.5
     - cost of decr.     ********   0.923   0.619   0.521   2.376
----------------------------------------------------------------
     - cost of incr.           43.566  23.695   8.465   8.217
 090 Increment, m3/a            785.9   756.0   766.6   824.9
     - cost of decr.           13.834  14.298   8.802   6.721
----------------------------------------------------------------
     - cost of incr.            4.098   2.503   3.800   1.404
 195 Cutting removal, m3/a      685.3   732.8   744.1   747.4
     - cost of decr.           15.849   2.721   1.408   5.824
----------------------------------------------------------------
     - cost of incr.           13.028  13.028  13.028   9.755
 193 -saw log                   387.3   387.3   387.3   390.2
     - cost of decr.          169.317 183.041 169.317   1.863
----------------------------------------------------------------
     - cost of incr.            0.025   0.135   0.135   0.135
 370 Net revenues, FIM/a       101863  114144  114144  114144
     - cost of decr.            0.093   0.035   0.035   0.035
----------------------------------------------------------------
     - cost of incr.     ********                          0.003
 800 Roadside value,FIM   3413323                         3276647
     - cost of decr.     ********                          0.013
----------------------------------------------------------------
```

Example H.43. A MELAOPT SCHEDULES report.

*** FX_FX_S4.SCH *** (excerpts)

SCHEDULES OF OPTIMUM SOLUTION 97

*	FU	#FU	#SU	#MU	#SS	S/M
	FX	1	1	1	13	1.00
	FX	1	1	2	5	1.00
	FX	1	1	3	1	0.38
	FX	1	1	3	13	0.62
	FX	1	1	4	1	1.00
	FX	1	1	5	19	1.00
	FX	1	1	6	2	1.00
	FX	1	1	7	8	1.00
	FX	1	1	8	1	1.00
	FX	1	1	9	1	1.00
	FX	1	1	10	1	1.00
	FX	1	1	11	22	1.00
	FX	1	1	12	14	1.00
	FX	1	1	13	1	1.00
	FX	1	1	14	4	0.71
	FX	1	1	14	33	0.29
	FX	1	1	15	3	1.00
	FX	1	1	16	1	1.00
	FX	1	2	17	1	1.00
	FX	1	2	18	1	1.00
	FX	1	2	19	1	0.10
	FX	1	2	19	9	0.90

* **<clip>** ... Part of the report was cut out ... **<clip>**

FX	1	5	73	3	1.00
FX	1	5	74	1	1.00
FX	1	5	75	1	1.00
FX	1	5	76	1	1.00
FX	1	5	77	1	1.00
FX	1	5	78	5	1.00
FX	1	6	79	1	1.00
FX	1	6	80	6	1.00
FX	1	6	81	1	1.00
FX	1	6	82	2	1.00
FX	1	6	83	4	1.00
FX	1	6	84	2	1.00
FX	1	6	85	28	1.00
FX	1	6	86	11	1.00
FX	1	6	87	1	1.00
FX	1	6	88	2	1.00
FX	1	6	89	1	1.00
FX	1	6	90	47	1.00
FX	1	6	91	9	1.00
FX	1	6	92	21	1.00

FU = name of the forestry unit
#FU = number of the forestry unit
#SU = number of the lowest level sub-unit
#MU = number of the management unit
#SS = number of the selected management schedule
S/M = proportion of the selected management schedule in the solution

Example H.44. A MELAOPT SHADOW_PRICES report.

```
* FX_FX_S4.SHP *

==============================================================
 <>MELA<>   FX  - all:
            S4 -MAXIMUM SUSTAINED YIELD,4%   solution is optimum
--------------------------------------------------------------
                          1996    2006    2016    2026    2036
--------------------------------------------------------------
 804 NPV 4 %             2917768                         3501322
     - shadow price        0.959                           0.034
--------------------------------------------------------------
 537 Forestry land area    195.4
     - shadow price        0.000
--------------------------------------------------------------
 700 Volume, m3          18472.0 18903.3 18728.5 18333.3 18724.2
     - shadow price        0.000   0.000   0.000   0.000   0.000
--------------------------------------------------------------
 697 -saw log             7503.8  7085.6  6752.4  6343.6  5971.5
     - shadow price        0.000   0.000   0.000   0.000   0.000
--------------------------------------------------------------
 090 Increment, m3/a           785.9   756.0   766.6   824.9
     - shadow price            0.000   0.000   0.000   0.000
--------------------------------------------------------------
 195 Cutting removal, m3/a     685.3   732.8   744.1   747.4
     - shadow price            0.000   0.000   0.000   0.000
--------------------------------------------------------------
 193 -saw log                  387.3   387.3   387.3   390.2
     - shadow price         -169.172 104.286  64.886   0.000
--------------------------------------------------------------
 370 Net revenues, FIM/a      101863  114144  114144  114144
     - shadow price            0.000  -0.467   0.006   0.460
--------------------------------------------------------------
 800 Roadside value,FIM  3413323                         3276647
     - shadow price        0.000                           0.000
--------------------------------------------------------------

-------------------------------------------------------------------
                        row              value        shadow price
-------------------------------------------------------------------
                        OBJ        2917767.816               1.000
                x2195-x1195             47.456               0.000
                x3195-x2195             11.316               0.000
                x4195-x3195              3.314               0.000
                x2193-x1193              0.000            -104.286
                x3193-x1193              0.000             -64.886
                x4193-x1193              2.851               0.000
                x2370-x1370          12280.852               0.000
                x3370-x2370              0.000              -0.467
                x4370-x3370              0.000              -0.460
            x4804-1.2*x0804              0.000              -0.034
-------------------------------------------------------------------
```

H.6 Re-simulation of Selected Management Schedules

Commands

```
>MELASIM
MELASIM>SIMULATE/MELA_TABLE#USER.TAB MSR FX S4
MELASIM>EXIT
```

Arguments

MS	see MS.PAR
FX	see FX.PAR
S4	see S4.MDL

Input files

S4.MDL	see Example H.19
FX.PAR	see Example 3.11
MELA_SET.PAR	see Example H.1
MS_EVENT.PAR	see Example H.6
MSR.PAR	see Example H.45
F1.RSD-F5.RSD, WR.RSD	initial data files, see FX.PAR
FX_sub_unit_S4.SMS	standwise simulation instructions
SYMBOL.SYM	see Example H.2
USER.TAB	see Example H.4
VOLUME.VOL	see Appendix C
	('sub_unit' stands for F1 to WR in turn)

Output files

MELASIM session log	see Examples H.46 and H.47
FX_sub_unit_S4_S.MSC	forest level summary files
FX_sub_unit_S4_S.MSD	forest level summary files
FX_sub_unit_S4_S.SUM	see Example H.48
	('sub_unit' stands for F1 to WR in turn)

Notice

For an introduction to re-simulation, see Chapter 4.1.4. For the variables of the management schedule summary report in Example H.47, see Example H.10.

OUTPUT (1) = 0 disables management schedule files.
OUTPUT (2) = 1 enables forest level summary reports.
OUTPUT (3) = 3 enables management schedule summaries in the MELASIM session log.

The value for the MELA_TABLE parameter can be provided either as a command option or among the application parameters (see Example H.45).

Example H.45. A parameter definition file for the re-simulation of the selected management schedules.

```
* MSR.PAR *

YEARS                1 11 21 31 41

OUTPUT               0 1 3 0 0 0 0 0 0 0

SIMULATION_CONTROL 41 50 0 0 1000 0 1 999 0 0 50 0 0 0 151 0 0

* The value for the MELA_TABLE parameter can be provided
* either as a command option or among application parameters.
* Remove '*' from the following row if required.
*MELA_TABLE#USER.TAB

INCLUDE MS_EVENT.PAR
```

Example H.46. A MELASIM session log from the re-simulation of the selected management schedules.

```
* MELASIM session log * (excerpts)

MELASIM> SIMULATE MSR FX S4
 .. Original command: SIMULATE MSR FX S4 ..

* <clip> ... Part of the report was cut out ... <clip>

 .. in MELA forest resource data (rsd) F1.RSD ..
 .. in simulation instructions for stands (sms) FX_F1_S4.SMS ..

 -- Writing over an existing file: >FX_F1_S4.MSC< --
 .. -> out summary of management schedules (MSC): FX_F1_S4.MSC ..
 -- Writing over an existing file: >FX_F1_S4.MSD< --
 .. -> out summary of management schedules (MSD): FX_F1_S4.MSD ..
.. log cmx: MSR FX S4
.. log cmd: SOVELLUS ALUE TEHTAVA
 -- Writing over an existing file: >FX_F1_S4_S.SUM< --
 .. -> out summary report (LOG): FX_F1_S4_S.SUM ..

* <clip> ... Part of the report was cut out ... <clip>

 .. Summary of the simulation: ..
    1      1.  1 1.00    2      2.  1 1.00    3      3.  1 0.38
    4      3.  1 0.62    5      4.  1 1.00    6      5.  1 1.00
    7      6.  1 1.00    8      7.  1 1.00    9      8.  1 1.00
   10      9.  1 1.00   11     10.  1 1.00   12     11.  1 1.00
   13     12.  1 1.00   14     13.  1 1.00   15     14.  1 0.71
   16     14.  1 0.29   17     15.  1 1.00   18     16.  1 1.00

 .. ** TOTAL: ..
 .. ** CALCULATION UNITS        18 ..
 .. ** MANAGEMENT SCHEDULES     18 ..

* <clip>... Part of the report was cut out ... <clip>

 .. in MELA forest resource data (rsd) WR.RSD ..
 .. in simulation instructions for stands (sms) FX_WR_S4.SMS  ..

 .. Summary of the simulation: ..
    1      1.  1 1.00    2      2.  1 1.00    3      3.  1 1.00
    4      4.  1 1.00    5      5.  1 1.00    6      6.  1 1.00
    7      7.  1 1.00    8      8.  1 1.00    9      9.  1 1.00
   10     10.  1 1.00   11     11.  1 1.00   12     12.  1 1.00
   13     13.  1 1.00   14     14.  1 1.00

 .. ** TOTAL: ..
 .. ** CALCULATION UNITS        14 ..
 .. ** MANAGEMENT SCHEDULES     14 ..

=====================================================================

 .. <MELASIM> end of execution of the command: MSR FX S4  ..

MELASIM>
```

Example H.47. A MELASIM session log for the selected management schedules in the re-simulation.

```
* MELASIM session log *

MELASIM> SIMULATE/MELA_TABLE#USER.TAB MSR FX S4

* <clip> ... Part of the file was cut out ... <clip>

.. <>    3.0000 ..
----------------
  M_unit  year      area        Y    X  nr   alt   TS   o u l s t t d d      dt    ft    st  n   clt dc   at    tt    pt    ct fbd cat lc
>>   3.0<<1996.     2.10 2.1                  0. 150. 1160. 0.1.1.3.0.3.0.0.0.    0.    0.  0. 0. 0. 6.1961.  0.1992.1992.  5. 1. 3.
----------------

>>>>    1<<      (0.103)          24930.          9971.          5801.          3909.          2834.
 row  year  cat  dc      ns  sp   ba      vol psbo value age     d     h    fel psbo cut  cl s a c t p d f   mort ivol ival     revs    costs
   1> 1996 1.00  6 0 1096. 1. 17.3 103.9 6400 17905. 47.  15.3 11.9  38.5 0X00 1.020 0.0.0.0.0.0.0.0.0.  0.15  7.4 1264.   6700.   2525.
   2> 2006 1.00  7 0  754. 1. 18.9 137.7 8200 23941. 55.  18.9 14.7  32.9 0X00 1.020 0.0.0.0.0.0.0.0.0.  0.19  6.9 1418.   5640.   1952.
   3> 2016 1.00  7 0  586. 1. 20.4 171.9 X000 32589. 63.  22.0 17.3   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.25  6.5 1639.      0.      0.
   4> 2026 1.00  7 0  577. 1. 25.5 234.1 X000 49098. 73.  24.5 19.3  74.1 X000 1.020 0.0.0.0.0.0.0.0.0.  0.24  5.9 1894.  16159.   3833.
   5> 2036 1.00  8 0  398. 1. 22.2 216.2 X000 52000. 84.  27.5 21.0   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.16  5.2 1398.      0.      0.
   6> 2041 1.00      396. 1. 24.2 241.2 X000 59019. 89.  28.7 21.7   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.00  0.0    0.      0.      0.
      <>       3.000          1 0.103 <>

 .. <>    3.0000 ..
>>>>    2<<      (0.897)         181359.         76351.         47223.         33062.         24501.
 row  year  cat  dc      ns  sp   ba      vol psbo value age     d     h    fel psbo cut  cl s a c t p d f   mort ivol ival     revs    costs
   7> 1996 1.00  6 0 1096. 1. 17.3 103.9 6400 17905. 47.  15.3 11.9  38.5 0X00 1.020 0.0.0.0.0.0.0.0.0.  0.15  7.4 1264.   6700.   2525.
   8> 2006 1.00  7 0  754. 1. 18.9 137.7 8200 23941. 55.  18.9 14.7   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.25  7.5 1512.      0.      0.
   9> 2016 1.00  7 0  740. 1. 25.4 210.0 8200 39196. 64.  21.7 17.0   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.46  7.6 1815.      0.      0.
  10> 2026 1.00  7 0  724. 1. 31.1 281.1 8200 57547. 74.  24.0 19.0 316.1 8200 2.030 0.1.1.0.0.0.0.0.0.  0.33  3.8 1054.  68228.  15954.
  11> 2036 1.00  3 0 2000. 1.  0.0   0.0       0.   4.   0.0  0.6 211.0 X000 1.020 0.0.0.0.1.0.0.0.0.  0.16  5.6 1182.  38752.  13178.
  12> 2116 1.00  8 0  772. 1. 22.7 227.3 X000 56613. 81.  27.7 21.9   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.00  0.0    0.      0.      0.
      <>       3.000          1 0.897 <>

* <clip> ... Part of the file was cut out ... <clip>

.. <>   13.0000 ..
----------------
  M_unit  year      area        Y    X  nr   alt   TS   o u l s t t d d      dt    ft    st  n   clt dc   at    tt    pt    ct fbd cat lc
>>   13.0<<1996.    1.70 1.7                  0.  90. 1175. 2.1.2.3.0.2.0.0.0.    0.    0.  0. 0. 0. 6.    0.    0.1992.  5. 1. 3.
----------------

>>>>    1<<      (1.000)         213501.        100972.         63129.         42696.         29861.
 row  year  cat  dc      ns  sp   ba      vol psbo value age     d     h    fel psbo cut  cl s a c t p d f   mort ivol ival     revs    costs
   1> 1996 1.00  6 0 1139. 2. 16.0 115.4 0X00 20466. 45.  15.6 14.3   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.15  9.6 1935.      0.      0.
   2> 2006 1.00  7 0 1117. 2. 25.5 210.3 0X00 39930. 55.  19.1 16.7   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.34 12.1 2561.      0.      0.
   3> 2016 1.00  7 0 1090. 2. 35.9 328.2 0X00 65728. 65.  22.5 18.8 125.8 0X00 1.020 0.0.0.0.0.0.0.0.0.  0.42 12.0 2925.  23729.   7091.
   4> 2026 1.00  8 0  629. 2. 31.5 317.9 0X00 71440. 76.  27.8 21.6 243.4 0X00 6.029 1.0.0.0.0.0.0.0.0.  0.16  7.5 2201.  51067.   9479.
   5> 2036 1.00  8 0   90. 2. 12.8 148.4 0X00 42467. 93.  42.8 27.9 431.7 0X00 1.020 0.0.0.1.0.0.0.0.0.  0.09  6.6 1311.  99498.  24293.
   6> 2111 1.00  8 0  867. 2. 20.1 202.3 0X00 41844. 73.  25.0 21.2   0.0      0.000 0.0.0.0.0.0.0.0.0.  0.00  0.0    0.      0.      0.
      <>       13.000          1 1.000 <>
     15

* <clip> ... The rest of the file was cut out ... <clip>

MELASIM>
```

Example H.48. A user-defined summary report from the re-simulation of the selected management schedules.

*** FX_F2_S4_S.SUM ***

MSR FX S4 F2

CUTTING REMOVALS, m³/a	1996	2006	2016	2026	2036
TOTAL CUTTING REMOVAL	60.0	130.5	185.9	155.2	
Saw logs	34.2	85.1	104.5	113.8	
Pulpwood	25.7	45.5	81.4	41.4	
PINE	6.5	88.0	149.1	101.8	
... 10 cm	0.6	0.0	0.0	0.0	
11 ... 20 cm	4.0	20.3	30.0	0.0	
21 ... 30 cm	1.2	64.3	75.1	62.8	
31 ... cm	0.8	3.5	44.0	39.0	
Saw logs	2.3	51.6	94.2	73.8	
Pulpwood	4.2	36.4	54.9	28.0	
SPRUCE	53.4	42.5	21.1	53.4	
... 10 cm	0.4	0.0	0.0	0.0	
11 ... 20 cm	13.4	5.9	14.9	0.0	
21 ... 30 cm	29.5	8.2	5.8	45.6	
31 ... cm	10.1	28.3	0.4	7.8	
Saw logs	31.9	33.5	10.3	40.0	
Pulpwood	21.5	9.1	10.8	13.4	
BIRCH	0.0	0.0	11.6	0.0	
... 10 cm	0.0	0.0	2.8	0.0	
11 ... 20 cm	0.0	0.0	8.8	0.0	
21 ... 30 cm	0.0	0.0	0.0	0.0	
31 ... cm	0.0	0.0	0.0	0.0	
Saw logs	0.0	0.0	0.0	0.0	
Pulpwood	0.0	0.0	11.6	0.0	
OTHER DECIDUOUS	0.0	0.0	4.1	0.0	
... 10 cm	0.0	0.0	0.0	0.0	
11 ... 20 cm	0.0	0.0	4.1	0.0	
21 ... 30 cm	0.0	0.0	0.0	0.0	
31 ... cm	0.0	0.0	0.0	0.0	
Saw logs	0.0	0.0	0.0	0.0	
Pulpwood	0.0	0.0	4.1	0.0	
THINNINGS	30.4	0.7	36.8	1.6	
Pine	5.8	0.0	0.0	1.6	
Spruce	24.6	0.7	21.1	0.0	
Birch	0.0	0.0	11.6	0.0	
Other deciduous	0.0	0.0	4.1	0.0	
REGENERATION CUTTINGS	9.4	124.2	126.8	120.6	
Pine	0.8	82.3	126.8	67.2	
Spruce	8.6	41.8	0.0	53.4	
Birch	0.0	0.0	0.0	0.0	
Other deciduous	0.0	0.0	0.0	0.0	
OVERSTORY CUTTINGS	20.2	5.7	22.3	33.0	
Pine	0.0	5.7	22.3	33.0	
Spruce	20.2	0.0	0.0	0.0	
Birch	0.0	0.0	0.0	0.0	
Other deciduous	0.0	0.0	0.0	0.0	

H.7 Processing of Management Report Records

Commands

Step I: simulate management schedules with relevant MSR and MSD variables

```
>MELASIM
MELASIM>SIMULATE MP F2
MELASIM>EXIT
```

Step II: store MPS variables for the selected management schedules in optimization

```
>MELAOPT
MELAOPT>INCLUDE MPS_VAR
MELAOPT>SOLVE S4 F2
MELAOPT>REPORT SUMMARY
MELAOPT>EXIT
```

Step III: read and print the stored MPS variables for the selected management schedules

```
>USER_MPS
```

Arguments

Step I:

MP	see MP.PAR
F2	forestry unit F2

Step II:

F2	forestry unit F2
S4	see S4.MDL
MPS_VAR	see MPS_VAR.PAR

Step III:

USER_MPS	see Example H.51 for source code

Input files

Step I:

MELA_SET.PAR	see Example H.1
MP.PAR	see Example H.49
MS_EVENT.PAR	see Example H.6
MSR_VAR.PAR	see Example H.49
F2.RSD	initial data file
SYMBOL.SYM	see Example H.2
TABLE.TAB	see Example H.3
VOLUME.VOL	see Appendix C.2

Step II:

S4.MDL	see Example H.19
F2.MSC	management schedule files
F2.MSD	management schedule files
MELA_SET.PAR	see Example H.1
MPS_VAR.PAR	see Example H.50
F2.RSD	initial data file
SYMBOL.SYM	see Example H.2

Step III:

F2_F2_S4.MPS	stand management file

Output files

Step I:

MELASIM session log	
F2.MSC	management schedule files
F2.MSD	management schedule files

Step II:

MELAOPT session log	
F2_F2_S4.MPS	stand management file
F2_F2_S4_O.MSC	forest level summary files
F2_F2_S4_O.MSD	forest level summary files
F2_F2_S4.SMS	standwise simulation instruction file
F2_F2_S4_O.SUM	forest level summary report

Step III:

USER_MPS session log	see Example H.52

Notice

Appendix H.7 shows the steps how to generate a short management proposal report for management units on the basis of the management report and optimum solution records in a stand management (**mps** type) file. In the similar way, the information of these records can be (if necessary, first put into a transfer file and then) loaded to the user's stand database using their applications.

For the generation of management report records, see also Example B.35.

For the UID concept, see also Appendix G.2.

MELASIM and MELAOPT session logs should be always checked for warnings and error messages.

Example H.49. The parameter definition files for the simulation of management schedules with the generation of management schedule records.

```
* MP.PAR * (for step I of Appendix H.7)

YEARS       1 11 21 31 41

OUTPUT      1 0 0 0 0 0 0 0 0 0

SIMULATION_CONTROL 41 50 0 0 1000 0 1 999 0 0 500 0 0 0 151 0 0

INCLUDE MSR_VAR.PAR

INCLUDE MS_EVENT.PAR
```

```
* MSR_VAR.PAR * (for step I of Appendix H.7)

MSR_VARIABLES
  1  1  3
  1 32 33
  1 36 36
 11 28 28
 11 70 70
 11  1  3
 11 32 33
 11 36 36
 21 28 28
 21 70 70
 21  1  3
 21 32 33
 21 36 36
```

Example H.50. A parameter definition file for the generation of the management report records in MELAOPT.

```
* MPS_VAR.PAR * (for step II of Appendix H.7)

MPS_OUTPUT 0

MPS_VARIABLES
#MSR 0 2
#MSR 0 3
#MSR 0 4
#MSR 0 5
#MSR 0 6
#MSD 0 700
#MSR 0 7
#MSR 0 8
#MSD 1 195
#MSD 1 370
*
#MSR 0 10
#MSR 0 11
#MSR 0 12
#MSR 0 13
#MSR 0 14
#MSD 1 700
#MSR 0 15
#MSR 0 16
#MSD 2 195
#MSD 2 370
*
#MSR 0 18
#MSR 0 19
#MSR 0 20
#MSR 0 21
#MSR 0 22
#MSD 2 700
```

Example H.51. A user routine for the processing of management report and optimum solution records in stand management files.

```
* USER_MPS * (for step III of Appendix H.7) (page 1/2)

* a short cutting proposal report for management units
* from management report and optimum solution records
* as an example how to process stand management files in user
* applications

      parameter (mxf=1000)
      dimension fp(mxf)
      double precision uid

*     open a mps type file
      open(1,file='F2_F2_S4.MPS',status='old'
     - ,form='unformatted')
      m=0

*     headings
      write(6,600)
600   format(1h ,'CUTTING PROPOSALS FOR'
     - ,' MANAGEMENT UNITS ON THE FIRST SUB-PERIOD')
      write(6,*)' '
      write(6,601)
601   format(1h ,' UID yr_1 area sp age   d '
     - ,' vol1   yr_c c   fel  revs  vol2 prop')
      write(6,*)' '

1     continue

*     read a physical record in MSB format
      read(1,end=2) uid,nwp,(fp(i),i=1,nwp)
      iuid=uid
      m=m+1
*        write(6,*)' Management unit ',iuid
*        write(6,'(1h ,10f7.1)')(fp(i),i=1,nwp)
```

```
* USER_MPS * (page 2/2)

*       collect the material for printing (assuming
*       that the information for one management schedule
*       is found from the logical records of the same
*       physical MSB type record)

        np=0
3       np=np+1
        itype=fp(np)
        np=np+1
        ip=fp(np)
        if(itype.eq.4)then
*       management report record
*         transformations for reporting
          ip1=ifix(fp(np+1))
          fp2=fp(np+2)
          ip3=ifix(fp(np+3))
          ip4=ifix(fp(np+4))
          fp5=fp(np+5)
*         volume m3/ha in the beginning of the first sub-period
          fp6=fp(np+6)/fp(np+2)
*         volume m3/ha at the end of the first sub-period
          fp16=fp(np+16)/fp(np+2)
          if(fp(np+7).gt.fp(np+1))then
*           cutting year
            ip7=ifix(fp(np+7))
*           cutting method
            ip8=ifix(fp(np+8))
*           cutting removal/ha
            fp9=fp(np+9)/fp(np+2)*10.
*           net revenues/ha
            ip10=ifix(fp(np+10)/fp(np+2)*10.+.5)
          else
            ip7=0
            ip8=0
            fp9=0.
            ip10=0
          endif
        elseif(itype.eq.6)then
*         optimum solution record
          prop=fp(np+2)
        endif
       np=np+ip
        if(np.lt.nwp)go to 3
*
*       print management proposal with some parameters
        write(6,602)iuid,ip1,fp2*prop,ip3,ip4,fp5,fp6,ip7,ip8
      - ,fp9,ip10,fp16,prop
602     format(1h ,i4,i5,f5.1,i3,i4,f5.1,f6.1,i6,i2
      - ,f6.1,i6,f6.1,f5.2)

        go to 1

2       continue
        write(6,*)' '
        write(6,*)' .. Management report records '
      - ,'in total ',m

        end
```

Example H.52. A short cutting proposal report by a user routine from the management report and optimum solution records in a stand management file.

```
* USER_MPS session log * (from step III of H.7)

 CUTTING PROPOSALS FOR MANAGEMENT UNITS ON THE FIRST SUB-PERIOD

  UID yr_1 area sp age   d  vol1   yr_c c   fel  revs  vol2 prop

 2001 1996  1.8  1   3  0.0   0.0     0 0   0.0     0   0.9 1.00
 2002 1996  0.9  1  28  5.9   0.0     0 0   0.0     0   0.0 1.00
 2003 1996  2.1  1  46 15.3 103.9  2001 1  37.2  4174 137.7 1.00
 2004 1996  1.1  1  43 14.2  43.4     0 0   0.0     0  85.5 1.00
 2005 1996  3.8  1  71 20.4 132.2     0 0   0.0     0 181.7 1.00
 2006 1996  3.2  1  73 18.4 174.2  2001 1  70.5  8926 154.2 1.00
 2007 1996  1.0  1  66 21.5 128.3     0 0   0.0     0 177.0 1.00
 2008 1996  1.6  2  86 27.2 242.6  2001 2 273.2 48063   0.0 1.00
 2009 1996  1.4  2   3  0.0 120.0  2001 4 141.3 25465   0.0 1.00
 2010 1996  0.9  1  70 19.5  50.5     0 0   0.0     0  60.9 1.00
 2011 1996  0.9  1 110 20.3 125.0  2001 1  34.2  4629 129.5 0.27
 2011 1996  0.7  1 110 20.3 125.0  2001 5 118.9 16142  29.5 0.20
 2011 1996  1.8  1 110 20.3 125.0     0 0   0.0     0 169.3 0.54
 2012 1996  1.1  1  38 10.9  71.0  2001 1   9.0   507 107.7 0.51
 2012 1996  1.1  1  38 10.9  71.0     0 0   0.0     0 134.1 0.49
 2013 1996  0.2  2  45 15.6 115.4  2001 1  29.7  3315 173.0 0.11
 2013 1996  1.2  2  45 15.6 115.4     0 0   0.0     0 210.3 0.71
 2013 1996  0.3  2  45 15.6 115.4     0 0   0.0     0 210.3 0.19

 .. Management report records in total           18
```

UID	unique management unit identifier (see Appendix G.2)
yr_1	beginning of the calculation period (in 1996)
area	area (of this management schedule), ha
sp	dominant tree species
age	mean age, a
d	mean diameter, cm
vol1	volume in the beginning of the first sub-period (in 1996), m^3/ha
yr_c	cutting year in the middle of the first sub-period
c	cutting method
fel	cutting removals, m^3/ha
revs	net revenues, FIM/ha
vol2	volume at the end of the first sub-period (in 2006), m^3/ha
prop	proportion of this management schedule in the solution

NOTE: Because of the relatively high number of (binding) constraints, several management units are split in Example H.52.

List of Examples

List of Examples

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Glossary

In the glossary, some concepts and terms are explained such as they are used in the MELA context and in the MELA Handbook.

Glossary

absolute year	A year expressed in absolute terms, for example 1996. See also relative year.
calculation period	The time interval being studied in the analysis. For example, management schedules, optimization problems and analysis results are generated for the calculation period. (However, decisions are usually made for the first years of the calculation period even if more far-reaching studies are carried out to ascertain the sustainability of forestry.) The calculation period is divided into sub-periods. See also presimulation, simulation period and sub-period.
command file	A text file consisting of operation system commands and/or MELA input lines. Command files are, for example, submitted for execution as batch jobs or included in interactive MELA sessions. See the INCLUDE command in Chapter 3.2.2.2.
commercial timber	Sum of saw log and pulpwood.
cost of decrease	A marginal change in the objective function value if a JLP x variable should get a slightly smaller value than in the current solution while all original constraints stay unchanged.
cost of increase	A marginal change in the objective function value if a JLP x variable should get a slightly higher value than in the current solution while all original constraints stay unchanged.
ctran	A JLP command for the transformations of c variables. See c variable and transformation.
cutting	Harvest of commercial timber from forest.
cutting drain	Sum of cutting removal and logging residue.
cutting potential	The estimate of the commercial timber that could be harvested at a moment or during a period according to the given forest management regimes.

cutting removal	Commercial timber harvested in cuttings.
c variable	A variable describing management units in JLP. See also d variable, x variable and z variable.
decision hierarchy	The hierarchical structure of a forestry unit consisting of one or more sub-units on several hierarchical levels.
decision variable	The variables of the MELA decision data records. Decision variables are used, for example, for the constraints and the objective function of JLP problems and for summary reports. See also x variable and z variable.
delivery price	See roadside price.
discounting	Assessing the present value of future revenues and costs according to the selected discount rate. See also interest rate.
discount rate	A rate used to calculate the present value of future revenues and costs and expressed in MELA in terms of the real annual rate of compound interest. See also interest rate.
domain	Any set of management units.
drain	See cutting drain and total drain.
dtran	A JLP command for the transformations of d variables. See d variable and transformation.
dual problem	The symmetrical formulation of the original linear programming problem. For further information, see Lappi (1992). See also linear programming, primal problem and shadow prices.
d variable	A variable describing data sets (data files) in JLP. See also c variable, x variable and z variable.
event	The basic step of the MELA simulation. Events are natural processes and human activities.
Finnish National Forest Inventory (FNFI)	The continuously repeated statistical survey of the forests of Finland since 1921 based on systematic field sampling. The ninth inventory began in 1996. The new multi-source inventory method combines field measurements with satellite imagery and other digital data. The purpose of the FNFI is to provide information and monitor the changes in the forests, timber resources and forest environment.
FNFI	Finnish National Forest Inventory.

forest land	See land-use category.
forest level	Regarding a forest area or several stands.
forest management	The act (and the art) of practising forestry for the specified objectives, for example, by the practical application of scientific, economic and social principles to the administration, use, handling and care of the forests.
forest management category	A class of land units where the same principles of forest management are followed for the specified use (e.g. timber production, protection or recreation). In MELA, users can define their own forest management categories.
forestry analysis	The analysis of the production, management and decision potentials in forestry, for example, for decision making.
forestry board district	A district level administration unit for private forestry in Finland (recently forestry centre).
forestry land	See land-use category.
forestry unit	The uppermost level of the decision hierarchy in a MELA optimization problem or the body of one or several hierarchically organized sub-units (and further management units) treated independently from other forestry units in the analysis. Depending on the decision or the question under study, the forestry unit can be, for example, a forest holding, enterprise forests or the forests of a country or a region.
forestry unit level	Regarding a forestry unit.
forest value	The monetary value of the forest peculiar to each decision maker in each decision situation. From the viewpoint of pure economic efficiency, the present value of forest when maximizing future net revenues without any constraints.
FORTRAN	A high-level, computer programming language especially used for scientific computation.
genuine stand	See stand. See also management unit.
gross income	The value of cutting removal applying roadside prices. See also net income.
hierarchy level	(1) One level in the MELA decision hierarchy. (2) One of the three hierarchy levels used for the description of management units, i.e. management unit, sample plot or sample tree level.

hierarchy member — A member of any decision hierarchy level.

human activity — A forest management operation or an administrational decision in the simulation of management schedules, for example a cutting. See also event.

income — The earnings from timber sales. See gross income and net income.

interest rate — A percentage that indicates a charge paid for the use of money. In investment calculations, money at different points of time is weighed by interest rates.

internal parameter database — Internal memory location to store and retrieve parameter definitions during a MELA session.

internal symbol database — Internal memory location to store and retrieve symbol definitions during a MELA session.

JLP — A general linear programming software package for solving Model I type forest management planning and conventional LP problems. JLP is characterized by its easy problem definition and outstanding capacity and speed in solving large dynamic multilevel LP problems (or in selecting optimal combinations from optional management schedules for hierarchically organized management units) on the basis of forest level objectives. JLP is the current LP solver of MELA. See also ctran, dtran, printlevel, solve, xtran, xvar, c variable, domain, d variable, transformation, x variable and z variable.

land-use category — The land area is divided into forestry and non-forestry land in FNFI (see Salminen 1993). Definitions of the forestry land categories are as follows:

- Forest land has the potential stemwood production capacity at least 1 m^3/ha/a on the average during the recommended rotation period.
- Scrub land has the potential stemwood production capacity from 0.1 to 1.0 m^3/ha/a.
- Waste land, if not naturally treeless, has lower potential stemwood production capacity than 0.1 m^3/ha/a.
- Other forestry land cannot be used for timber growing for permanent or temporary reasons (for example forest roads and timber depots).

Non-forestry land is divided into the following categories:

- Agricultural land consists of arable and pasture land as well as associated waste land and farm tracks.
- Built-up areas consist of urban, semi-urban and other settlement areas as well as industrial areas.
- Roads, power lines, etc. are roads, railways, airfields, power lines and similar areas outside urban and semi-urban areas.
- Lakes and rivers.
- Sea.

land value — The net present value for bare land from the perpetually repeated optimal rotations with the same optimal management schedules. The value of the future tree generations.

linear programming — A mathematical programming technique to search for the optimum (maximum or minimum) of a linear function subject to linear constraints.

logging residue — Parts of stems suitable in size or quality neither for pulpwood nor sawlog.

LP — See linear programming.

management option — See management schedule.

management schedule — The (predicted or simulated) development of the growing stock for a management unit under given management operations over the given calculation period.

management unit — The basic data unit and the smallest unit for individual management decisions in simulation and optimization. A management unit is a genuine stand, a sample stand, or a set of homogeneous stands (or sample plots in homogeneous stands respectively) with regard to the present stand characteristics and the expected future management and development. In MELA, management units (and stands respectively) are described by sample plots and sample trees.

maximum sustained yield — The estimate of the maximum amount of timber that can be harvested from a forestry unit on a sustainable basis according to the given forest management regimes and the conditions for sustainability. Maximum sustained yield can be expressed in

	terms of commercial timber or cutting drain, for example. See also sustainability and sustained yield.
MELA	MELA is a Finnish forestry model and an operational decision support tool for integrated forest production and management planning. MELA is used for solving problems related to the production potentials of forests and how to manage forest stands in order to achieve the overall (usually forest level) goals for forestry in each particular decision situation.
mortality	The stem volume of the dead trees (that are not used as commercial timber).
National Forest Inventory	See Finnish National Forest Inventory.
natural process	A natural event in the development of management units (without or as a consequence of human activities) in the simulation of management schedules, for example, the growth and the mortality of trees. See also event.
net income	Gross income minus costs. See also gross income.
net present value	All predicted future net incomes discounted to the present, compressing the future (of the management schedule, for example) into one figure temporally weighed by the discount rate. See also discounting, discount rate, interest rate and net incomes.
net revenue	See net income.
non-forestry land	See land-use category.
NPV	See net present value.
objective function	The function to be maximized or minimized in optimization. See also linear programming and optimization.
operating system	The software managing and maintaining the operation of a computer system, for example, by controlling the execution of other programs, by sharing system resources and by providing common services.
operational planning	Short-term planning focusing on the activities and operations in the near future (for the implementation of the strategic plan).
optimization	Search for the best solution subject to given conditions, for example goals and constraints. Mathematically, either maximization or minimization of the objective function. In the

	MELA context also, solving of the given optimization problem using linear programming and the JLP software.
other forestry land	See land-use category.
planning horizon	The time period being considered in the planning process.
present value	The discounted value of future revenues and costs. See also discounting and net present value.
presimulation	The automatic updating (of the growth of the trees) for the management unit data up to the beginning of the calculation period (i.e. the year when the simulation of the management schedules begins).
primal problem	The original formulation of the linear programming problem with the linear objective function and constraints. See also dual problem and linear programming.
printlevel	A JLP command for the selection of the extent of the JLP terminal report.
prob	A JLP command for definition of a optimization problem in the JLP problem paragraph (or in the respective 'prob' section of a MELA **mdl** type file).
production program	The optimal solution (of an optimization problem) from the production point of view. In MELA, the management schedules for the management units selected in the optimal solution.
pulpwood	The part of stems not saw log but suitable for size and quality for the manufacture of pulp, paper, fiberboard, or other wood fiber products. See also saw log.
reduced cost	The marginal cost (change of the objective function) of including a new activity (management schedule) into the optimal solution. It equals to zero for all optimal management schedules.
relative year	A year expressed in relative terms in relation to the beginning of the calculation period, like 1 or 11. See also absolute year.
re-simulation	The repeated simulation of the management schedules selected for the management units in the optimal solution. For example, re-simulation is used for the calculation and reporting of the information not stored in the previous calculation steps.
revenue	See income.

roadside price	The price of the timber at the roadside, i.e. the price including implicitly or explicitly the costs of logging and hauling.
sample plot	The sub-unit (representing a part) of a management unit, for example, a part of a stand or a genuine field sample plot. Sample plots describe the management unit and the different types of variation in a management unit. See also management unit and sample tree.
sample tree	A genuine sample tree or its simulated equivalent on a sample plot (of a management unit). Sample trees represent the growing stock (or tree distribution) on a sample plot. See also management unit and sample plot.
saw log	The part of stems suitable in size and quality for the production of lumber (or saw log timber).
saw timber	See saw log.
schedule	See management schedule.
scrub land	See land-use category.
shadow price	The marginal change of the objective function caused by the slight modifications of the original LP problem. In JLP, shadow prices are calculated for constraints, x variables, management units and management schedules. For further details, see Lappi (1992).
simulation	The (computational) imitation of (real) objects, phenomena and processes.
simulation period	The time period from the beginning of the calculation period to the actual end of simulation (after the calculation period). For the calculation of some decision variables, the simulation of each management schedule can be continued after the calculation period until the end of the on-going rotation period at the end of the calculation period. See also calculation period.
site type	A soil fertility class according to the FNFI classification system (see Salminen 1993). The classification is based on forest site types (mineral soils) and peatland types and their ground vegetation. The site type classes are: • Very rich sites on mineral soil or peatland. • Rich sites on mineral soil or peatland.

- Damp sites on mineral soil or peatland.
- Sub-dry sites on mineral soil or peatland.
- Dry sites on mineral soil or peatland.
- Barren sites on mineral soil or peatland.
- Rocky or sandy areas.
- Open mountains.

solution	The result of optimization.
solve	A JLP command for solving a JLP problem.
stand	A sufficiently homogeneous and large piece of forest with regard to soil and growing stock to constitute an individual management (and management planning) entity.
stand level	Regarding one stand (at a time).
state	The internal status of a management unit between events in the simulation of management schedules.
strategic planning	Long-term planning focusing on long range objectives and aspects, for example, for obtaining specific goals or results (in the future).
stumpage price	The price of standing timber excluding the costs of logging and hauling.
sub-period	An intermediate step of the calculation period. A calculation period consists of the sub-periods constituting the time framework for simulation, optimization and reporting in MELA. Typically, the length of one sub-period is from two to ten years. See also calculation period and simulation period.
sustainability	The management policy of taking the satisfaction of the (expected) future needs into account in the (current) human activities, for example, in the form of non-declining objectives for production and/or development in the future (and forever). See also sustained yield and maximum sustained yield.
sustained yield	The periodical balance of the harvests and the net increment in timber production. See also maximum sustained yield and sustainability.

symbol	A short, alternative name for a MELA command or parameter.
timberland	A land wholly or partly used for timber production.
total drain	Sum of cutting removal, waste wood and mortality.
transformation	The creation of new c, d and x variables in JLP. See also ctran, dtran and xtran.
treatment	See human activity.
utility function	A function expressing the satisfaction that the (forest) production process yields (to the decision maker).
value growth	See value increment.
value increment	The increase in the monetary value of a tree or of the growing stock as a consequence of the growth of the tree(s) during the given period.
volume table	A table showing the estimated (average) stem volume of the trees based on given tree characteristics, for example, tree species, diameter and height.
waste land	See land-use category.
waste wood	Sum of logging residue and the stem volume of felled trees from the clearing of regeneration areas and the tending of young stands.
xdat file	A JLP file containing the x variables or the management schedule (**msc** and **msd** type) files respectively in MELA.
xtran	A JLP command for the transformations of x variables. See transformation and x variable.
xvar	A JLP command for the definition of the x variables (or the decision variables) to be read in (from the management schedule (**msc** and **msd** type) files) for the subsequent JLP problem definitions (in the respective 'prob' section of a MELA **mdl** type file). See also prob.
x variable	A variable describing management schedules in JLP. See also decision variable, c variable, d variable and z variable.
year	See absolute year and relative year.
z variable	A variable used to formulate conventional LP problems in JLP. See also c variable, d variable and x variable.

Finnish Terms

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MELA Customer Response Sheet

We would appreciate your feedback very much. Your experiences in the use of the MELA System and your opinions and suggestions concerning the MELA Handbook will help us to improve our methods and products in the future.

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ISBN 951-40-1543-6
ISSN 0358-4283