

METSÄNTUTKIMUSLAITOS  
FINNISH FOREST RESEARCH INSTITUTE

# MELA Handbook

2000 Edition

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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 system, stand and tree simulation, forest and stand level optimization, linear programming

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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

## **Preface to the 1999 Edition**

The MELA Handbook 1999 Edition is the documentation of the MELA Version 1999. The 1999 Edition covers the changes of the software since the Version 1996 up to the Version 1999 (standard package). The first update of the MELA Handbook is published electronically only.

Kari Härkönen and Olli Salminen programmed and documented the new features of the software. The final publication was prepared and completed by Harri Kilpeläinen, who also recalculated numerical examples. Markku Siitonen checked the changes and made corrections. The 1999 Edition is largely based on the 1996 Edition of the MELA Handbook by Siitonen, M., Härkönen, K., Hirvelä, H., Jämsä, J., Kilpeläinen, H., Salminen, O., and Teuri, M. (The Finnish Forest Research Institute, Research Papers 622).

Special thanks to the modeling team led by Dr. Jari Hynynen in the Finnish Forest Research Institute for the new growth models of the MELA System.

Helsinki, 10 December 1999

Markku Siitonen

## **Preface to the 2000 Edition**

The MELA Handbook 2000 Edition is the documentation of the MELA Version 2000. The 2000 Edition covers the changes of the software since the Version 1996 up to the Version 2000 (standard package). This update of the MELA Handbook is published electronically only and made available for public in internet.

Arto Haara, Kari Härkönen, Visa Redsvén and Olli Salminen programmed and documented the new features of the software. The final publication was prepared and completed by Aimo Anola-Pukkila and Aila Suokas. Markku Siitonen and Tuula Nuutinen supervised the design and implementation of the new features and their integration. Hannu Hirvelä made valuable

comments on the manuscript. The 2000 Edition is based on the 1996 Edition of the MELA Handbook and 1999 Edition (Siitonen, M., Härkönen, K., Kilpeläinen, H., and Salminen, O. (eds.) 1999. MELA Handbook 1999 Edition. The Finnish Forest Research Institute. 492 p.)

Special thanks to Dr. Risto Ojansuu in the Finnish Forest Research Institute for the new diameter model for small trees.

Helsinki, 26 April 2001

Editors

# MELA Handbook User's Guide

## MELA Version 2000

The MELA Handbook 2000 Edition describes the MELA System in November 2000 excluding stand data extensions (standard package). The Handbook covers several individual subjects in one package dealing with MELA and how to apply it.

The new features in MELA 2000 version are (including changes in stand data extensions)

- event definition for the selection of retained trees in regeneration cuttings and their impact on growth (standard package),
- a new diameter model for small trees (stand data extensions),
- several sample plots per calculation unit in stand data files and in updated stand data files (stand data extensions),
- trees in addition to tree stratum in stand data file data (stand data extensions),
- retained tree stratum and trees in stand data files and in updated stand data files (stand data extensions),
- log-volume reduction or log-volume percentage in stand data files (standard package and stand data extensions),
- hardware based control of sharing the software resources (standard package and stand data extensions).

Several parameter definitions have changed since the MELA 1996 and MELA 1999 version, including new features in the EVENT\_CALL item of the EVENT parameter and changed LOG\_VOLUME\_REDUCTION parameter. For new and changed parameters, see Appendices B.1 and B.2.

For new features in stand data extensions, see Kilpeläinen, H., Malinen, J. and Haara, A. 2000. MELA LAAJENNUSOSAT. MELA2000 versio. Käyttöohje (User's Guide).

## Earlier MELA Versions

The **MELA Version 1996** was the first standard MELA version for users in practical forestry. It was not compatible with earlier, "unofficial" MELA versions because of many changes, for example, in the file formats, in the names of MELA programs, commands and parameters and in the definitions of variables. See the MELA Handbook 1996 Edition (Siitonen et al. 1996).

The MELA Version 1996 contained two extensions: one for generating initial MELA data and the other for updating forest resource data. The extensions serve analyses based on stand data. For further information, contact the MELA Team.

In the **MELA Version 1998**, new growth models (Hynynen et al. 2000) were introduced. Some minor changes in the MELA programs were included.

New characteristics of the **MELA Version 1999** included

- updated forest management instructions,
- new cost models for harvesting based on productivity and time expenditure functions,
- extended and more open control of parameters, and
- modified growth models for peatlands and for birch on mineral soils.

Several parameter definitions had changed since the MELA 1996 version, including the role of the FOREST\_CATEGORIES item of the EVENT parameter in the delineation of the feasibility of events. For new and changed parameters, see Appendices B.1 and B.2.

**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 familiar with forest analysis problems** - 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 descriptions of 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 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
<b>MELASET.PAR</b>	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] instructions
```

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

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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

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### 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,

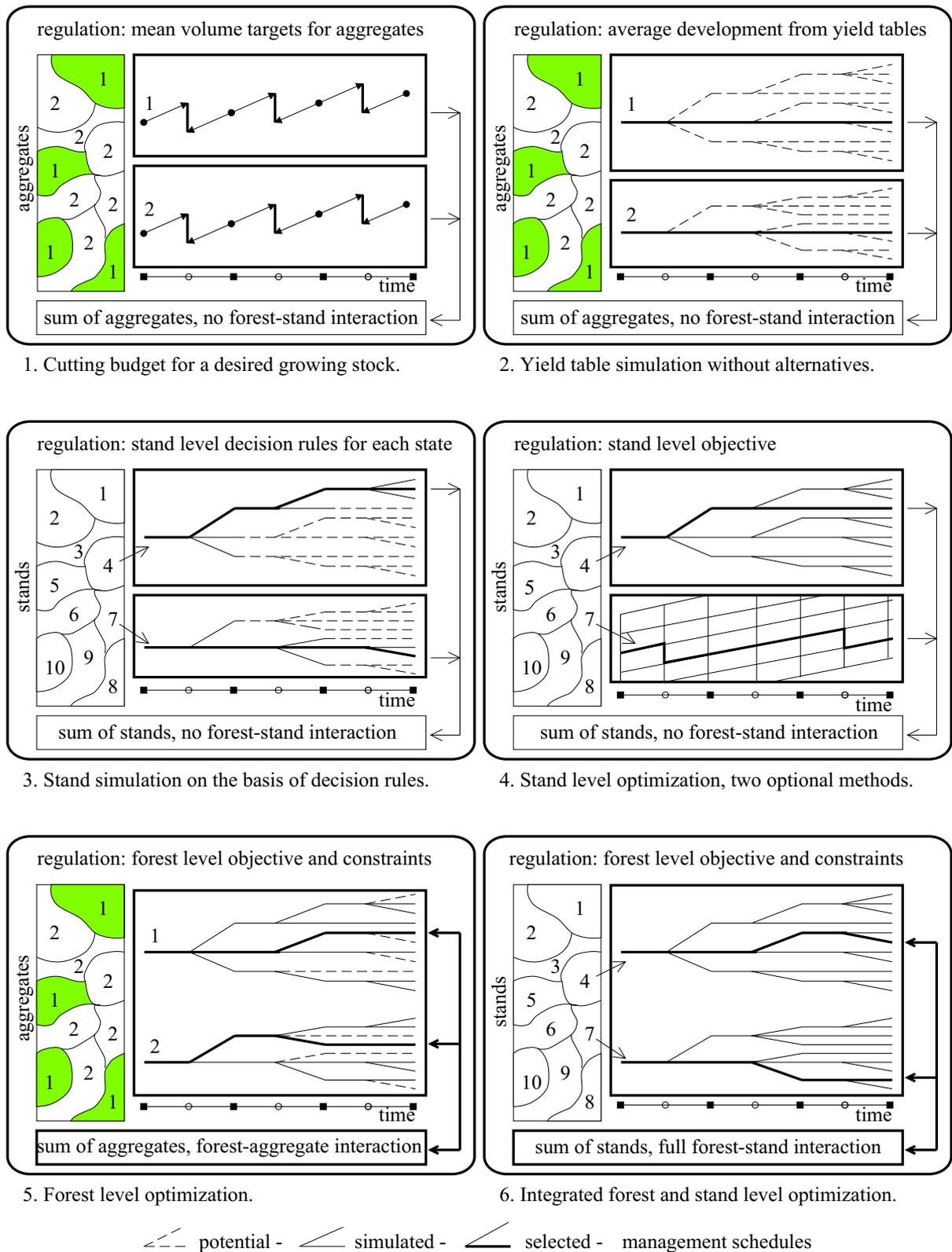
1993, 1994 and 1995) discussed here, and consequently the increasingly versatile and detailed analyses of forest production in the broad sense.

## 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 & Nyysönen 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).



**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, the true optima over time seem irrelevant in forestry due to multiple uncertainties of natural processes and 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.

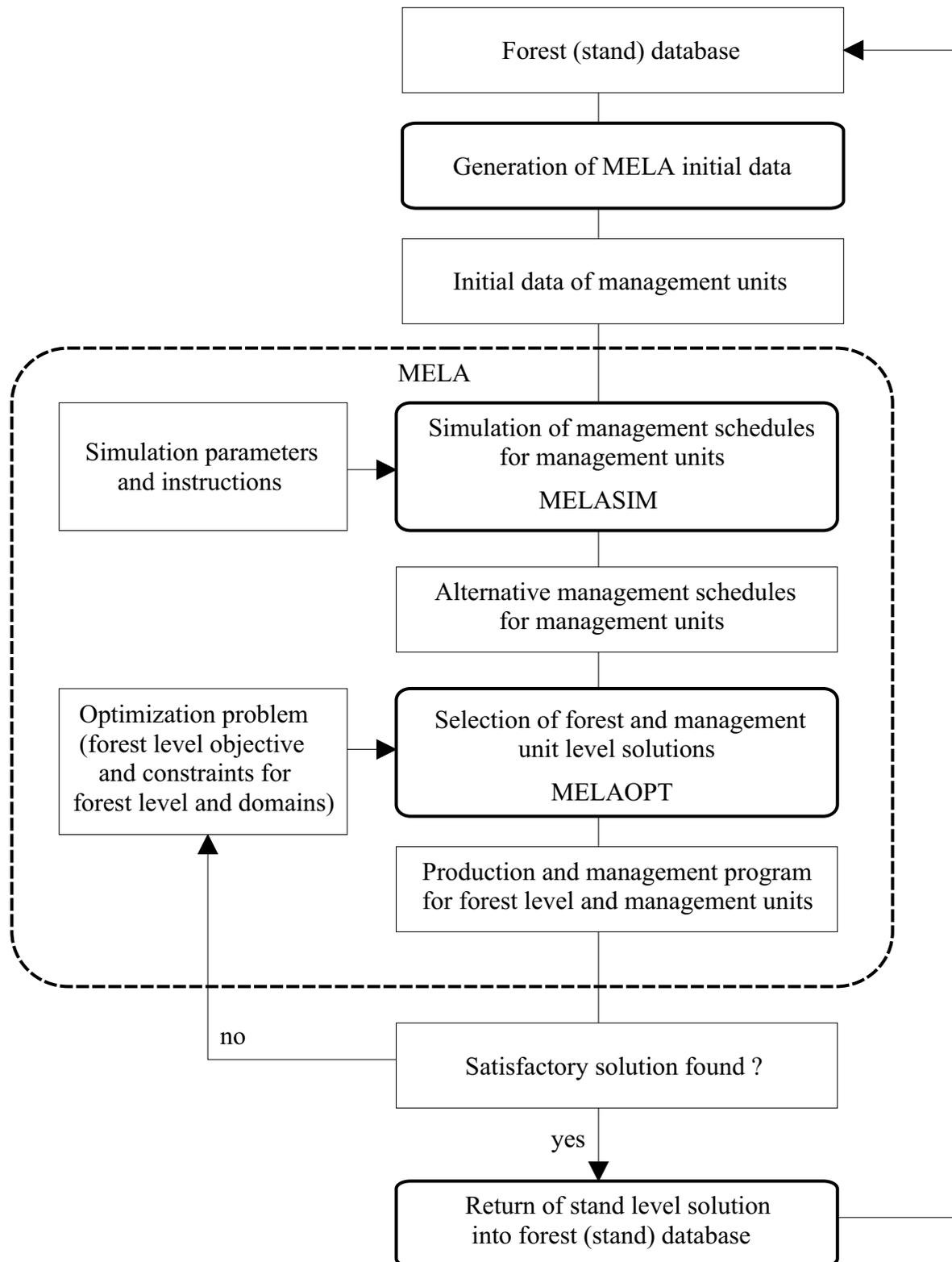
### 1.2.2 Methods

#### 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. Increment of diameter, for example, is a function of tree species, diameter and height

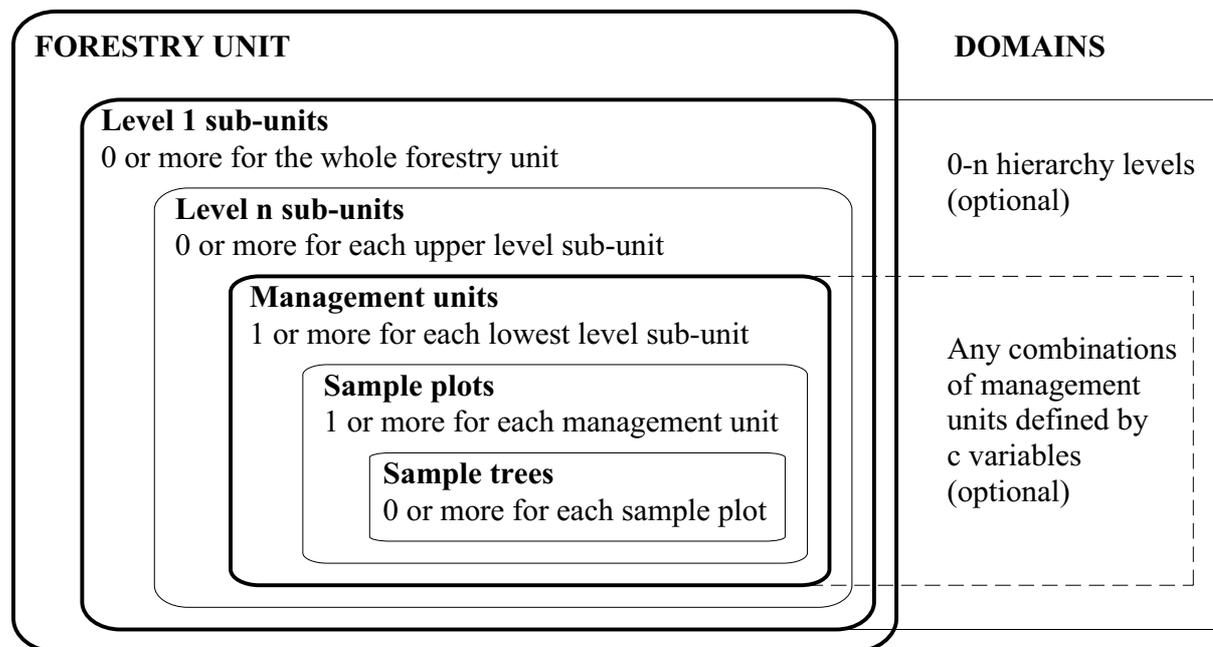
SIMULATION OF MANAGEMENT SCHEDULES					SELECTION OF FOREST AND MANAGEMENT UNIT LEVEL SOLUTIONS								
C variables				Management		JLP problem definition	JLP shadow prices	JLP management unit level solutions					
A	B	c	d	e	units			schedules	selected schedules	x10	x20	x40	x11 etc.
1	1	1	2	3	1		(1)	(2)	1.00	**	**	**	**
1	1	1	1	4	2		(1)	(2)	1.00	**	**	**	**
1	1	3	2	1	3		(1)	(1)	1.00	**	**	**	**
1	1	3	1	4	4		(1)	(2)	0.13	**	**	**	**
1	2	1	2	2	5		(1) ... (5)	(1)	1.00	**	**	**	**
1	2	2	1	1	6		(1) ... (6)	(4)	1.00	**	**	**	**
1	2	3	1	4	7		(1) ... (12)	(9)	1.00	**	**	**	**
1	3	1	2	3	8		(1)	(1)	1.00	**	**	**	**
1	3	3	1	2	9		(1) ... (3)	(2)	1.00	**	**	**	**
2	4	2	1	1	10		(1) ... (5)	(4)	1.00	**	**	**	**
2	4	2	2	1	11		(1) ... (6)	(6)	1.00	**	**	**	**
2	5	1	2	2	12		(1) ... (7)	(3)	1.00	**	**	**	**
2	5	3	1	1	13		(1)	(1)	1.00	**	**	**	**
2	5	2	2	2	14		(1) ... (5)	(5)	1.00	**	**	**	**
							JLP forest level solution						
The decision variables describing <i>(in the management schedule data)</i> ■ the states and ○ the events of each subperiod, of each management schedule and of each management unit  <i>(in the optimum solution also)</i> for the hierarchy level members, for the domains and for the forestry unit					<b>all:</b> x1_ area      **      **      **      ** x2_ volume    **      **      **      ** x3_ removal    **      **      **      ** x4_ NPV        **      **      **      ** <b>B=1:</b> x1_ area      **      **      **      ** x2_ volume    **      **      **      ** x3_ removal    **      **      **      ** x4_ NPV        **      **      **      ** etc.								

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

of the tree, basal area of the stand, site type, geographical location, etc. (Hynynen et al. 1999, 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. Respectively, the costs of logging and silviculture are calculated from unit prices and time expenditure models (Kuitto et al. 1994, Rummukainen et al. 1995) or user-supplied time expenditure assumptions. 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 an explicit utility function are solved through the iterative use of LP, the analysis of primal and dual solutions and the regulation of constraints for the forestry unit and the stands. See also Chapter 3.5.

"Built-in" constraints of JLP, for example area constraints and domains, reduce the memory needs of 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.

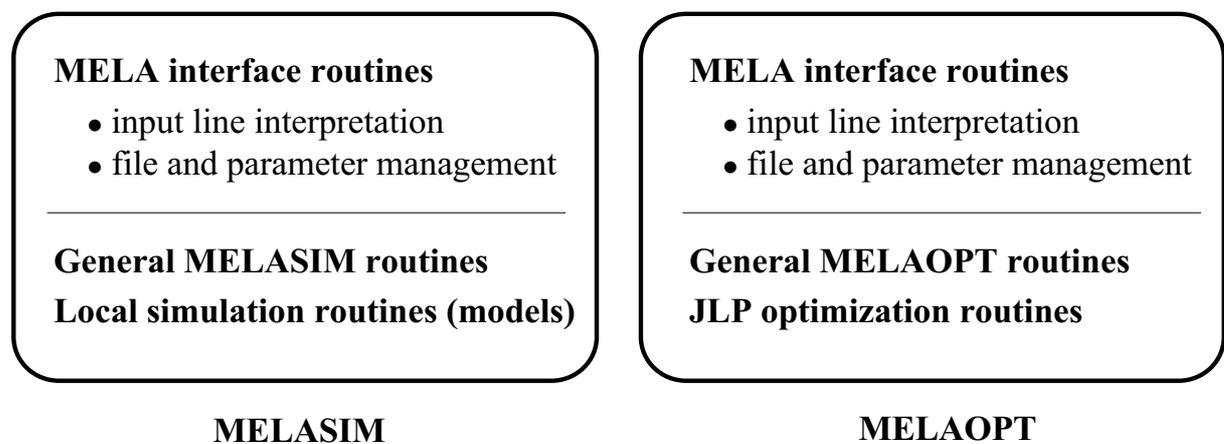
The optimization problem is open in MELA. Actual JLP problems are given in user-supplied problem definition files. Any of the stored decision variables over the calculation period (hundreds in total) and their linear combinations are available as optional decision criteria (objective or constraints of 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 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. A JLP solution as such comprises, for example a summary of the decision variables for the domains referred in the problem definitions, a list of the management schedules selected in the JLP solution, and 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 Pentium family processor with an 16 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, 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 hundreds of thousands management units and millions management schedules in total with ten or so decision variables in one optimization problem on a typical UNIX server. 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 national timber production analyses in Finland since the middle of the 1980s (for example, The Forest 2000 Program in 1986, The Presentation of the Revised Forest 2000 Program in 1992 and Finland's National Forest Programme 2010 in 1999). MELA is widely used by clients in state, company and private forestry as the forest management planning module of their own forest (stand) information systems in Finland. See also Part 4.

## 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 have proved 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.

Multiple future uncertainties and unpredictably changing human needs may challenge the simple interpretation of the 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

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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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### 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 several rounds of national timber production analysis in Finland since the middle of the 1980s.

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.

## 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: 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:					
P4-CUTTING POTENTIAL-NPV 4 % solution is optimum					
-----					
	1996	2006	2016	2026	2036
-----					
804 NPV 4 %	433331				519997
537 Forestry land area	24.1				
700 Volume, m3	2829.4	2918.2	2710.2	2588.3	2562.1
697 -saw log	1224.6	1298.1	1384.0	1219.4	1094.2
090 Increment, m3/a		114.6	103.2	102.2	114.4
195 Cutting removal, m3/a		98.8	109.5	109.5	109.5
193 -saw log		62.5	62.5	69.1	66.0
370 Net revenues, FIM/a	14451.9	16016.2	18663.2	18663.2	
800 Roadside value, FIM	525340				474515
-----					

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.

1<>mela<> 31199 172517					
=====					
F2 - S4-MAXIMUM SUSTAINED YIELD-NPV 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	2918.2	2710.2	2588.3	2562.1
Pine	1790.9	1961.5	1424.8	825.1	1120.0
Spruce	969.6	810.1	1026.7	1337.2	1037.3
Birch	53.6	111.1	211.9	332.1	347.1
Other deciduous	15.3	35.6	46.8	93.9	57.7
Saw log	1224.6	1298.1	1384.0	1219.4	1094.2
Pulpwood	1472.8	1487.7	1224.5	1228.7	1295.6
VALUE (roadside prices), FIM	525340	554734	535668	507149	474515
NET PRESENT VALUE (NPV) 3%	589268	624389	653455	661831	673087
	1996	2006	2016	2026	2036
INCREMENT, m3/a	114.6	103.2	102.2	114.4	
Pine	65.4	54.3	37.2	46.6	
Spruce	40.2	32.9	40.5	46.4	
Birch	6.8	11.2	16.6	17.0	
Other deciduous	2.2	4.8	8.0	4.4	
TOTAL DRAIN, m3/a	105.7	124.0	114.4	117.0	
Mortality	4.8	7.9	3.3	3.5	
Cutting drain	100.9	116.2	111.1	113.5	
CUTTING REMOVAL, m3/a	98.8	109.5	109.5	109.5	
Over story removal	0.0	14.6	22.9	15.8	
Thinnings	23.5	13.1	15.3	58.2	
Regeneration cuttings	75.3	81.9	71.3	35.5	
Pine	46.6	101.2	95.1	15.8	
Spruce	52.2	5.4	9.1	75.3	
Birch	0.0	0.0	3.4	14.0	
Other deciduous	0.0	2.9	1.9	4.4	
Saw log	62.5	62.5	69.1	66.0	
Pulpwood	36.3	47.0	40.4	43.5	
TOTAL CUTTING AREA, ha/a	0.8	1.2	1.2	1.1	
Thinnings	0.3	0.2	0.3	0.7	
Clear cuttings	0.1	0.0	0.0	0.1	
Over story cuttings	0.0	0.4	0.5	0.3	
Seed tree cuttings	0.3	0.5	0.3	0.0	
Shelterwood cuttings	0.0	0.0	0.0	0.0	
REGENERATION AREA, ha/a	0.5	0.5	0.3	0.1	
Artificial regeneration	0.1	0.0	0.0	0.1	
Natural regeneration	0.3	0.5	0.3	0.0	
TENDING YOUNG STANDS, ha/a	0.2	0.4	0.6	0.3	
GROSS REVENUES, FIM/a	20911.4	22581.6	24554.0	24970.3	
TOTAL COSTS, FIM/a	6459.4	6565.4	5890.8	6307.1	
NET REVENUES, FIM/a	14451.9	16016.2	18663.2	18663.2	
=====					

### 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.

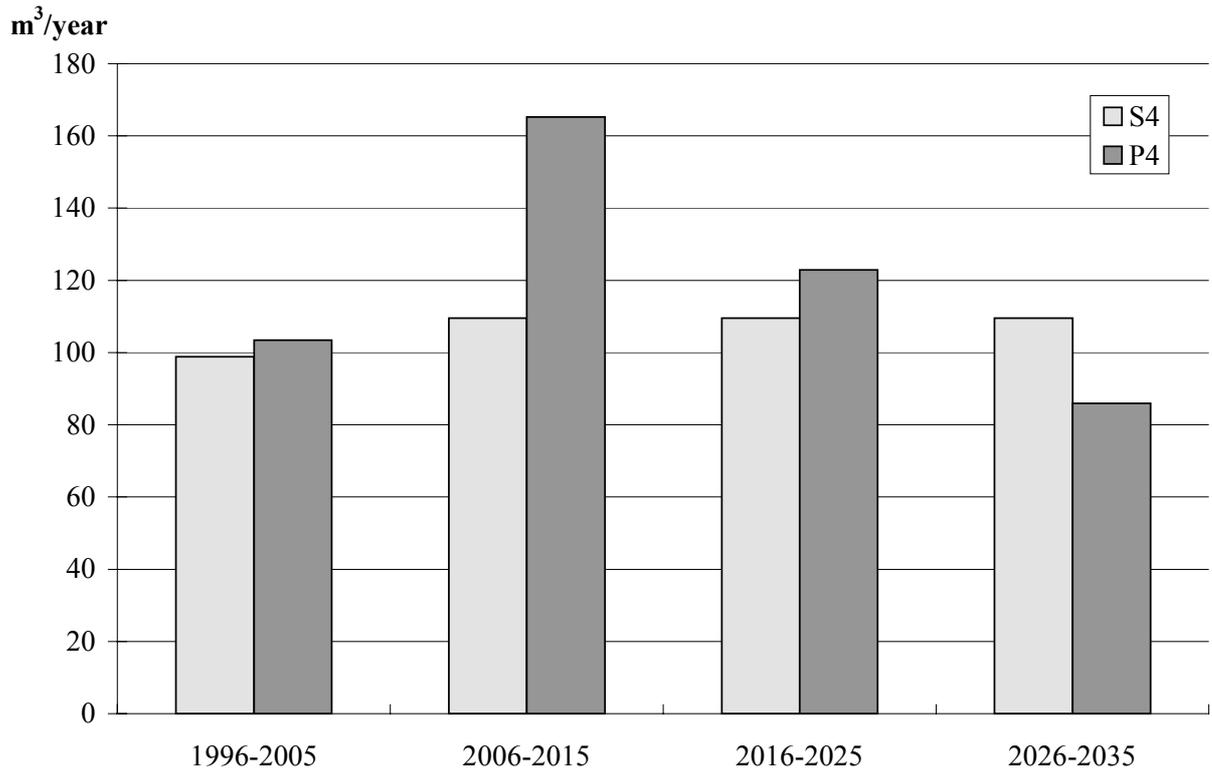
If possible, draw the development of the cutting removals into one figure and the development of the growing stock into another one - solutions P1, ..., P5 and solutions S1, ..., S5 separately, two figures in total - in order to see the differences between different solutions. You can draw the figures 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?

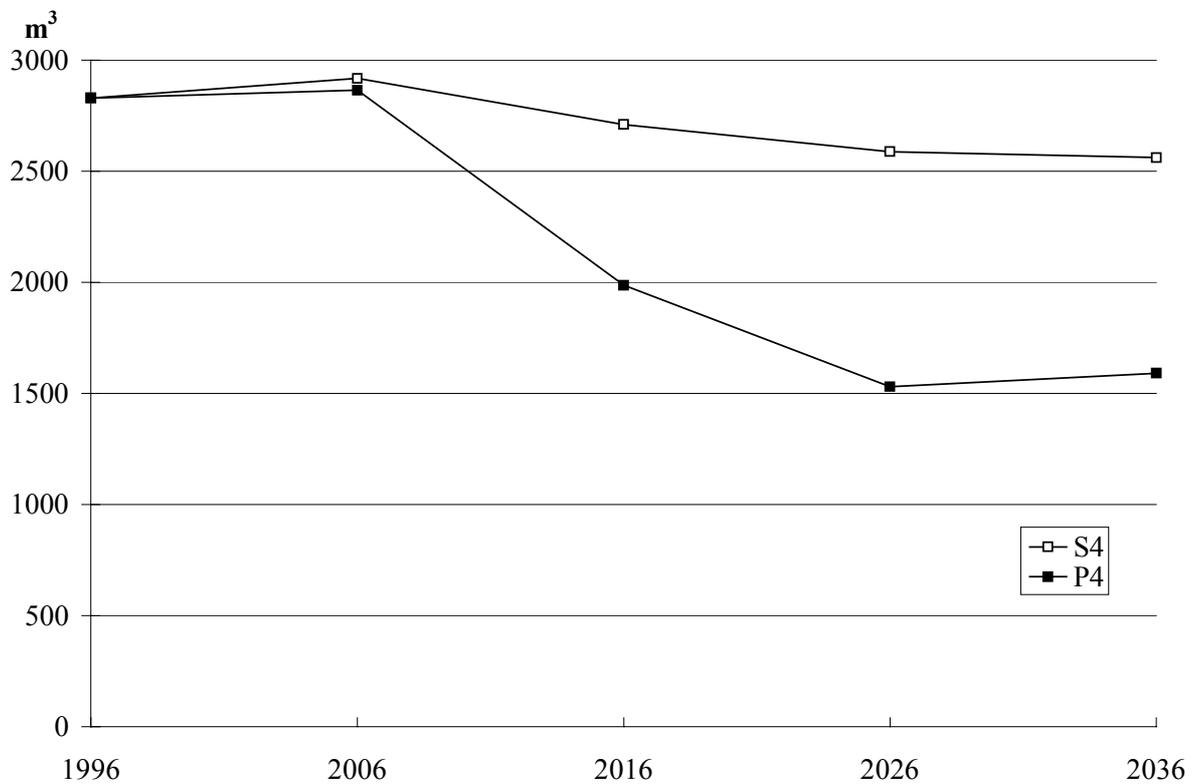
### 2.2.2.5 Feasible (or final) production program

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
```

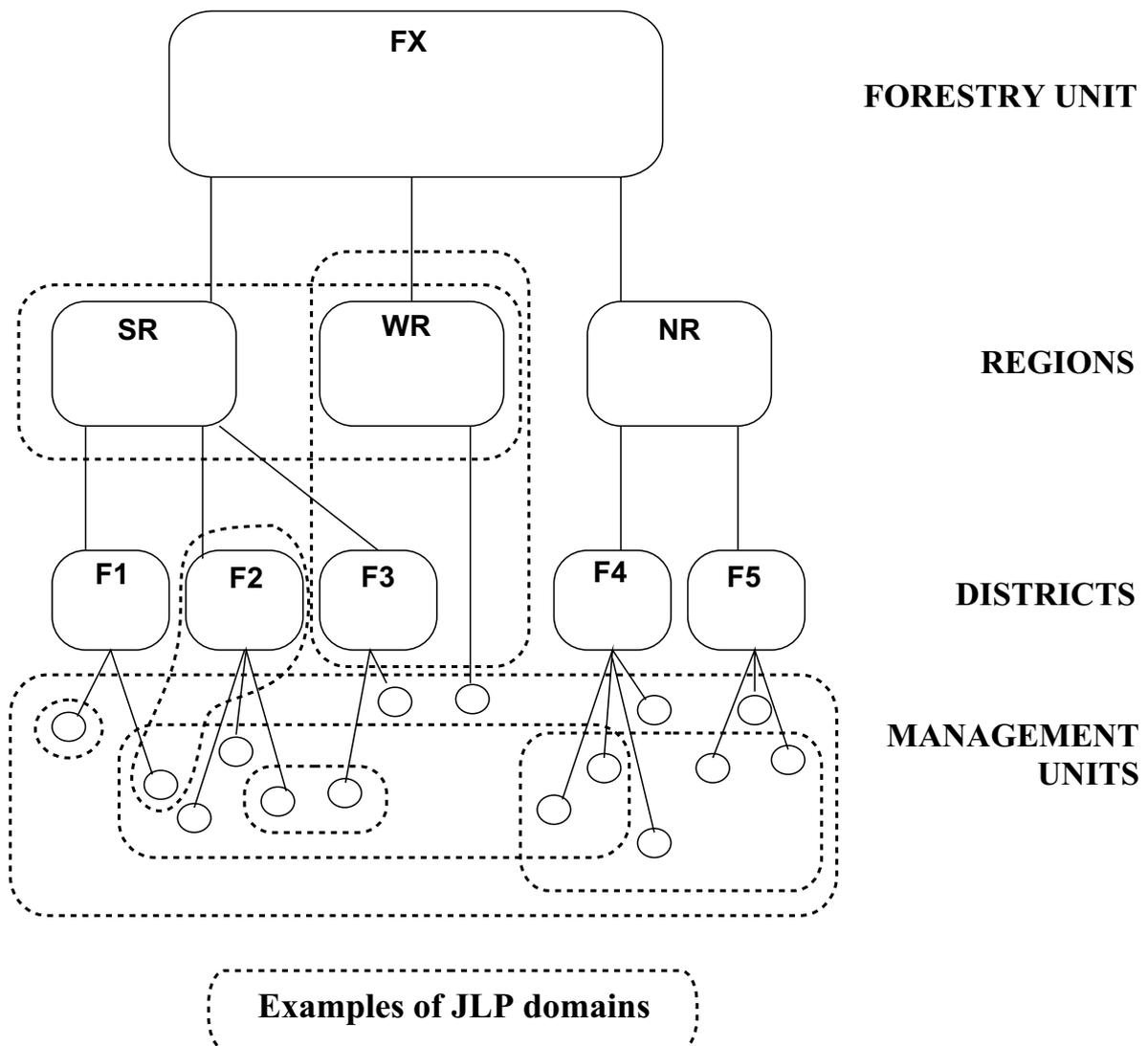
```
MELASIM>SIMULATE MSR F2 Z0
MELASIM>EXIT
```

- 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.

```
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.

Notice that all the REPORT SOLUTION commands above generate the solution report file **FX\_S4.SOL**. After each REPORT SOLUTION command copy the **FX\_S4.SOL** file to another file, for example to **FX\_S4\_SR.SOL** and so on.

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

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

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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

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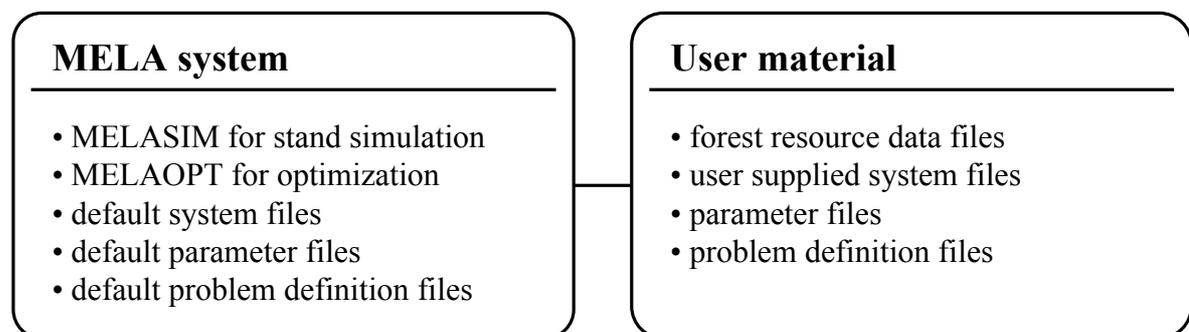
---

### 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.



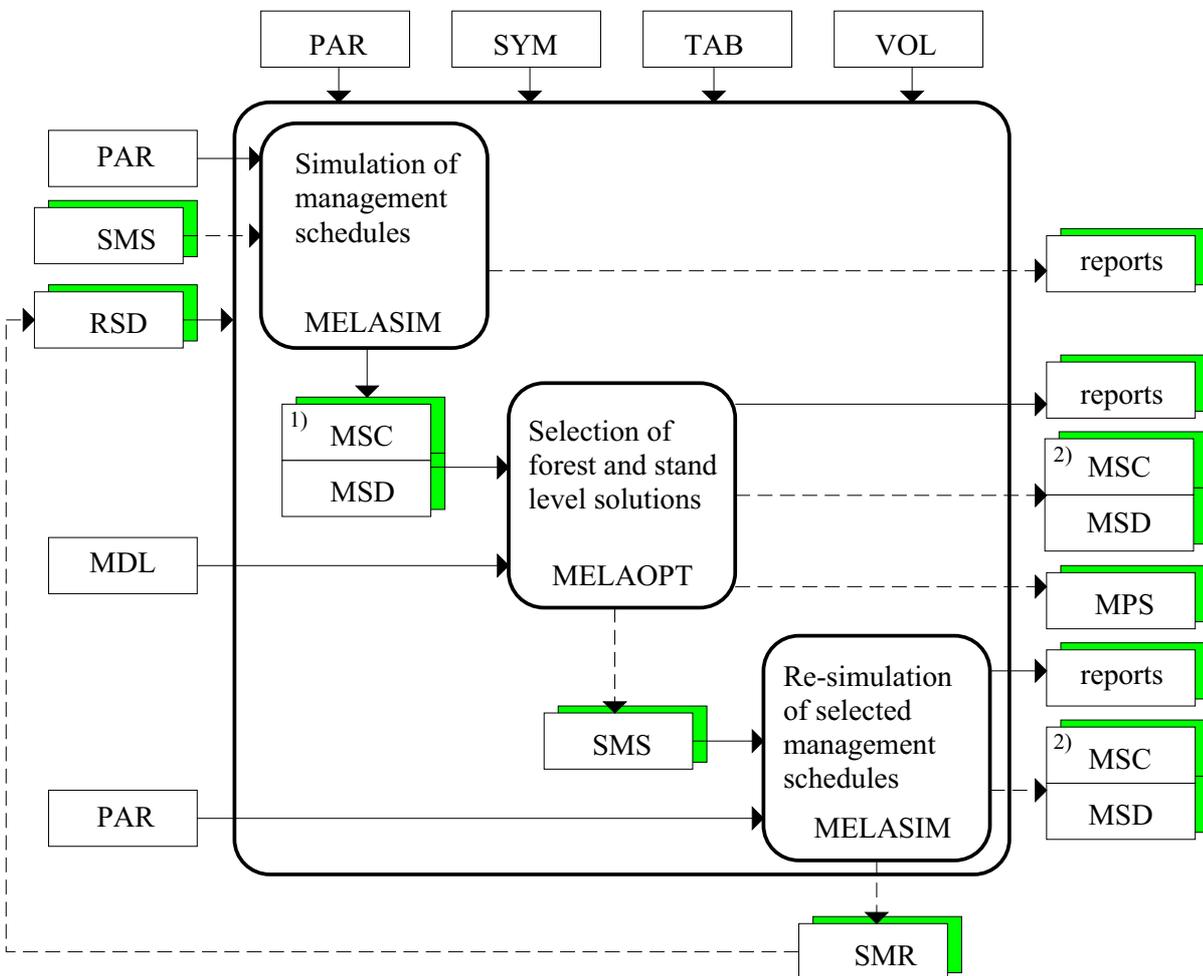
**Figure 3.1.** The components of the MELA System.

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. For the MELA stand data extensions, contact the MELA Team.

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 into 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.
```



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 about 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 into 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).

NOTE: When old parameter definitions are removed from the internal parameter database, the same parameter may not necessarily get new values. If you want to change parameter values, it is a safe way to restart the MELA program with new parameter values.

**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, parameters and error messages 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 into the internal symbol database to be retrieved by the MELA programs.



## 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** A file name 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** A file name extension 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 a 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`

internal parameter database.

A parameter name to be removed from the

**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**A 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 file name extension.

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 a file name and VOL is an 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:

$\Sigma$	'FX', 'F2', 'S4'	values of command arguments
	'S'	character constant
$\Sigma$	'SUM'	extension
$\Sigma$	'_'	delimiter between file naming components
$\Sigma$	'.'	delimiter between the file name and the 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)

Default values for naming components, their order in file names, and 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 is 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 your operating system commands for saving or renaming the old file version before the execution of the MELA programs, if necessary. Use also 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.

- An 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 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.26).

NOTE: The decision hierarchy selection may appear during a 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 **mnc** 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** A 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.

- a 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

- a 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.

- a value of the **proposals** component in a 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** A 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 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 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 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 for 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 from 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 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 MELAOPT routines and 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** A 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 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 a name of the **rsd** type file the containing initial data and of 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 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 report files, see Appendix C.2, and for reports, see examples in Appendix H.

NOTE: Domain definitions are valid for 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**, **mpu**, **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 in Lappi (1992). Domain definitions are valid for 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 domains 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 SOLUTION and SUMMARY requests, the domains from 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
a name of the c variable in the last JLP problem solved	a valid value for the c variable
a name of the decision hierarchy level in the last JLP problem solved	a member of the decision hierarchy level
'data'	a value (or one of the values) for the argument <b>forestry_unit</b> 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 a value for 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 in 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\_MUUTTUIJAT

Names of the *c* variables stored in management unit records (see Appendix D.2) of initial data (**rsd** type) files. For details, see the C\_VARIABLES parameter in Appendix B.2 and Example H.1.

### INTEGERAPPROXIMATION

Generic name in Finnish: KOKONAISSLUKURATKAISU

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 for 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 JLP problem definitions.

**msc** type files The description of 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 the selected decision variables from MELASIM to MELAOPT.

**par** type files MELA parameter values.

**rsd** type files User-supplied initial forest resource data, including c variables of 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 from 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 in binary files for further processing (for example, for transmission into user's forest database).

**mpu** type files Selected simulation and decision variables in text files for further processing (for example, for transmission into user's forest database).

**mrg** type files Cost of change reports.

**msc** type files A description of 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 shadow prices in order to learn the nature of the problem. Study 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

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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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## 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 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, 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**

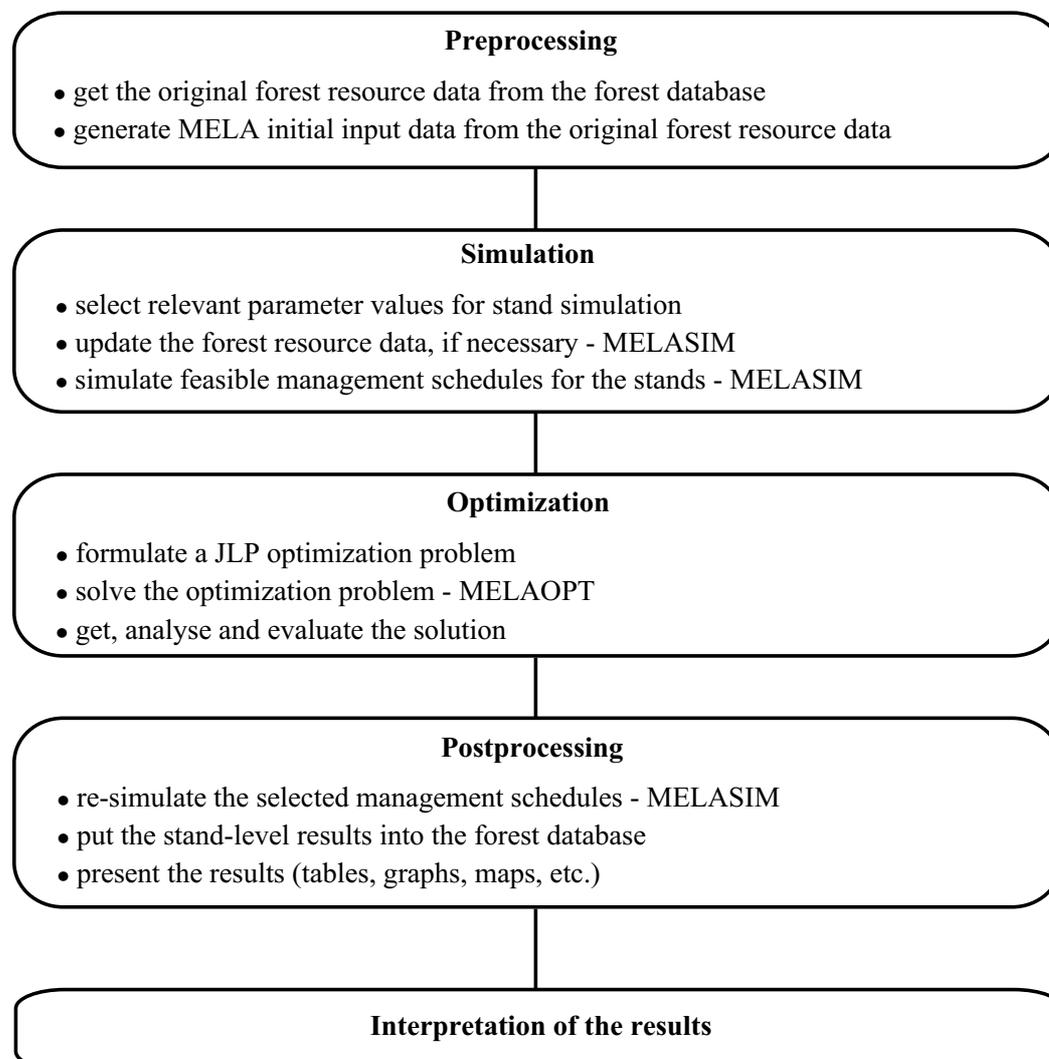
The policy in the current MELA software is to provide results both in the form of table type reports directly for users and in the form of files for further processing by user programs or commercial software for creating tables, graphics, maps, etc. The reports and the files currently available are shortly 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 Appendices D.3 and D.4) 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 a **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 to **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. The 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: Shadow prices are valid only with the solution of the defined linear programming problem. 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 shadow prices and 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 shadow prices and 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 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 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 shadow prices of management units and 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 (**m<sub>ps</sub>** type or **m<sub>pu</sub>** 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 (and the management report text records) are generated for each management schedule from the decision data and management schedule records of the management schedule (**m<sub>sd</sub>** type) files. The optimum solution records for the management units are obtained from the MELAOPT solution.

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

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

The stand management (**m<sub>ps</sub>** type or **m<sub>pu</sub>** 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 (**m<sub>sc</sub>** and **m<sub>sd</sub>** 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 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 (**m<sub>sc</sub>** and **m<sub>sd</sub>** 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 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 for decision variables are presented in MELA summary reports comparable to 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 file name extension has to be renamed from **smr** to **rsd** before the use of 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. Multiple pertinent factors and future uncertainties make 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 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 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 unexpected changes in forest management, errors of data and 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.

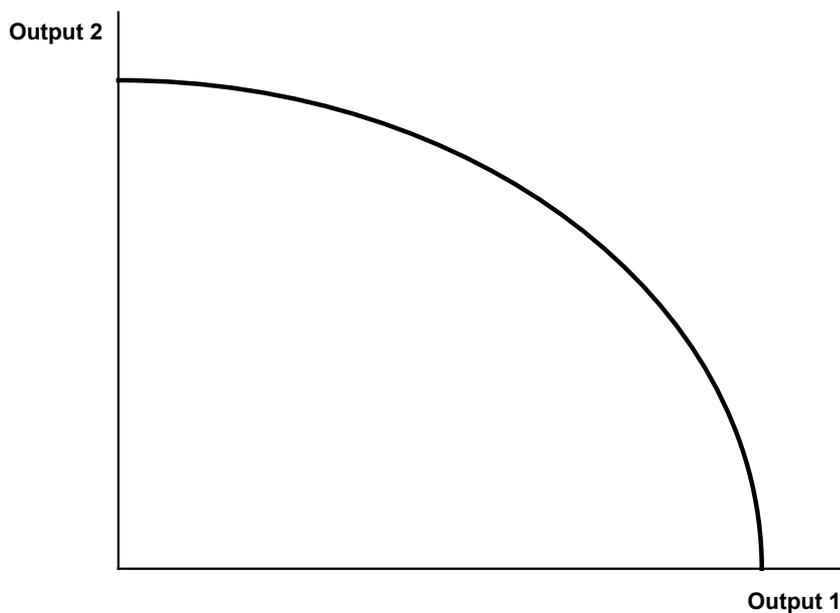
Direct constraints for harvest level and structure can be used to predict the development of forest resources under given conditions, see Examples H.22 to H.24.

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 for 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/mpu** 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 SUMMARY 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:

- Conventional management schedules directly from the stand simulation (MELASIM) may be used in pure stand level comparisons and analyses. Standwise simulation instructions may be needed to generate the specific alternatives, instead of the automatically controlled simulation of 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 cannot 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:

- The 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 many 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 to 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 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 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 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. For the stand data extensions, contact the MELA team.

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 stand variables. A sample of trees is taken from the diameter distribution and 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 (see Appendix D.7) in **sms** type files (see Appendix C.2). If standwise simulation instructions are given, they are obeyed instead or before general event definitions. The user can control how standwise simulation instructions and general event definitions are combined.

Typically, simulation instructions are used in the re-simulation of the MELAOPT solution. 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 general event definitions are simulated after that.

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

### 4.6.4.3 Management unit records

Standwise classification variables for optimization can be stored in management unit (c variable) records of initial 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 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 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 varying 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, 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 misuse. 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. & Gilles, 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.



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Finland's National Forest Programme 2010. 1999. Ministry of Agriculture and Forestry Publications 2/1999. 41 pp. ISBN 951-53-1948-X.

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

Hynynen, J., Ojansuu, R., Hökkä, H., Salminen, H., Haapala, P., Härkönen, K. & Repola, J. 1999. Models for predicting stand development - Version for description of biological processes in MELA system. Finnish Forest Research Institute. Manuscript.

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.

Kuitto, P.-J., Keskinen, S., Lindroos, J., Oijala, T., Rajamäki, J., Räsänen, T. & Terävä, J. 1994. Puutavaran koneellinen hakkuu ja metsäkuljetus. Summary: Mechanized cutting and forest haulage. *Metsätehon tiedotus 410 (Metsäteho Report 410)*. 38 pp. + appendices.

Kuusela, K. & Nyysönen, A. 1962. Tavoitehakuulaskelma. 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 relationships 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. 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.

Luonnonläheinen metsänhoito - metsänhoitosuositukset (in Finnish). 1994. Metsäkeskus Tapion julkaisu 6/1994. 3rd edition. Helsinki. 72 pp. ISSN 1236-6331, ISBN 952-9891-03-2. [English summary in: *Good forests for the good of all*. 1994. Forestry Centre Tapio. Helsinki. 16 pp. ISBN 952-9891-04-0].

Metsäpalkkarakenteen uudistaminen - koulutusaineisto. (Reforming the foundations of forest wages, in Finnish.) 1995. Metsäpalkkauksen kehittämisen projektiryhmä 10.1.1995. 4. painos. Oriveden kirjapaino. 45 pp.

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 (Finnish Forest Research Institute, Research Papers 385). 59 pp. ISBN 951-40-1268-2, ISSN 0015-5543.

Ojansuu, R. 1996. Kangasmaiden kasvupaikan kuvaus MELA-järjestelmässä. (Description of mineral soils in the MELA System, in Finnish). In: Hynynen, J. & Ojansuu R. (eds.). 1996. *Puuston kehityksen ennustaminen - MELA ja vaihtoehtoja*. Tutkimusseminaari Vantaalla 1996. *Metsäntutkimuslaitoksen tiedonantoja* 612 (Finnish Forest Research Institute, Research Papers 612): 39-56. ISBN 951-40-1530-4, ISSN 0358-4283.

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

Rummukainen, A., Alanne, H. & Mikkonen, E. 1995. Wood procurement in the pressure of change - resource evaluation model till year 2010. Acta Forestalia Fennica 248. 98 pp. ISBN 951-40-1478-2, ISSN 0001-5636.

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 (University of Helsinki, Department of Forest Mensuration publications 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. 1994. 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. 1995. The MELA System as a forestry modeling framework. Lesnictvi-Forestry, 41,1995 (4): 173-178. ISSN 0024-1105.

Siitonen, M., Härkönen, K., Hirvelä, H., Jämsä, J., Kilpeläinen, H., Salminen, O., & Teuri, M. 1996. MELA Handbook 1996 Edition. Finnish Forest Research Institute, Research Papers 622. 455 pp. ISBN 951-40-1543-6, ISSN 0358-4283.

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



# Appendices

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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

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Appendix A provides information about the MELA delivery.

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# Appendix A

## MELA Delivery and Installation

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### 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** (text file)  
general MELA parameters for MELASIM and MELAOPT
- **SYMBOL.SYM** (text file)  
symbolic names of MELA commands, parameters and message texts for MELASIM and MELAOPT (in English)
- **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
- **USER.PAR** (text file)  
license information
- 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 on the following operating systems:

- Windows 3.1x, Windows 95/98, Windows NT,
- VAX/VMS, and
- several UNIX versions.

The PC versions (for example Windows 3.1x, Windows 95/98 and Windows NT) are compiled with the WATCOM F77<sup>32</sup> FORTRAN compiler.

For details and other versions, contact 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 Pentium 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 16 Mb (or more).

The MELA programs require 3-10 Mb hard disk space according to the size of the programs.

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. Depending to user data materials, at least tens or hundreds of Mb disk space may 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 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

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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

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### B.1 Introduction

The task of parameter definitions is to control the execution of the MELASIM and MELAOPT programs. The definitions of the most of the MELA parameters are optional, in principle, since the MELA programs use built-in default values for the undefined parameters, if available. Formally, explicit parameter definitions are needed when the built-in defaults are to be substituted. However, the default values should never be used without checking their applicability for the analysis and the geographical region in question. Some parameters have to be defined for every single 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 in lower case letters (see also Chapter 3.3).

The MELA parameters are presented here in alphabetical order. In the MELA99 version, there are new parameters and some parameter definitions have changed since earlier MELA versions.

The following parameters are first time presented here:

BASAL\_AREA\_INSTRUCTIONS  
BOUND\_FOR\_SUPPLEMENTARY\_PLANTING  
BOUND\_FOR\_YOUNG\_STAND\_REGENERATION  
FEASIBLE\_TREE\_SPECIES  
H50\_CALIBRATION  
LOGGING\_COSTS  
MANAGEMENT\_UNIT\_TYPE  
MAX\_REGENERATION\_TIME  
MIN\_NUMBER\_OF\_STEMS\_AFTER\_THINNING  
NUMBER\_OF\_SEED\_TREES  
TIME\_EXPENDITURE\_IN\_LOGGING

Most of the parameters are unchanged since the MELA Version 1996.

NOTE: The MPS\_OUTPUT and MIN\_BASAL\_AREA\_AFTER\_THINNING parameters in the earlier MELA versions are substituted by the STAND\_MANAGEMENT\_FILES and BASAL\_AREA\_INSTRUCTIONS parameters.

## B.2 Parameters

Current MELA parameters:

### In English:

BASAL\_AREA\_INSTRUCTIONS +  
 BOUND\_FOR\_SUPPLEMENTARY\_PLANTING +  
 BOUND\_FOR\_YOUNG\_STAND\_REGENERATION +  
 C\_VARIABLES  
 D\_CLASSES\_IN\_REMOVAL  
 DISCOUNT\_RATES  
 EVENT \*  
 EVENT\_DEFAULTS  
 FEASIBLE\_TREE\_SPECIES +  
 FILE\_NAMING  
 FORESTRY\_UNIT  
 forestry\_unit\_LEVELS  
 forestry\_unit\_members  
 GROWTH\_CALIBRATION  
 H50\_CALIBRATION +  
 INTEGERAPPROXIMATION  
 LAND\_VALUES \*  
 LOG\_VOLUME\_REDUCTION  
 LOGGING\_COSTS +  
 LOWEST\_LEVEL  
 MANAGEMENT\_CATEGORY\_GROUPS  
 MANAGEMENT\_UNIT\_TYPE +  
 MAX\_REGENERATION\_TIME +  
 MAX\_LENGTH\_OF\_FILENAME  
 MELA\_TABLE  
 MIN\_NUMBER\_OF\_SEEDLINGS \*  
 MIN\_NUMBER\_OF\_STEMS\_AFTER\_THINNING +  
 MIN\_REGENERATION\_AGE \*  
 MIN\_REGENERATION\_DIAMETER \*  
 MPS\_VARIABLES  
 MSD\_VARIABLES  
 MSR\_VARIABLES  
 NUMBER\_OF\_SEED\_TREES +  
 OUTPUT  
 PRINT\_INPUT\_LINES  
 RE\_SIMULATION\_INSTRUCTIONS  
 ROADSIDE\_LOG\_PRICE\_ADJUSTMENT  
 ROADSIDE\_PRICES  
 SILVICULTURAL\_COSTS \*  
 SIMULATION\_CONTROL  
 STAND\_MANAGEMENT\_FILES  
 STUMPAGE\_PRICES  
 TIMBER\_PRODUCTION\_LAND  
 TIME\_EXPENDITURE\_IN\_LOGGING +  
 UNUSED\_GROWTH\_ESTIMATES  
 VOLUME\_CALIBRATION  
 YEARS

### Generic names in Finnish:

PPA\_OHJE  
 TAIMIKON\_TAYDENNYSTASO  
 TAIMIKON\_UUDISTAMISRAJA  
 C\_MUUTTUJAT  
 KERTYMAN\_LPM\_LUOKAT  
 LASKENTAKOROT  
 TAPAHTUMA  
 TAPAHTUMA\_OLETUSARVOT  
 PUULAJIOHJE  
 TIEDOSTOT  
 METSATALOUS\_YKSIKKO  
 metsatalous\_yksikko\_TASOT  
 metsatalous\_yksikko\_jasenet  
 KASVUN\_TASOKORJAUS  
 H50\_KALIBROINTI  
 KOKONAISLUKURATKAISU  
 MAAN\_ARVOT  
 TUUKKIVAHENNYS  
 KORJUUKUSTANNUKSET  
 ALIN\_TASO  
 KASITTELYLUOKAT  
 LASKENTAYKSIKON\_TARKENNE  
 SALLITTU\_UUDISTUMISAIKA  
 TIEDOSTONIMEN\_PITUUS  
 MELATAULUKKO  
 MIN\_VILJELYTIHEYS  
 MIN\_RLUKU\_HARV\_JALKEEN  
 MIN\_UUDISTUSIKA  
 MIN\_UUDISTUSLAPIMITTA  
 MPS\_MUUTTUJAT  
 MSD\_MUUTTUJAT  
 MSR\_MUUTTUJAT  
 SIEMENPUIDEN\_MAARA  
 TULOSTUS  
 SYOTTORIVIEN\_TULOSTUS  
 TOISTO\_OHJE  
 TIENVARSIHINNAN\_JAREYSKORJAUS  
 TIENVARSIHINNAT  
 METSANHOITOKUSTANNUKSET  
 SIMULONNIN\_OHJAUS  
 LASKENTAYKSIKKOPALAUTE  
 KANTOHINNAT  
 PUUNTUOTANNON\_MAA  
 KORJUUN\_AJANMENEKKI  
 KASVUMUISTI  
 TILAVUUDEN\_TASOKORJAUS  
 VUODET

### Notations:

- + New MELA99 parameter. This parameter is presented for the first time in the MELA99 Version.
- Changed MELA99 parameter. The format of this parameter is changed since earlier MELA versions. Check your parameter definitions.

---

## **BASAL\_AREA\_INSTRUCTIONS**

---

### **Functions**

The `BASAL_AREA_INSTRUCTIONS` parameter defines exogenous density guidelines for growing stands in terms of minimum basal area requirements before and after thinning, for example, for the generation of thinning alternatives in simulation for limitedly endogenous analysis or for fully exogenously controlled simulation of thinnings. Basal area limit after thinning is used both for relative thinning intensity and exogenous density regulation methods. Basal area limit after thinning serves mainly exogenously regulated simulation of thinnings.

There are several optional ways to apply the parameter directly and indirectly in simulation in conjunction with the specific `EVENT_CALL` arguments of thinnings based on basal area instructions. Thinning control should be selected with regard to the aimed endogeneity of thinnings in the analysis in question (see the `EVENT` parameter).

In MELA, when applying more or less endogenous approach for thinnings, the parameter with the specific `EVENT_CALL` arguments guide (i.e. restrict) the generation of thinning alternatives in simulation phase. Actual thinnings are selected from the simulated thinning alternatives in integrated forest and stand level optimization.

Notice that the `BASAL_AREA_INSTRUCTIONS` parameter resembles the "thinning models" applied in Finland for the pure exogenous control of thinnings without endogenous analysis. In case of exogenously controlled thinnings, the `BASAL_AREA_INSTRUCTIONS` parameter will serve as a conventional "thinning model" in MELA simulation.

In the absence of user-supplied parameter values, built-in default values (see Example B.1) are used. The default values are based on the common thinning recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994).

NOTE: Default values apply for Southern Finland only.

**Generic name in Finnish:** PPA\_OHJE

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 576

**Default values:** See Example B.1

**Valid since:** MELA99

## Legend

(1) - (288) Minimum basal areas (m<sup>2</sup> per hectare) before thinning.

Categories:

- soil and peatland category: 2 (mineral soil, peatland)
- tree species: 4 (pine, spruce, silver birch, downy birch and other deciduous trees)
- forest site type category: 4 (see the sample plot variable (13) of the initial data record in Appendix D.1)
  - 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)
- dominant height before thinning: 9 (10, 12, ..., 24, 26 m)

(289) - (576) Minimum basal areas (m<sup>2</sup> per hectare) after thinning.

Categories: The same as for items (1) - (288)

**Example B.1.** A definition of the BASAL\_AREA\_INSTRUCTIONS parameter.

```

BASAL_AREA_INSTRUCTIONS
* Minimum basal area before thinning.
* Dominant height before thinning, m
*   10   12   14   16   18   20   22   24   26
* MINERAL SOIL
* FOREST SITE TYPE CATEGORY 1-2
* pine
*   20.0  24.0  27.2  29.0  29.7  30.0  30.2  30.2  30.3
* spruce
*   18.0  22.0  25.2  28.0  30.0  31.9  33.2  33.7  34.0
* silver birch
*   9.6  14.2  17.5  18.9  20.0  20.6  21.2  21.6  22.0
* downy birch & other deciduous trees
*   13.0  14.9  16.8  18.5  19.9  20.8  21.2  21.2  21.2
* FOREST SITE TYPE CATEGORY 3
*   20.0  24.0  27.2  29.0  29.7  30.0  30.2  30.2  30.3
*   18.0  21.0  24.0  26.2  27.6  28.9  29.8  30.1  30.1
*   9.6  14.2  17.5  18.9  20.0  20.6  21.2  21.6  22.0
*   13.0  14.9  16.8  18.5  19.9  20.8  21.2  21.2  21.2
* FOREST SITE TYPE CATEGORY 4
*   19.0  22.2  25.0  26.2  27.0  27.4  27.4  27.4  27.4
*   18.0  21.0  24.0  26.2  27.6  28.9  29.8  30.1  30.1
*   9.6  14.2  17.5  18.9  20.0  20.6  21.2  21.6  22.0
*   13.0  14.9  16.8  18.5  19.9  20.8  21.2  21.2  21.2
* FOREST SITE TYPE CATEGORY 5-8
*   15.0  17.5  20.2  22.2  23.2  24.0  24.5  24.5  24.5
*   15.0  17.5  20.2  22.2  23.2  24.0  24.5  24.5  24.5
*   9.6  14.2  17.5  18.9  20.0  20.6  21.2  21.6  22.0
*   13.0  14.9  16.8  18.5  19.9  20.8  21.2  21.2  21.2
* PEATLAND
* FOREST SITE TYPE CATEGORY 1-2
*   20.0  24.0  27.2  29.0  29.7  30.0  30.2  30.2  30.3
*   18.0  22.0  25.2  28.0  30.0  31.9  33.2  33.7  34.0
*   9.6  14.2  17.5  18.9  20.0  20.6  21.2  21.6  22.0
    
```

	13.0	14.9	16.8	18.5	19.9	20.8	21.2	21.2	21.2
* FOREST SITE TYPE CATEGORY 3									
	20.0	24.0	27.2	29.0	29.7	30.0	30.2	30.2	30.3
	18.0	21.0	24.0	26.2	27.6	28.9	29.8	30.1	30.1
	13.0	14.9	16.8	18.5	19.9	20.8	21.2	21.2	21.2
	13.0	14.9	16.8	18.5	19.9	20.8	21.2	21.2	21.2
* FOREST SITE TYPE CATEGORY 4									
	19.0	22.2	25.0	26.2	27.0	27.4	27.4	27.4	27.4
	18.0	21.0	24.0	26.2	27.6	28.9	29.8	30.1	30.1
	13.0	14.9	16.8	18.5	19.9	20.8	21.2	21.2	21.2
	13.0	14.9	16.8	18.5	19.9	20.8	21.2	21.2	21.2
* FOREST SITE TYPE CATEGORY 5-8									
	15.0	17.5	20.2	22.2	23.2	24.0	24.5	24.5	24.5
	15.0	17.5	20.2	22.2	23.2	24.0	24.5	24.5	24.5
	13.0	14.9	16.8	18.5	19.9	20.8	21.2	21.2	21.2
	13.0	14.9	16.8	18.5	19.9	20.8	21.2	21.2	21.2
* Minimum basal area after thinning.									
* Dominant height before thinning, m									
* 10 12 14 16 18 20 22 24 26									
* MINERAL SOIL									
* FOREST SITE TYPE CATEGORY 1-2									
	13.0	15.8	17.9	19.6	21.0	22.0	22.5	22.7	23.0
	10.8	14.0	17.0	20.0	22.5	24.5	25.7	26.5	26.5
	5.0	7.6	9.9	11.7	13.2	14.5	15.6	16.5	17.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
* FOREST SITE TYPE CATEGORY 3									
	13.0	15.8	17.9	19.6	21.0	22.0	22.5	22.7	23.0
	10.5	13.0	15.5	17.5	19.0	20.5	21.5	22.0	22.0
	5.0	7.6	9.9	11.7	13.2	14.5	15.6	16.5	17.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
* FOREST SITE TYPE CATEGORY 4									
	12.5	15.0	17.0	18.3	19.2	19.8	20.0	20.0	20.0
	10.5	13.0	15.5	17.5	19.0	20.5	21.5	22.0	22.0
	5.0	7.6	9.9	11.7	13.2	14.5	15.6	16.5	17.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
* FOREST SITE TYPE CATEGORY 5-8									
	9.0	11.2	13.2	15.0	16.1	17.0	17.5	18.0	18.0
	9.0	11.2	13.2	15.0	16.1	17.0	17.5	18.0	18.0
	5.0	7.6	9.9	11.7	13.2	14.5	15.6	16.5	17.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
* PEATLAND									
* FOREST SITE TYPE CATEGORY 1-2									
	13.0	15.8	17.9	19.6	21.0	22.0	22.5	22.7	23.0
	10.8	14.0	17.0	20.0	22.5	24.5	25.7	26.5	26.5
	5.0	7.6	9.9	11.7	13.2	14.5	15.6	16.5	17.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
* FOREST SITE TYPE CATEGORY 3									
	13.0	15.8	17.9	19.6	21.0	22.0	22.5	22.7	23.0
	10.5	13.0	15.5	17.5	19.0	20.5	21.5	22.0	22.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
* FOREST SITE TYPE CATEGORY 4									
	12.5	15.0	17.0	18.3	19.2	19.8	20.0	20.0	20.0
	10.5	13.0	15.5	17.5	19.0	20.5	21.5	22.0	22.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
	9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
* FOREST SITE TYPE CATEGORY 5-8									
	9.0	11.2	13.2	15.0	16.1	17.0	17.5	18.0	18.0
	9.0	11.2	13.2	15.0	16.1	17.0	17.5	18.0	18.0

9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0
9.0	10.5	12.0	13.2	14.0	14.6	15.0	15.0	15.0

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## **BOUND\_FOR\_SUPPLEMENTARY\_PLANTING**

### **Functions**

The BOUND\_FOR\_SUPPLEMENTARY\_PLANTING parameter defines the minimum seedling density (plants per hectare) of a stand feasible for further growing without supplementation. Below these densities the supplementary planting is executed with the most suitable tree species (see the FEASIBLE\_TREE\_SPECIES parameter).

Notice that the BOUND\_FOR\_YOUNG\_STAND\_REGENERATION parameter implicitly defines the lower bound for feasible supplementary planting. See also the MIN\_NUMBER\_OF\_SEEDLINGS parameter that defines the recommended seedling density for the supplementation.

**Generic name in Finnish:** TAIMIKON\_TAYDENNYSTRAJA

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 16

**Default values:** See Example B.2

**Valid since:** MELA99

### **Legend**

(1) - (20) Maximum number of seedlings (per hectare) expressing the need of the supplementary planting.

Categories:

- tree species: 4 (pine, spruce, silver birch and other deciduous species, downy birch)
- forest site type category: 4 (see the sample plot variable (13) of the initial data record in Appendix D.1)
  - 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.2.** A definition of the BOUND\_FOR\_SUPPLEMENTARY\_PLANTING parameter.

```
BOUND_FOR_SUPPLEMENTARY_PLANTING

* Tree species:
* (1) pine
* (2) spruce
* (3) silver birch and other deciduous species
* (4) downy birch

* (1) (2) (3) (4)
* Forest site type category 1-2
  1600 1400 1200 1400
* Forest site type category 3
  1600 1300 1200 1300
* Forest site type category 4
  1400 1300 1200 1300
* Forest site type category 5-8
  1200 1300 1200 1300
```

The default values are based on the Finnish recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994). The default values in Example B.2 are used for the temperature sum above 900 dd and decrease automatically about 15 % for each 100 dd below 900 dd. Notice that this mechanism does not work with the user-supplied values.

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## **BOUND\_FOR\_YOUNG\_STAND\_REGENERATION**

### **Functions**

The BOUND\_FOR\_YOUNG\_STAND\_REGENERATION parameter defines the minimum number of seedlings (plants per hectare) considered feasible for further growing without immediate regeneration.

The parameter values control the generation of regeneration alternatives for young (sapling) stands, see the specific EVENT\_CALL arguments of regeneration cuttings. The parameter values define also the lower bound for supplementary planting (see the BOUND\_FOR\_SUPPLEMENTARY\_PLANTING parameter).

See also the MIN\_NUMBER\_OF\_SEEDLINGS parameter that defines recommended seedling densities.

**Generic name in Finnish:** TAIMIKON\_UUDISTAMISRAJA

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 32

**Default values:** See Example B.3

**Valid since:** MELA99

### **Legend**

(1) - (20) Number of seedlings (per hectare) used as an upper bound for the regeneration of young stand.

#### Categories

- tree species: 2 (coniferous trees; deciduous trees)
- height class: 4 (1–2 m, 2–3 m, 3–5 m, 5–7 m)
- forest site type category: 4 (see the sample plot variable (13) of the initial data record in Appendix D.1)
  - 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.3.** A definition of the BOUND\_FOR\_YOUNG\_STAND\_REGENERATION parameter.

```
BOUND_FOR_YOUNG_STAND_REGENERATION

* Coniferous species
* HEIGHT CLASS:
* 1-2 2-3 3-5 5-7 m
* Forest site type category 1-2
  600 600 600 600
* Forest site type category 3
  600 600 600 600
* Forest site type category 4
  600 600 600 600
* Forest site type category 5-8
  500 500 500 500

* Deciduous species
  600 600 600 600
  600 600 600 600
  600 600 600 600
  500 500 500 500
```

The default values are based on the Finnish recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994).

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

---

## C\_VARIABLES

---

### Functions

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

**Generic name in Finnish:** C\_MUUTTUIJAT

**Origin:** System parameter

**Program:** MELAOPT

**Type:** Character

**Number of items:** Optional, the number of the c variables in management unit records of an actual **rsd** type file

**Default values:** None

**Valid since:** MELA96

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.4.** A definition of the C\_VARIABLES parameter.

C_VARIABLES#SITE#AGE#OWNER
----------------------------

There are three c variables in 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

**Valid since:** MELA96

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.5.** 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

**Valid since:** MELA96

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.6.** 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 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. The 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

**Valid since:** MELA96, changed MELA99, MELA2000

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 built-in basic event routines of MELASIM. 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 variables of the decision data record 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.
- selecting of ‘retained trees’ to be left standing on regeneration areas.

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)).

An unlimited number of continuation items can follow each of the items (2) to (n).

Continuation items are for splitting EVENT definition items overriding the maximum length of input lines (i.e. 131 characters, see Examples B.8 and B.17 as well as Chapters 3.2.1.1 and 3.2.1.4). Continuation items must not contain other than numerical values.

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]**

(Optional continuation items with prefix ‘#>>’ as continuation indicator)

```
#>> value[ value ]
```

NOTE: The continuation items apply for the items (2) - (n) of the EVENT parameter only.

The event identification line is a header of the event definition. Optional event definition items control the simulation of events in general and describe the relationships between 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.7.** 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 27 28 29 50

* Optional event definition item (6)
#FEASIBLE_PRECEDESSORS 70 71 99

* Optional event definition item (7)
#FOREST_CATEGORIES 3 30 0 -3.99999

* One basic event call
#EVENT_CALL 2 1 3 1 0 800 800 8 12 0 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.

**Example B.8.** The use of continuation items in the EVENT parameter.

```
EVENT
* Event identification line
#20 THINNING - BASAL AREA INSTRUCTIONS

* Optional event definition item (7)
* - are splitted on two lines with a continuation item.
#FOREST_CATEGORIES 3 30 0 -3.99999
#>> 3 12 1.0 4.0

* One basic event call
* - are splitted on three lines with continuation items.
#EVENT_CALL 2 1 1 1 0 0 0 10 1.2 0 1.5 1 1 0 0 0 0
#>> 0.8 0.8 0.8 0.8 1 1 1 1 0 0
#>> 1 3 6 99 2 2 -1 -1 8 -0.5 1 0 0 0 8 -0.5 1
```

A thinning based on basal area instructions is declared with optional tree selection instructions in the EVENT\_CALL item. The values of the FOREST\_CATEGORIES and EVENT\_CALL items are splitted on several lines with continuation items

## Event identification line of the EVENT parameter

Item (1) of the EVENT parameter: event\_identification

**Functions:** The identification line of the EVENT parameter is a header of the event definition.

The general syntax of the event identification line is

<b>#event_identification characterization</b>
---

**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.7, 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
```

<b>EVENT_YEARS</b>	A name of the event definition item.
<b>year</b>	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.
<b>repeat_interval</b>	A number of years between the event years after the last event year provided. This is the last argument of the EVENT_YEARS item.

NOTE: The 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.9.** 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**

A name of the event definition item.

**interval**

A 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.10.** 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**

A name of the event definition item.

**value**

A branching control for each event year. The last value is repeated if further branching control is required. The 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.11.** 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.11, 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.11, 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**

A name of the event definition item.

**event\_identification**

An identification number of an event defined for the application, see event\_identification in the item (1) of the EVENT parameter.

**Example B.12.** 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 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**      A name of the event definition item.

**event\_identification**      An identification number of the event defined for the application, see event\_identification in the item (1) of the EVENT parameter.

**Example B.13.** 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

NOTE: The former built-in forest category restrictions were removed from the event subroutines of the MELA Version 1999, thus enabling full control over the feasibility delineation of the events by means of the FOREST\_CATEGORIES item of the EVENT parameter.

The general syntax of the FOREST\_CATEGORIES item is

```
#FOREST_CATEGORIES feasibility_condition
```

**FOREST\_CATEGORIES**                      A 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]
```

<b>'0'</b>	The delimiter of category groups denoting the logical operator OR between adjacent category groups (see Example B.17).
<b>number</b>	A number of the following arguments (variable and value(s)) in the current category definition.
<b>variable</b>	A management unit variable in the simulation record (see simulation data variables in Appendix D.3).
<b>value</b>	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.14, B.15, B.16 and B.17.

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 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.16 and B.17.

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.23).

**Example B.14.** 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 (see Appendix D.3) is equal to 1.
```

**Example B.15.** 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.16.** 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.17.** 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 the continuation item of the FOREST_CATEGORIES
item.
```

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**            A 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.18.** 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**

A name of the event definition item.

**argument\_value**

A value of the 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.19.** A definition of the EVENT\_CALL item of the EVENT parameter and 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 1500 1 0.5 0 0 0 0
*           A B 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
#>> 1 3 3 99 3 3 15 99 3 1 1 2 -1 -1 8
*    16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
#>> -0.5 1 0 0 0 8 -0.5 1
*    31 32 33 34 35 36 37 38
* argument types: common (A, B) and specific (1-38) arguments
* Notice multiple continuation items of the EVENT_CALL
item.
```

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.19), and
- specific EVENT\_CALL arguments (see 1 to 38 in Example B.19) 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.19) 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.8 and B.22.

*Common EVENT\_CALL arguments for all basic events*

<p>(A) identification number of the basic event routine being called</p> <ul style="list-style-type: none"> <li>'1' natural processes</li> <li>'2' cuttings</li> <li>'3' tending of young stands</li> <li>'4' artificial regeneration</li> <li>'5' clearing of regeneration area</li> <li>'6' soil preparation</li> <li>'7' drainage of peatlands</li> <li>'8' fertilization</li> <li>'9' pruning of pine</li> <li>'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</li> <li>'12' selecting of 'retained trees' to be left standing on the cutting areas.</li> </ul> <p>(B) '1'</p>
--

*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 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, birch and aspen)
- 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*

In the integrated forest and stand level optimization of MELA, actual thinnings for management units are selected from the simulated thinning alternatives. The endogeneity potential of each analysis results from the user-supplied optional events and the details of the event definitions in simulation, including thinning options and the branching of simulation. Exogenous density limit without branching simulation leads to fully exogenous density regulation without alternatives (and without a possibility to endogenous selection of thinnings).

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 per hectare.

The alternative methods to select the thinning intensity in MELASIM are

- (a) relative thinning intensity ("thinning percentages"), and
- (b) exogenous density regulation ("thinning models").

Thinning intensity method is selected and adjusted by the specific EVENT\_CALL arguments for thinnings (see arguments (3) and (10) with others for further details) and such parameters as BASAL\_AREA\_INSTRUCTIONS and MIN\_NUMBER\_OF\_STEMS\_AFTER\_THINNING.

Relative thinning intensity method combined with the branching simulation of thinning alternatives enables the endogenous solution of both the thinning intensity and the level of growing stock after thinning, besides the time of thinning in the integrated forest and stand level optimization. However, the number of alternative management schedules may rise high with several intensities and other thinning options.

Exogenous density regulation with branching simulation and basal area limit after thinning with explicit minimum cutting removal, for example, allows endogenous timing (i.e. limited thinning intensity selection) in optimization.

Exogenous density regulation with basal area limits before and after thinning without branching leads to exogenous density regulation without alternatives (and without possibility to endogenous selection of thinnings). This approach is indispensable for the simulation of thinnings with preformed growing stock requirements without endogeneity in optimization. Exogenous regulation of thinnings by "thinning models" was a popular approach before the methods for forest level comparison of stand management options on the basis of goals for forestry. It is still a valid method if deviations from the preformed stand management regimes shall not be considered at all.

Minimum cutting removal requirement prevents the simulation of thinning alternatives considered absolutely impracticable in order to minimize the number of management schedules and consequently the endogeneity of thinnings in analysis. Minimum cutting removal for relative thinning intensity method (a) is supplied by the specific EVENT\_CALL arguments (4) and (5). In the case of the exogenous density regulation method (b), minimum cutting removal requirement is the higher one of the following two values, either the difference of the basal area limits set by the BASAL\_AREA\_INSTRUCTIONS parameter adjusted by the specific EVENT\_CALL arguments (16) - (23) or the specific EVENT\_CALL arguments (4) and (5). Notice that either of the two controllers is cancelled by low values or respective adjustments. For example, minimum basal area after thinning with explicit minimum cutting removal regulation is obtained by means of relevant values of basal area after thinning and the specific EVENT\_CALL arguments (4) and (5) with any low basal area before thinning.

The tree size and tree species selection is controlled by the tree selection instructions of the EVENT\_CALL arguments, see also Appendix F.

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 (m<sup>2</sup>/hectare) in management unit for relative thinning intensity method (a) or if explicit expression is required instead of minimum basal area before thinning; otherwise '0'
- (5) minimum removal (m<sup>2</sup>/hectare) on sample plot for relative thinning intensity method (a) or if explicit expression is required instead of minimum basal area before thinning; otherwise '0'
- (6) minimum mean height before thinning, m
- (7) maximum mean diameter before thinning in relation to the exogenous minimum regeneration diameter requirement (0 - 10.0) (see the MIN\_REGENERATION\_DIAMETER parameter)
- (8) minimum acceptable basal area after thinning in relation (0 - 10.0) to the exogenous basal area requirement after thinning calibrated by the arguments (20) - (23) if the relative thinning intensity method (a) is applied; otherwise '0' (see the lower limit of the BASAL\_AREA\_INSTRUCTIONS parameter)
- (9) maximum mean age before thinning in relation to the exogenous minimum regeneration age requirement (0 - 10.0) (see the MIN\_REGENERATION\_AGE parameter)
- (10) basal area target after thinning in relation (0 - 10.0) to the exogenous basal area requirement after thinning calibrated by the arguments (20) - (23) if the exogenous density regulation method (b) is applied; otherwise '0' (see the lower limit of the BASAL\_AREA\_INSTRUCTIONS parameter)
- (11) maximum proportion of basal area to be removed in thinning (0 - 1.0) if the exogenous density regulation method (b) is applied; otherwise '0'
- (12) '0' (not in use)
- (13) logging season
  - '0' random (1 or 2), weighted by statistics of realized loggings
  - '1' summer, logging on unfrozen and snow-free ground
  - '2' winter, logging on frozen and snowy ground

- (14) mechanized or manual (labour-intensive) logging
  - '0' cost minimizing method (1 or 2)
  - '1' mechanized logging (one-grip harvester and forwarder)
  - '2' manual logging (logging with chainsaw and forwarder)
- (15) logging skills for manual time expenditure functions
  - '0' or '1' professional
  - '2' non-professional, forest owners self-reliant work
- (16) calibration coefficient for the minimum basal area requirement of pine before thinning defined by the `BASAL_AREA_INSTRUCTIONS` parameter
- (17) calibration coefficient for the minimum basal area requirement of spruce before thinning defined by the `BASAL_AREA_INSTRUCTIONS` parameter
- (18) calibration coefficient for the minimum basal area requirement of silver birch before thinning defined by the `BASAL_AREA_INSTRUCTIONS` parameter
- (19) calibration coefficient for the minimum basal area requirement of downy birch and other deciduous trees before thinning defined by the `BASAL_AREA_INSTRUCTIONS` parameter
- (20) calibration coefficient for the minimum basal area requirement of pine after thinning defined by the `BASAL_AREA_INSTRUCTIONS` parameter
- (21) calibration coefficient for the minimum basal area requirement of spruce after thinning defined by the `BASAL_AREA_INSTRUCTIONS` parameter
- (22) calibration coefficient for the minimum basal area requirement of silver birch after thinning defined by the `BASAL_AREA_INSTRUCTIONS` parameter
- (23) calibration coefficient for the minimum basal area requirement of downy birch and other deciduous trees after thinning defined by the `BASAL_AREA_INSTRUCTIONS` parameter
- (24) '0' (not in use)
- (25) '0' (not in use)
- (26) - (n) user-supplied tree selection instructions, see Appendix F (optional)

The arguments (16) - (23) are for the tree species calibration of the values of the `BASAL_AREA_INSTRUCTIONS` parameter (see Example B.20). Notice that the basal area limit before thinning is cancelled by the calibration of the arguments (16) - (19) by zero, effecting the arguments (4) and (5) as the minimum cutting removal requirement.

Notice also the multiplicative effects of arguments and possible conflicts in case of the exogenous density regulation method (b) especially. Improper use of arguments

may result unintended loss of simulated thinning alternatives and less sound analysis as a consequence. Pay attention to the arguments (4), (5), (8), (10), (11) and (16) - (23), at least. The arguments (4), (5) and (11) may become conflicting with basal area instructions or their calibration results with the arguments (16) - (23). The exogenous basal area requirements after thinning adjusted by the arguments (8) and (10) are first calibrated with the arguments (20) - (23).

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.

When user-supplied tree selection instructions are not given, built-in default selection instructions for thinning based on basal area instructions are used (see Example F.3).

**Example B.20.** Two different EVENT\_CALL definitions for thinnings with the basal area instructions method.

```
* Only the minimum basal area after thinning is in use.
* The level is 90 % of the default values (arguments 10 and 16-23).
* Minimum cutting removal is 4 m2/ha (arguments 4-5).
* Maximum proportion of removed basal area is 50 % (arguments 11).
#EVENT_CALL 2 1 1 1 0 4 4 10 1.2 0 1.5 0.9 0.5 0 0 0 0
#>> 0 0 0 0 1 1 1 1 0 0

* The minimum basal area before and after thinning are in use.
* The level is 80 % of the default values before thinning
* (arguments 16-19) and 100 % after thinning (arguments 10, 19-23).
* Cutting removal is determined by 'thinning models', NOT
* by arguments 4,5 and 11.
#EVENT_CALL 2 1 1 1 0 0 0 10 1.2 0 1.5 1 1 0 0 0 0
#>> 0.8 0.8 0.8 0.8 1 1 1 1 0 0
```

## 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<sup>2</sup>/hectare
- (5) minimum removal on sample plot, m<sup>2</sup>/hectare
- (6) minimum mean diameter before cutting in relation to the exogenous minimum regeneration diameter requirement (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 exogenous minimum regeneration age requirement (see the MIN\_REGENERATION\_AGE parameter)
  - 0 - 10.0 relative mean age
  - >10 absolute mean age
- (8) maximum basal area (mean diameter >8 cm) or number of stems (mean diameter < 8 cm) before cutting in relation to the respective exogenous minimum requirement (0 - 10.0) for the recognition of the low-stocked stands and the generation of a clear cutting option (see the BASAL\_AREA\_INSTRUCTIONS parameter)
- (9) minimum mean age before cutting in relation to the exogenous regeneration age requirement 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 exogenous regeneration age requirement 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) logging season
  - '0' random (1 or 2), weighted by statistics of realized loggings
  - '1' summer, logging on unfrozen and snow-free ground
  - '2' winter, logging on frozen and snowy ground
- (14) mechanized or manual (labour-intensive) logging
  - '0' cost minimizing method (1 or 2)
  - '1' mechanized logging (one-grip harvester and forwarder)
  - '2' manual logging (logging with chainsaw and forwarder)
- (15) logging skills for manual time expenditure functions
  - '0' or '1' professional
  - '2' non-professional, forest owners self-reliant work
- (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.

When user-supplied tree selection instructions are not given, built-in default selection instructions for clear cutting are used (see Example F.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/hectare   |
| (5)  | minimum removal on sample plot, stems/hectare   |
| (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 exogenous number of stems per hectare requirement (0 - 10.0) if the relative thinning intensity or method (a) is applied; otherwise '0' (see the MIN_NUMBER_OF_STEMS_AFTER_THINNING parameter) |
| (9)  | minimum number of stems per hectare before cutting, stems/hectare   |
| (10) | number of stems per hectare after thinning in relation to the exogenous number of stems per hectare requirement (0 - 10.0) if the minimum growing stock after thinning or method (b) is applied; otherwise '0' (see the MIN_NUMBER_OF_STEMS_AFTER_THINNING parameter)           |
| (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) logging season
  - '0' random (1 or 2), weighted by statistics of realized loggings
  - '1' summer, logging on unfrozen and snow-free ground
  - '2' winter, logging on frozen and snowy ground
  
- (14) mechanized or manual (labour-intensive) logging
  - '0' cost minimizing method (1 or 2)
  - '1' mechanized logging (one-grip harvester and forwarder)
  - '2' manual logging (logging with chainsaw and forwarder)
  
- (15) logging skills for manual time expenditure functions
  - '0' or '1' professional
  - '2' non-professional, forest owners self-reliant work
  
- (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.

When user-supplied tree selection instructions are not given, built-in default selection instructions for thinning based on number of stems instructions are used (see Example F.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<sup>2</sup>/hectare
- (5) minimum removal on sample plot, m<sup>2</sup>/hectare
- (6) minimum mean diameter before cutting in relation to the exogenous minimum regeneration diameter requirement (0 - 10.0) (see the MIN\_REGENERATION\_DIAMETER parameter)
- (7) minimum mean age before cutting in relation to the exogenous minimum regeneration age requirement (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 exogenous number of plants requirement after regeneration (0 - 10.0) (see the MIN\_NUMBER\_OF\_SEEDLINGS parameter)
- (11) '0' (not in use)
- (12) '0' (not in use)
- (13) logging season
  - '0' random (1 or 2), weighted by statistics of realized loggings
  - '1' summer, logging on unfrozen and snow-free ground
  - '2' winter, logging on frozen and snowy ground
- (14) mechanized or manual (labour-intensive) logging
  - '0' cost minimizing method (1 or 2)
  - '1' mechanized logging (one-grip harvester and forwarder)
  - '2' manual logging (logging with chainsaw and forwarder)
- (15) logging skills for manual time expenditure functions
  - '0' or '1' professional
  - '2' non-professional, forest owners self-reliant work

(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.

When user-supplied tree selection instructions are not given, built-in default selection instructions for over story removal are used (see Example F.3).

### 2.5 Seed tree cutting (for natural regeneration of pine, birch and aspen)

The specific EVENT\_CALL arguments for seed tree cutting are

- (1) '5' (cutting method = seed tree cutting for natural regeneration of pine, birch and aspen)
- (2) '1' (probability to simulate the event - not in use)
- (3) '0' (not in use)
- (4) minimum removal in management unit, stems/hectare
- (5) minimum removal on sample plot, stems/hectare
- (6) minimum mean diameter before cutting in relation to the exogenous minimum regeneration diameter requirement (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 exogenous minimum regeneration age requirement (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 exogenous minimum basal area requirement after thinning (0 - 10.0) (see the BASAL\_AREA\_INSTRUCTIONS parameter)
- (9) maximum mean age before cutting in relation to the exogenous minimum regeneration age requirement (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) logging season
  - '0' random (1 or 2), weighted by statistics of realized loggings
  - '1' summer, logging on unfrozen and snow-free ground
  - '2' winter, logging on frozen and snowy ground

- (14) mechanized or manual (labour-intensive) logging
  - '0' cost minimizing method (1 or 2)
  - '1' mechanized logging (one-grip harvester and forwarder)
  - '2' manual logging (logging with chainsaw and forwarder)
- (15) logging skills for manual time expenditure functions
  - '0' or '1' professional
  - '2' non-professional, forest owners self-reliant work
- (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.

When user-supplied tree selection instructions are not given, built-in default selection instructions for seed tree cutting are used (see Example F.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/hectare
- (5) minimum removal on sample plot, stems/hectare
- (6) minimum mean diameter before cutting in relation to the exogenous minimum regeneration diameter requirement (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 exogenous minimum regeneration age requirement (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 exogenous minimum basal area requirement after thinning (0 - 10.0) (see the BASAL\_AREA\_INSTRUCTIONS parameter)
- (9) maximum mean age before cutting in relation to the exogenous minimum regeneration age requirement (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) logging season
  - '0' random (1 or 2), weighted by statistics of realized loggings
  - '1' summer, logging on unfrozen and snow-free ground
  - '2' winter, logging on frozen and snowy ground

- (14) mechanized or manual (labour-intensive) logging
  - '0' cost minimizing method (1 or 2)
  - '1' mechanized logging (one-grip harvester and forwarder)
  - '2' manual logging (logging with chainsaw and forwarder)
- (15) logging skills for manual time expenditure functions
  - '0' or '1' professional
  - '2' non-professional, forest owners self-reliant work
- (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.

When user-supplied tree selection instructions are not given, built-in default selection instructions for shelterwood cutting are used (see Example F.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 exogenous number of stems requirement after tending (0 - 10.0) (see the MIN_NUMBER_OF_SEEDLINGS parameter)                             |
| (4)        | minimum number of stems before tending in relation to the exogenous number of stems requirement after tending (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 (per hectare) to be removed in management unit and on sample plot  |
| (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 ( <u>optional</u> )  |

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.

When user-supplied tree selection instructions are not given, built-in default selection instructions for tending of young stands are used (see Example F.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 tree variable (2) of the initial data record in Appendix D.1)
- (5) number of plants (per hectare) used in regeneration (see the MIN\_NUMBER\_OF\_SEEDLINGS parameter)
  - 0 based on the exogenous number of plants requirement
  - <10 number of plants in relation to the exogenous number of plants requirement
  - >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, see the sample plot variable (13) of the initial data record in Appendix D.1
- (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 sample plot variable (13) of the initial data record in Appendix D.1 |
| (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 sample plot variable (13) of the initial data record in Appendix D.1 |
| (4) | upper bound for the site type   |

*7. Specific EVENT\_CALL arguments for drainage of peatlands*

- |     |   |
|-----|---|
| (1) | type of drainage<br>'1' new ditching<br>'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 exogenous minimum regeneration diameter requirement (0 - 10.0) (see the MIN\_REGENERATION\_DIAMETER parameter)
- (4) maximum mean diameter before fertilization in relation to the exogenous minimum regeneration diameter requirement (0 - 10.0) (see the MIN\_REGENERATION\_DIAMETER parameter)
- (5) minimum basal area before fertilization in relation to the exogenous minimum basal area requirement after thinning (0 - 10.0) (see the BASAL\_AREA\_INSTRUCTIONS parameter)
- (6) maximum basal area before fertilization in relation to the exogenous minimum basal area requirement after thinning (0 - 10.0) (see the BASAL\_AREA\_INSTRUCTIONS parameter)
- (7) minimum mean age before fertilization in relation to the exogenous minimum regeneration age requirement (0 - 10.0) (see the MIN\_REGENERATION\_AGE parameter)
- (8) maximum mean age before fertilization in relation to the exogenous minimum regeneration age requirement (0 - 10.0) (see the MIN\_REGENERATION\_AGE parameter)
- (9) lower bound for the site type, see the sample plot variable (13) of the initial data record in Appendix D.1
- (10) upper bound for the site type

*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/hectare
- (6) lower bound for the site type, see the sample plot variable (13) of the initial data record in Appendix D.1
- (7) upper bound for the site type

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.21.** 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 27 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

```

The 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.22.** 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 27 25 28 29 30
#FOREST_CATEGORIES  3 30 0 -3.99999

* The basic event call defining a basal area thinning
* on the first and second line
* with tree selection arguments on the third line.
* The second and third lines are continuation items.
#EVENT_CALL 2 1  1 1 0 4 2 10 1.5 0 1.5 0.9 0.35
#>>  0 0 0 0 0.0 0.0 0.0 0.0 1.0 1.0 1.0 1.0 0 0
#>>  1 3 6 99 2 2 -1 -1 8 -0.5 1 0 0 0 8 -0.5 1

```

A thinning based on basal area instructions is declared with optional tree selection instructions in the EVENT\_CALL item with two continuation items.

**Example B.23.** An event definition with explicit logging instructions.

```

EVENT
* Event identification line
#20 THINNING - BASAL AREA INSTRUCTIONS

* Optional event definition item
#COMPARABLE_EVENTS  10 25 27 28 29 30
#FEASIBLE_PRECEDESSORS  70 71 99

* Valid only for spruce forests (last three arguments).
#FOREST_CATEGORIES  3 30 0 -3.99999 2 32 2

* The basic event call defining a basal area thinning
* executed manually (argument 14) in winter time (argument 13).
#EVENT_CALL 2 1  1 1 0 4 4 10 1.2 0 1.5 0.9 0.5 0 2 2 0
#>>  0 0 0 0 1 1 1 1 0 0

```

An event definition is declared for manual thinning of spruce forests based on the basal area instructions method in winter time.

### *12. Specific EVENT\_CALL arguments for selecting of 'retained trees' to be left standing on regeneration areas*

This event is designed to be used together with regeneration cuttings, clear cutting, seed tree cutting (for natural regeneration of pine, birch and alder) and shelterwood cutting (for natural regeneration of spruce). The retained trees are left untouched in respective regeneration cutting and further cuttings and silvicultural treatments.

Selecting of retained trees and respective regeneration cutting are declared in one event definition with two successive basic event calls (EVENT\_CALL items, see Example B.24).

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.

Selecting of retained trees uses the general tree selection routine (see Appendix F.1). Trees to be selected as retained trees are those which are included in the selection group definition and which are left untouched in the selection routine (see Appendix F.2) (i.e. the retained trees are complement from the tree selection).

Optional tree selection instructions are declared in the EVENT\_CALL item. The values of the EVENT\_CALL item can be splitted on several lines with continuation items (Example B.24)

The specific EVENT\_CALL arguments for selecting of ‘retained trees’ on regeneration areas are

- |      |  |
|------|--|
| (1)  | '0' (not in use)   |
| (2)  | '0' (not in use)   |
| (3)  | '0' (not in use)   |
| (4)  | maximum number of ‘retained trees’ on calculation unit, stems/hectare  |
| (5)  | maximum number of ‘retained trees’ on sample plot, stems/hectare   |
| (6)  | minimum mean diameter before selecting of ‘retained trees’ in relation to the exogenous minimum regeneration diameter requirement (see the MIN_REGENERATION_DIAMETER parameter)<br>0 - 10.0 relative mean diameter<br>>10 absolute mean diameter |
| (7)  | minimum mean age before selecting of ‘retained trees’ in relation to the exogenous minimum regeneration age requirement (see the MIN_REGENERATION_AGE parameter)<br>0 - 10.0 relative mean age<br>>10 absolute mean age                          |
| (8)  | '0' (not in use)   |
| (9)  | '0' (not in use)   |
| (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 diameter (6) or mean age (7) is reached, selecting of retained trees can be simulated with regard to the rotation period rules (6) and (7).

The trees to be selected (i.e. the selection quantity and maximum selection intensity in tree selection, see Appendix F.2) are expressed in terms of stem volume, see the tree variable (8) of the simulation record in Appendix D.3.

**Example B.24.** An event definition with two event calls.

```

EVENT
#30 SELECTING OF RETAINED TREES AND CLEAR CUTTING
*-----
#COMPARABLE_EVENTS      10 20 25 27 28 29
#FEASIBLE_PRECEDESSORS  70 71 99
#FOREST_CATEGORIES      3 30 0 -1.99999
* basic event call for selecting of retained trees
#EVENT_CALL 12 1 0 0 0 20 20 0.9 0.9 0 0 0 0 0 0 0
* tree selection instructions in continuation items
#>>      2.  3.  7.0 40. 17. -99.  1.
#>>      1.  0.  0.  0.  8.  -0.5  4.
* basic event call for clear cutting
#EVENT_CALL 2 1 2 1 1 0 0 0.9 0.9 0.5 2 1.15 0 0 0 0
    
```

The selecting of retained trees and clear cutting are 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. The values of the EVENT\_CALL item for retained are splitted on several lines with continuation items

For further examples of basic event calls, see event definitions in Appendix H.6.

## EVENT\_DEFAULTS

---

### Functions

The EVENT\_DEFAULTS parameter defines the default values for the optional items of event definitions. Default 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

**Valid since:** MELA96

### 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.25.** 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.24, the default value (= 0) of the FOREST\_CATEGORIES item means that the event can be simulated for all forest management categories.

## FEASIBLE\_TREE\_SPECIES

### Functions

The FEASIBLE\_TREE\_SPECIES parameter provides the guiding (maximum) proportions (values 0 - 1) for the tree species considered feasible in a stand. The parameter is used, for example, in determining acceptable dominant tree species and in selecting tree species for regeneration or for logging (see also Appendix F).

Following parameter values have specific interpretations:

1.00	the most suitable tree species, feasible for regeneration
0.99	suitable tree species
> 0.50	acceptable as dominant tree species
< 0.50	not acceptable as dominant tree species

**Generic name in Finnish:** PUULAJIOHJE

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 192

**Default values:** See Example B.25

**Valid since:** MELA99

### Legend

(1) - (192) The guiding proportions (0 – 1) of tree species in a stand.

Categories:

- tree species: 8 (see the tree variable (2) of the initial data record in Appendix D.1)
- forest site type: 8 (see the sample plot variable (13) of the initial data record in Appendix D.1)
- soil and peatland category: 3 (mineral soils; spruce mires; pine mires and treeless mires, see the sample plot variable (12) of the initial data record in Appendix D.1)

**Example B.26.** A definition of the FEASIBLE\_TREE\_SPECIES parameter.

```

FEASIBLE_TREE_SPECIES
* Tree species:
* 1 2 3 4 5 6 7 8
* SOIL AND PEATLAND CATEGORY 1 (mineral soils)
* Forest site type category 1
0.25 0.75 1.00 0.49 1.00 0.50,0.45 0.99
* Forest site type category 2
0.45 1.00 1.00 0.49 0.75 0.25 0.50 0.50
* Forest site type category 3
1.00 1.00 1.00 0.49 0.50 0.10 0.99 0.50
* Forest site type category 4
1.00 0.20 0.50 0.10 0.10 0.10 0.99 0.10
* Forest site type category 5
1.00 0.05 0.50 0.10 0.10 0.05 0.10 0.10
* Forest site type category 6
1.00 0.05 0.50 0.10 0.10 0.05 0.10 0.10
* Forest site type category 7
1.00 0.50 0.50 0.50 0.50 0.10 0.50 0.50
* Forest site type category 8
1.00 1.00 0.99 0.99 0.20 0.20 0.50 0.50
* SOIL AND PEATLAND CATEGORY 2 (spruce mires)
0.25 1.00 0.75 1.00 0.75 0.75 0.45 0.50
0.45 1.00 0.50 1.00 0.50 0.45 0.50 0.45
1.00 1.00 0.50 1.00 0.10 0.10 0.99 0.10
1.00 0.50 0.50 0.50 0.10 0.10 0.99 0.10
1.00 0.05 0.50 0.50 0.10 0.05 0.10 0.10
1.00 0.05 0.50 0.10 0.10 0.05 0.10 0.10
1.00 0.50 0.50 0.50 0.50 0.10 0.50 0.50
1.00 1.00 0.99 0.99 0.20 0.20 0.50 0.50
* SOIL AND PEATLAND CATEGORY 3 to 5 (pine mires and treeless mires)
0.50 1.00 0.50 1.00 0.50 0.50 0.50 0.50
0.50 1.00 0.50 1.00 0.10 0.50 0.50 0.45
1.00 1.00 0.50 1.00 0.10 0.10 0.99 0.10
1.00 0.45 0.50 0.50 0.10 0.10 0.99 0.10
1.00 0.05 0.50 0.50 0.10 0.05 0.10 0.10
1.00 0.05 0.50 0.10 0.10 0.05 0.10 0.10
1.00 0.50 0.50 0.50 0.50 0.10 0.50 0.50
1.00 1.00 0.99 0.99 0.20 0.20 0.50 0.50

```

The default values follow the Finnish recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994).

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## 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

**Valid since:** MELA96

### Legend

The general syntax of the FILE\_NAMING parameter is

```
(1) - (n) unit_number ext delimiter name_component [name_component]
```

<b>unit_number</b>	A number of the input/output unit. Unit numbers are built-in constants in MELA programs and they cannot be changed by the user.
<b>ext</b>	An file name extension.
<b>delimiter</b>	A delimiter between the naming components in the file name. The character '-' prevents the use of delimiters in the file name.
<b>name_component</b>	A 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 are substituted by their actual values provided in the MELA program session while character constants are used as such. For instance in Example B.26, 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 the 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.26) 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.26).

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.27.** 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  0
#23 MSD  _  FORESTRY_UNIT  SUB_UNIT  PROBLEM  0

* 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  0
#23 MSD  _  FORESTRY_UNIT  PROBLEM  0

* 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  0
#23 MSD  _  FORESTRY_UNIT  SUB_UNIT  APPLICATION
PROBLEM  0

```

## 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 forestry\_unit\_LEVELS and forestry\_unit\_members parameters.

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

**Valid since:** MELA96

### 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.28.** 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

**Valid since:** MELA96

### Legend

(1) - (n) Names of the decision hierarchy levels appearing in the definition of the forestry\_unit\_members parameter.

**Example B.29.** 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, 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

**Valid since:** MELA96

### Legend

(1) - (n) <code>name_of_sub_unit</code> [ <code>explanation</code> ]
--

`name_of_sub_unit`                      A 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). Given adjustment coefficients are used as such for calibration of basal area increment models (on tree level) and of height increment models (on tree level).

**Generic name in Finnish:** KASVUN\_TASOKORJAUS

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 1 or 100

**Default values:** 0

**Valid since:** MELA96

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.29).

Categories:

- tree species: 4 (pine, spruce, birch, other deciduous species)
- forestry board districts: 20 (see the sample plot variable (29) of the initial data record in Appendix D.1)

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.30.** 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.29 are hypothetical.

## H50\_CALIBRATION

### Functions

The H50\_CALIBRATION parameter enables the adjustment of the growth models by the calibration of dominant height indices (H50) on the basis of the age and height measurements of the initial simulation trees, if available. H50 indices are used by sample plots as a predicting variable of the growth models on mineral soils (see Ojansuu 1996). In the calibration procedure, trees larger than mean diameter at breast height are used.

NOTE: Only true age and height measurements of sample trees should be used for calibration.

**Generic name in Finnish:** H50\_KALIBROINTI

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 1

**Default values:** 0

**Valid since:** MELA99

### Legend

(1) Calibration of H50 indices.

'0' calibration disabled (default)

'1' calibration enabled

**Example B.31.** A definition of the H50\_CALIBRATION parameter.

```
H50_CALIBRATION 1
```

Dominant height indices H50 are calibrated with simulation trees.

## 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:** KOKONAISSLUKURATKAISU

**Origin:** System parameter

**Program:** MELAOPT

**Type:** Numerical

**Number of items:** 1

**Default values:** 0

**Valid since:** MELA96

### 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.32.** 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 (i.e. the values of future tree generations or soil expectation values beyond the simulation period) used as a component of the net present value (NPV, see the decision variables 801 – 805 in Appendices D.4 and E).

The explicit definition of the LAND\_VALUES parameter replaces the built-in land values calculated using discount rates of 1, 2, 3, 4 and 5 %. Notice that the built-in form of default land values tabulated according to interest rate, site type, soil and peatland category and temperature sum (see Example B.33) differs from the definition of the LAND\_VALUES parameter (see Example B.32). The built-in land values are interpolated with respect to the temperature sum (but not with the interest rates). There is no interpolation in the use of user-defined land values.

Relevant land values are needed for every application, region, growth models, prices, costs, etc. An application-specific set of land values (see Example B.32) according to the Faustmann formula can be generated by a specific MELA simulation using respective (bare land) initial data in a **rsd** type file and user-supplied discount rates. See Chapter 4.5.1, the items (16) and (17) of the SIMULATION\_CONTROL parameter and the DISCOUNT\_RATES parameter.

**Generic name in Finnish:** MAAN\_ARVOT

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 160

**Default values:** None

**Valid since:** MELA96, changed MELA99

NOTE: User has to ensure that land values are compatible with discount rates and other parameter values used in simulation and consequently optimization (see the DISCOUNT\_RATES parameter) and with summary reports (see **tab** type files in Appendix C.2) being applied.

### Legend

(1) - (160) Land values (FIM per hectare).

Categories (see Example B.32):

- discount rate: 5 (see the DISCOUNT\_RATES parameter)
- forest site type category: 8 (see the sample plot variable (13) of the initial data record in Appendix D.1)
- soil and peatland category: 4 (see the sample plot variable (12) of the initial data record in Appendix D.1)

**Example B.33.** 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

```

NOTE: The land values in Example B.32 do not represent the default values in the MELA system (see Example B.33).

**Example B.34.** The current built-in land values (FIM/hectare) for mineral soils.

* TEMPERATURE SUM 600				
* Discount rates, %				
* 1	2	3	4	5
* Forest site type category 1				
12200	175	60	0	0
* Forest site type category 2				
15250	200	70	0	0
* Forest site type category 3				
9325	130	30	0	0
* Forest site type category 4				
8200	100	10	0	0
* Forest site type category 5				
7825	0	0	0	0
* Forest site type category 6				
2550	0	0	0	0
* Forest site type category 7				
0	0	0	0	0
* Forest site type category 8				
0	0	0	0	0
* TEMPERATURE SUM 800				
27000	3100	105	50	25
34000	5100	105	50	25
20250	3500	75	15	10
16100	2525	15	5	0
15700	2350	0	0	0
7250	300	0	0	0
0	0	0	0	0
0	0	0	0	0
* TEMPERATURE SUM 1000				
68115	12890	1275	315	150
72000	16450	3735	285	130
53950	12030	2385	155	60
40870	10745	3345	700	10
36345	8465	2140	145	0
20005	3725	260	0	0
0	0	0	0	0
0	0	0	0	0
* TEMPERATURE SUM 1100				
123500	31500	9500	1750	375
98500	24500	6500	450	225
77200	23500	5575	800	165
55500	15250	5400	1700	100
53250	14250	4600	1280	0
25700	4900	525	0	0
0	0	0	0	0
0	0	0	0	0
* TEMPERATURE SUM 1200				
149500	40475	13385	4795	1200
128865	35495	13165	4485	875
100345	24775	8635	3195	640
62085	17825	6590	2325	330
58435	16075	5640	1835	280
31025	6580	1585	250	0
0	0	0	0	0
0	0	0	0	0
* TEMPERATURE SUM 1300				
173760	53775	21390	9975	4450
134075	45915	19795	8715	3530

127395	40300	16700	7125	2525
84365	25785	10370	4480	1825
78925	23370	9025	3650	1265
39400	10105	2985	500	0
0	0	0	0	0
0	0	0	0	0

## LOG\_VOLUME\_REDUCTION

### Functions

The LOG\_VOLUME\_REDUCTION parameter controls the use of the built-in saw log volume reduction model and the use of the log volume reduction given in forest resource data.

In simulation, estimates of total and timber assortment volumes for single trees are used. They are found in binary volume table file (Appendix C.2 MELA File Types) and are based on Finnish taper curve models and volume functions (Laasasenaho 1982).

The saw log volume is obtained from the log volume model based on tree species, diameter and height (formula 1).

$$VOL_S = f(s, d, h) \quad , \text{where} \quad (1)$$

$VOL_S$  = saw log volume  
 $s$  = tree species  
 $d$  = breast height diameter  
 $h$  = tree height

The saw log volume estimate  $VOL_S$  can be adjusted with the built-in log volume reduction model and with user-supplied log volume information in the forest resource data.

The built-in reduction model provides an empirical reduction to the saw log volume. The current saw log volume reduction is a function of tree species, age and diameter (formula 2). This is also the default value of the LOG\_VOLUME\_REDUCTION parameter (see Legend)

$$VOL_{SR} = f(VOL_S, s, a, d) \quad , \text{where} \quad (2)$$

$VOL_{SR}$  = log volume based on built-in log volume reduction model  
 $VOL_S$  = saw log volume from log volume model  
 $s$  = tree species  
 $a$  = age  
 $d$  = breast height diameter

The saw log volume  $VOL_{SR}$  can be further adjusted with user-supplied log volume information in the forest resource data. This is a calibration procedure where  $VOL_{SR}$  is calibrated with the user-supplied log volume information. The calibration procedure consists of three steps (formulas 3-5).

First, log volume based on user-supplied log volume reduction is calculated (formula 3).

$$VOL_{SD} = C_{data} * VOL_S \quad , \text{where} \quad (3)$$

$VOL_{SD}$  = log volume based on user-supplied log volume reduction  
 $VOL_S$  = saw log volume from log volume model  
 $C_{data}$  = user-supplied log volume reduction coefficient

In the forest resource data, user-supplied log volume information can appear in two different forms: 1) Log volume reduction coefficient for the log volume model or 2) Saw log volume percentage of the tree or stratum. The saw log volume percentage is in simulation transformed into log volume reduction coefficient  $C_{data}$  (see formula 3).

Second, the calibration coefficient is calculated (formula 4)

$$C = VOL_{SD} / VOL_{SR} \quad , \text{where} \quad (4)$$

$C$  = calibration coefficient

$VOL_{SD}$  = log volume based on user-supplied log volume reduction

$VOL_{SR}$  = log volume based on built-in log volume reduction model

The calibration coefficient is calculated in the beginning of the simulation and the obtained coefficient is used through the whole simulation.

Finally, the calibrated log volume is calculated (formula 5)

$$VOL_{SC} = C * VOL_{SR} \quad , \text{where} \quad (5)$$

$VOL_{SC}$  = calibrated log volume

$C$  = calibration coefficient

$VOL_{SR}$  = log volume based on built-in log volume reduction model

The ‘reduced’ part of the saw log volume of the estimates,  $VOL_S - VOL_{SR}$  or  $VOL_S - VOL_{SC}$  is added to the pulpwood so that the total volume of timber remains unchanged.

The calibration procedure is activated by the `LOG_VOLUME_REDUCTION` parameter value, not by the presence of user supplied log volume information in the forest resource data (see Legend).

User-supplied log volume information should be given only to those strata or trees where it is considered necessary. The calibration procedure (formulas 3-5) is used only if log volume information in the forest resource data is found and if the trees are tall enough to have saw log volume in the beginning of the simulation. For all other trees, only the built in log volume reduction model is applied (formula 2). For trees ‘born’ in the simulation, calibration is not applied.

In the beginning of the simulation the calibrated saw log volumes  $VOL_{SC}$  are at the level of the user-supplied log volume information. Later on, they are tied to the  $VOL_{SR}$  at the relative level indicated by the calibration coefficient  $C$  (formula 4). However, the level of  $VOL_{SC}$  is reduced not to get higher than  $VOL_S$ .

The calibration with user-supplied log volume information can produce log volume estimates much different than those obtained with built-in models. The relevance of calibration results should be carefully checked when applying this feature.

**Generic name in Finnish:** TUKKIVAHENNYS

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 1

**Default values:** 1

**Valid since:** MELA96, changed MELA2000

## 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)

'2' saw log volume reduction on the basis of the built-in log volume reduction model calibrated with user-supplied log volume information.

**Example B.34.** A definition of the LOG\_VOLUME\_REDUCTION parameter.

```
LOG_VOLUME_REDUCTION 0
```

The saw log volume reduction model is omitted in the simulation.

## LOGGING\_COSTS

### Functions

The LOGGING\_COSTS parameter defines the unit costs (FIM/hour) of felling and forest haulage. Unit cost is a component of the logging cost calculations besides cutting removal and time expenditure, see the TIME\_EXPENDITURE\_IN\_LOGGING parameter.

See also the MANAGEMENT\_UNIT\_TYPE parameter for the proper selection of the management unit type of the initial data for the logging cost calculations.

The costs of logging and silvicultural operations are used together with the roadside prices in the calculation of net revenues and net present values, consequently determining the preference and the priority of management operations in the analysis from the economic point of view. The consistency of prices and costs is of great importance, besides the cost level. See the SILVICULTURAL\_COSTS and ROADSIDE\_PRICES parameters.

**Generic name in Finnish:** KORJUUKUSTANNUKSET

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 2 to 5

**Default values:** 4 130 420 280 80

**Valid since:** MELA99

### Legend

- |   |          |
|---|----------|
| (1) Number of cost items to be given (1-4). |          |
| (2) Manual felling                          | FIM/hour |
| (3) Mechanized felling                      | FIM/hour |
| (4) Forest haulage                          | FIM/hour |
| (5) Supervision                             | FIM/hour |

**Example B.36.** A definition of the LOGGING\_COSTS parameter.

```
LOGGING_COSTS 2 75 400
```

The values are only given for manual and mechanized felling. The item (1) determines the number of the following items in the cost vector. Default values are used for omitted values.

## 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

**Valid since:** MELA96

### Legend

(1) Name of the lowest level of the decision hierarchy in the current MELA program session.

**Example B.37.** 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:** KASITTELYLUOKAT

**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.

**Valid since:** MELA96

## Legend

(1) - (10) **group\_id** **management\_category**[ [-]management\_category]

<b>group_id</b>	An index of the management category group.
<b>management_category</b>	A value for 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.38.** 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.37, groups 8, 9, and 10 are overlapping sums of management units.

## MANAGEMENT\_UNIT\_TYPE

### Functions

The MANAGEMENT\_UNIT\_TYPE parameter defines the type of the management units and, if necessary, the average size of stands in the management units of the initial data.

In MELA analysis, management units can be true stands with actual area (default) or they may represent an aggregate set of stands with an average area of stands (see also Chapter 4.3). If the management units are stand aggregates, the average size of stands is needed for the calculation of appropriate logging and silvicultural costs. See also the LOGGING\_COSTS and SILVICULTURAL\_COSTS parameters.

**Generic name in Finnish:** LASKENTAYKSIKON\_TARKENNE

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 1 or 7

**Default value:** 0

**Valid since:** MELA99

### Legend

(1) Type of the management units in the initial data.

'0' real stands without items (2) - (7)

'1' stands are aggregate ones without items (2)-(7)

'2' stands are aggregate ones with items (2)-(7)

(2) Average cutting area in thinnings based on basal area, hectares.

(3) Average cutting area in clear cuttings, hectares.

(4) Average cutting area in thinnings based on number of stems, hectares.

(5) Average cutting area in over story removal, hectares.

(6) Average cutting area in seed tree cuttings, hectares.

(7) Average cutting area in shelterwood cuttings, hectares.

NOTE: When value '1' are given for item (1), built-in values are used. See items (2)-(7) in Example B.38.

**Example B.39.** A definition of the MANAGEMENT\_UNIT\_TYPE parameter.

```
MANAGEMENT_UNIT_TYPE 2  
4.0 3.0 4.0 4.5 3.5 3.5
```

In Example B.38, user defines management units as aggregate stands and gives average are as for different cuttings. Notice that the values of the example are the built-in values concerning the type 1.

## MAX\_REGENERATION\_TIME

### Functions

The MAX\_REGENERATION\_TIME parameter defines the maximum acceptable time from regeneration cutting to an acceptable regeneration result. Maximum regeneration time is used in the calculation of simulated development class, see the sample plot variable (24) of the simulation record in Appendix D.3.

**Generic name in Finnish:** SALLITTU\_UUDISTUMISAIKA

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 8

**Default values:** See Example B.39

**Valid since:** MELA99

### Legend

(1) - (8) Years from the regeneration cutting to an acceptable regeneration result.

Categories:

- tree species: 4 (pine, spruce, birch, other deciduous species)
- regeneration type: 2 (natural, artificial)

**Example B.40.** A definition of the MAX\_REGENERATION\_TIME parameter.

```
MAX_REGENERATION_TIME

* Tree species:
* (1) pine
* (2) spruce
* (3) birch
* (4) other deciduous

* (1) (2) (3) (4)
* natural regeneration
  8  10  5  5
* artificial regeneration
  4   4  4  4
```

The default values are based on the Finnish recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994).

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## **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

**Valid since:** MELA96

### **Legend**

(1) Maximum number of characters in a file name (extension excluded).
---

**Example B.41.** 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

**Valid since:** MELA96

### Legend

(1) Name of the <b>tab</b> type file.
---------------------------------------

**Example B.42.** 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\_NUMBER\_OF\_SEEDLINGS**

### **Functions**

The MIN\_NUMBER\_OF\_SEEDLINGS parameter defines the general guiding number of seedlings (or seedling density plants per hectare) for silvicultural management operations. The parameter values are applied in simulation as such or modified in event definitions by the specific EVENT\_CALL arguments of the EVENT parameter.

The parameter values serve as simulation control for artificial regeneration, tending of young stands, and over story removal, for example (see the specific EVENT\_CALL arguments of the respective events). See also the BOUND\_FOR\_SUPPLEMENTARY\_PLANTING and BOUND\_FOR\_YOUNG\_STAND\_REGENERATION parameters defining density guidelines for the further growing of seedling stands.

**Generic name in Finnish:** MIN\_VILJELYTIHEYS

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 16

**Default values:** See Example B.42

**Valid since:** MELA96, changed MELA99

### **Legend**

(1) - (16) General guiding number of seedlings per hectare.

Categories:

- tree species: 4 (pine, spruce, silver birch, other deciduous)
- forest site type category: 4 (see the sample plot variable (13) of the initial data record in Appendix D.1)
  - 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.43.** A definition of the MIN\_NUMBER\_OF\_SEEDLINGS parameter.

```
MIN_NUMBER_OF_SEEDLINGS
* Tree species:
* (1) pine
* (2) spruce
* (3) silver birch
* (4) other deciduous species

* (1) (2) (3) (4)
* Forest site type category 1-2
  2500 2000 1600 2000
* Forest site type category 3
  2500 1800 1600 1800
* Forest site type category 4
  2000 1800 1600 1800
* Forest site type category 5-8
  2000 1800 1600 1800
```

The default values are based on the Finnish recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994).

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## **MIN\_NUMBER\_OF\_STEMS\_AFTER\_THINNING**

### **Functions**

The MIN\_NUMBER\_OF\_STEMS\_AFTER\_THINNING parameter defines the number of stems left to grow after thinning based on number of stems instructions in young stands. For level adjustments by events, see the specific EVENT\_CALL argument (10) of the EVENT parameter for thinning based on number of stems instructions. See also the BASAL\_AREA\_INSTRUCTIONS parameter.

**Generic name in Finnish:** MIN\_RLUKU\_HARV\_JALKEEN

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 16

**Default values:** See Example B.43

**Valid since:** MELA99

### **Legend**

(1) - (16) Number of trees per hectare after thinning based on number of stems instructions.

Categories:

- tree species: 4 (pine, spruce, silver birch and other deciduous species, downy birch)
- forest site type category: 4 (see the sample plot variable (13) of the initial data record in Appendix D.1)
  - 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.44.** A definition of the MIN\_NUMBER\_OF\_STEMS\_AFTER\_THINNING parameter.

```
MIN_NUMBER_OF_STEMS_AFTER_THINNING

* Tree species:
* (1) pine
* (2) spruce,
* (3) silver birch and other deciduous species
* (4) downy birch

* (1) (2) (3) (4)
* Forest site type category 1-2
  1350 1350 1000 1250
* Forest site type category 3
  1350 1350 1000 1250
* Forest site type category 4
  1250 1250 1000 1250
* Forest site type category 5-8
  1100 1100 1000 1250
```

The default values are based on the Finnish recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994).

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## **MIN\_REGENERATION\_AGE**

---

### **Functions**

The MIN\_REGENERATION\_AGE parameter defines the guiding minimum rotation periods in terms of biological age, for example, for controlling the generation of cutting alternatives in the simulation.

The parameter is often applied in conjunction with the MIN\_REGENERATION\_DIAMETER parameter and the specific EVENT\_CALL arguments for cuttings. For example, regeneration alternatives are simulated if the minimum regeneration age, the minimum mean diameter or both of them are reached. On the other hand, extraordinary high parameter values cancel the role of age enabling pure mean diameter control in the simulation of regeneration alternatives.

The user-supplied parameter values are used as such (without modifications on the basis of temperature sum, see below).

In the absence of user-supplied parameter values, built-in default values (see Example B.44) are used with modifications as a function of the temperature sum. Default values are applied in simulation as such for temperature sums above 1100 dd. Instead, values are increased 10-20 years for each 100 dd below 1100 dd. However, the maximum increase for deciduous species is limited to 20 years. For example, modified minimum regeneration age defaults for pine at 750 dd vary from 120 to 160 years. The default values and their modifications are based on the common rotation period recommendations by the Forestry Development Centre Tapio (Luonnonläheinen.. 1994).

**Generic name in Finnish:** MIN\_UUDISTUSIKA

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 20

**Default values:** See Example B.44

**Valid since:** MELA96, changed MELA99

## Legend

(1) - (20) Minimum rotation periods (years) based on biological age.

Categories:

- tree species: 5 (pine, spruce, silver birch, downy birch, other deciduous species)
- forest site type category: 4 (see the sample plot variable (13) of the initial data record in Appendix D.1)
  - 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.45.** A definition of the MIN\_REGENERATION\_AGE parameter.

```
MIN_REGENERATION_AGE

* Tree species:
* (1) pine
* (2) spruce
* (3) silver birch
* (4) downy birch
* (5) other deciduous species
* (1) (2) (3) (4) (5)
* Forest site type category 1-2
  80  80  60  60  40
* Forest site type category 3
  80  90  70  70  40
* Forest site type category 4
  90  90  70  70  40
* Forest site type category 5-8
 110  90  70  70  40
```

NOTE: The explicit values in Example B.44 are applied as such for temperature sums above 1100 dd.

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## **MIN\_REGENERATION\_DIAMETER**

### **Functions**

The MIN\_REGENERATION\_DIAMETER parameter defines the guiding minimum rotation periods in terms of the mean diameter, for example, for controlling the generation of cutting alternatives in the simulation.

The parameter is often applied in conjunction with the MIN\_REGENERATION\_AGE parameter and the specific EVENT\_CALL arguments for cuttings. For example, regeneration alternatives are simulated if the minimum regeneration age, the minimum mean diameter or both of them are reached. On the other hand, extraordinary high parameter values cancel the role of mean diameter enabling pure age control in the simulation of regeneration alternatives.

In the absence of user-supplied parameter values, built-in default values (see Example B.45) are used. The default values are based on the common rotation period recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994).

NOTE: Default values apply for Southern Finland only.

**Generic name in Finnish:** MIN\_UUDISTUSLAPIMITTA

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 20

**Default values:** See Example B.45

**Valid since:** MELA96, changed MELA99

### **Legend**

(1) - (20) Minimum mean diameters (cm) before regeneration.

Categories:

- tree species: 5 (pine, spruce, silver birch, downy birch, other deciduous species)
- forest site type category: 4 (see the sample plot variable (13) of the initial data record in Appendix D.1)
  - 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.46.** A definition of the MIN\_REGENERATION\_DIAMETER parameter.

```
MIN_REGENERATION_DIAMETER

* Tree species:
* (1) pine
* (2) spruce
* (3) silver birch
* (4) downy birch
* (5) other deciduous species

* (1) (2) (3) (4) (5)
* Forest site type category 1-2
  29  28  28  25  20
* Forest site type category 3
  29  26  26  25  20
* Forest site type category 4
  27  26  26  25  20
* Forest site type category 5-8
  25  26  26  25  20
```

**NOTE:** The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## MPS\_VARIABLES

### Functions

The MPS\_VARIABLES parameter names the variables of

- management report records (see Appendix D.6) for storing into **mps** type files, or
- management report text records (see Appendix D.10) for storing into **mpu** type files

and further for the transmission of information about the selected management schedules to user programs and databases.

Management report records (or management report text 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/mpu** type files, see Chapter 3.5.2.2 and Appendix C.2. See also the item (1) of the OUTPUT parameter and the STAND\_MANAGEMENT\_FILES 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

**Valid since:** MELA96

### Legend

(1) - (n) <b>origin sub-period variable</b>
---

for the variables originating from **decision data** records

**origin**

'MSD'

**sub-period**

An index of the sub-period (see the actual definition of the YEARS parameter and **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** An identification 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** An 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 of **mps** type files (or management report text records of **mpu** type files) is the same as in the definition of the MPS\_VARIABLES parameter.

**Example B.47.** A definition of the MPS\_VARIABLES parameter with the preceding definitions of the YEARS, MSR\_VARIABLES and MSD\_VARIABLES parameters 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 a management schedule record
* for storing into a msd type file
*
MSR_VARIABLES
* Variables (1)-(3) of a management schedule record
1 1 3
* Variables (4)-(6) of a management schedule record
1 32 33
1 36 36
* Variables (7)-(8) of a management schedule record
11 28 28
11 70 70
* Variables (9)-(16) of a management schedule record
11 1 3
11 32 33
11 36 36
21 28 28
21 70 70
* Variables (17)-(22) of a management schedule record
21 1 3
21 32 33
21 36 36
*
* variables of a 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.46:

(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.

Notice that Example B.46 suites also for management report text records and **mpu** type files.

## MSD\_VARIABLES

### Functions

The MSD\_VARIABLES parameter expresses in MELASIM the variables of decision data records (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.

Decision variables should be selected according to actual decision problems and 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.47

**Valid since:** MELA96

### Legend

(1) - (n) **variable** [ [-]variable ]

**variable**

An 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.48.** 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 of **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

**Valid since:** MELA96

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 ]
```

<b>year</b>	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).
<b>first_variable</b>	An index of the first management unit variable in the simulation record to be stored in management schedule records by this definition.
<b>last_variable</b>	An index of the last management unit variable in the simulation record to be stored in management schedule records 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.46. In Example B.46, 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.

---

## NUMBER\_OF\_SEED\_TREES

---

### Functions

The NUMBER\_OF\_SEED\_TREES parameter defines the guiding number of trees to be left for seeding in natural regeneration cuttings. For the user-supplied tree selection instructions, see the specific EVENT\_CALL arguments for seed tree and shelterwood cuttings and Appendix F.

**Generic name in Finnish:** SIEMENPUIDEN\_MAARA

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 24

**Default values:** See Example B.48

**Valid since:** MELA99

### Legend

(1) - (24) Number of trees (per hectare) to be left for seeding in natural regeneration cuttings.

Categories:

- tree species: 3 (pine, spruce, deciduous species)
- forest site type category: 8 (see the sample plot variable (13) of the initial data record in Appendix D.1)

**Example B.49.** A definition of the NUMBER\_OF\_SEED\_TREES parameter.

```
NUMBER_OF_SEED_TREES

* Tree species:
* (1) pine
* (2) spruce
* (3) deciduous tree species

* (1) (2) (3)
* Forest site type category 1
  150 250 30
* Forest site type category 2
  120 250 30
* Forest site type category 3
  90 200 20
* Forest site type category 4
  60 150 20
* Forest site type category 5
  50 150 20
* Forest site type category 6
  50 100 10
* Forest site type category 7
  50 100 10
* Forest site type category 8
  50 100 10
```

The default values are based on the Finnish recommendations for Southern Finland by the Forestry Centre Tapio (Luonnonläheinen.. 1994).

NOTE: The default values should never be used without checking their applicability for the analysis and the geographical region in question.

## 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

**Valid since:** MELA96

### 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 management schedule (**msc** and **msd** type) files disabled

'1' generation of management schedule (**msc** and **msd** type) files enabled (default)

(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 (default)

'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 the 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 (default)
  - '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 (default)
  - '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 the 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 (default)
  - '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 (default)
  - '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 (default)
- '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 (default)
- '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.50.** A definition of the OUTPUT parameter.

```
OUTPUT 0 0 3 0 0 0 0 0 0 0
```

In Example B.49, 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\_TULOSTUS

**Origin:** System parameter

**Program:** MELASIM, MELAOPT

**Type:** Numerical

**Number of items:** 1

**Default values:** 0

**Valid since:** MELA96

### **Legend**

(1) Display of input lines on the terminal.

'0' display of input lines disabled (default)

'1' display of input lines enabled

**Example B.51.** 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 in **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

**Valid since:** MELA96

### Legend

(1) Storing of re-simulation instructions.

'0' storing of re-simulation instructions disabled

'1' storing of re-simulation instructions enabled (default)

**Example B.52.** 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

**Valid since:** MELA96

### 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 (default)

(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.52 (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.53.** 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 in the calculation of net revenues and net present values. They also determine the preference and priority of management operations in the analysis from the economic point of view. The consistency of prices and 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.

NOTE: By default, roadside prices for saw logs are adjusted according to the default coefficients in the ROADSIDE\_LOG\_PRICE\_ADJUSTMENT parameter (see Example B.52). If the user does not want to use these coefficients, he or she must disable the saw log price adjustment or give own values for adjustment coefficients.

**Generic name in Finnish:** TIENVARSIHINNAT

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 17

**Default values:** See Example B.53

**Valid since:** MELA96

### Legend

(1) '0'

(2) - (9) Saw log prices (FIM/m<sup>3</sup>) at the roadside by tree species.

(10) - (17) Pulpwood prices (FIM/m<sup>3</sup>) 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.54.** 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 defines the costs of silvicultural operations.

The costs of silvicultural and logging operations are used together with the roadside prices to calculate net revenues and to determine the preference and priority of management operations in the analysis from the economic point of view. The consistency of prices and costs is of great importance, besides the cost level. See also the LOGGING\_COSTS and ROADSIDE\_PRICES parameters.

**Generic name in Finnish:** METSANHOITOKUSTANNUKSET

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 19

**Default values:** See Example B.54

**Valid since:** MELA96, changed MELA99

**Legend**

(1) Cost of clearing of regeneration area	FIM/hectare
(2) Cost of harrowing and scarification	FIM/hectare
(3) Cost of ploughing and mounding	FIM/hectare
(4) Cost of seeding FIM/hectare	
(5) Purchase price of a pine seedling	FIM/seedling
(6) Purchase price of a spruce seedling	FIM/seedling
(7) Purchase price of a birch seedling	FIM/seedling
(8) Purchase price of a pine seedling for supplementary planting	FIM/seedling
(9) Purchase price of a spruce seedling for supplementary planting	FIM/seedling
(10) Purchase price of a birch seedling for supplementary planting	FIM/seedling
(11) Cost of prevention of grass	FIM/hectare
(12) Cost of tending of seedling stands	FIM/hectare
(13) Cost of pruning	FIM/stem
(14) Cost of fertilization	FIM/hectare
(15) Cost of forest drainage FIM/hectare	
(16) Cost of ditch cleaning	FIM/100 meters
(17) Cost of supplementary drainage	FIM/100 meters
(18) Unit cost of silvicultural work	FIM/hour
(19) Unit cost of felling work	FIM/hour

**Example B.55.** A definition of the SILVICULTURAL\_COSTS parameter.

SILVICULTURAL_COSTS	345	755	1065	930	0.5	0.85	1.15	0.85	0.95	1.50
	500	785	4.5	775	750	225	250	80	130	

## **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.55

**Valid since:** MELA96

### **Legend**

- (1) Relative year when the generation of 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 (default)  
     '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 (default)
  - '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 (default)
    - 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.56.** 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.

## STAND\_MANAGEMENT\_FILES

### Functions

The STAND\_MANAGEMENT\_FILES parameter controls the output of **mps** type files (in binary form) and **mpu** type files (in text form) (see Appendix C.2). The parameter defines the format and the number of files to be written in a MELAOPT session. Either **mps** type files or **mpu** type files can be generated in the same MELAOPT session. See also the MPS\_VARIABLES parameter.

**Generic name in Finnish:** LASKENTAYKSIKKOPALAUTE

**Origin:** System parameter

**Program:** MELAOPT

**Type:** Numerical

**Number of items:** 2

**Default values:** 0 0

**Valid since:** MELA96

### Legend

(1) Format of **mps/mpu** type files.

'0' management report information is written into **mps** type files (default)

'1' management report information is written into **mpu** type files

(2) Number of **mps/mpu** type files to be stored.

'0' management report information is written into several files in accordance with **rsd** type files (default)

'1' management report information is written into one forestry unit level file

NOTE: The item (2) has substituted the earlier MPS\_OUTPUT parameter.

**Example B.57.** A definition of the STAND\_MANAGEMENT\_FILES parameter.

```
STAND_MANAGEMENT_FILES 1 1
```

The information about management units is written into one **mpu** type file for the whole forestry unit.

## 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 cutting revenues without taking costs into account. See also the ROADSIDE\_PRICES parameter.

NOTE: Stumpage prices are not used in the calculation of net revenues and net present values.

**Generic name in Finnish:** KANTOHINNAT

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 17

**Default values:** See Example B.57

**Valid since:** MELA96

### Legend

(1) '0'

(2) - (9) Stumpage prices (FIM/m<sup>3</sup>) of saw logs by tree species.

(10) - (17) Stumpage prices (FIM/m<sup>3</sup>) 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.58.** 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 TIMBER\_PRODUCTION\_LAND and MANAGEMENT\_CATEGORY\_GROUPS parameters 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

**Valid since:** MELA96

### Legend

(1) Upper bound for forest management categories belonging to timberland when calculating decision variables.

**Example B.59.** 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 values for decision variables. Notice the compatibility with the definitions of the MANAGEMENT\_CATEGORY\_GROUPS parameter in Example B.37.

## TIME\_EXPENDITURE\_IN\_LOGGING

### Functions

The TIME\_EXPENDITURE\_IN\_LOGGING parameter defines the user-supplied time expenditure figures (hours/m<sup>3</sup>) of logging related operations in the simulation in order to replace the respective values obtained from the built-in default time expenditure functions.

The default time expenditure functions are based on Finnish work studies of Kuitto et al. (1994), Rummukainen et al. (1995) and on the agreement of the manual felling work (Metsäpalkkarakenteen.. 1996).

Time expenditure is a component of the logging cost calculations besides cutting removal and unit prices, see the LOGGING\_COST and the ROADSIDE\_PRICES parameters.

Notice that the TIME\_EXPENDITURE\_IN\_LOGGING parameter as such has no default values because of the built-in default time expenditure functions.

**Generic name in Finnish:** KORJUUN\_AJANMENEKKI

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 108

**Default values:** None

**Valid since:** MELA99

### Legend

(1) - (108) Time expenditure, hours/m<sup>3</sup>.

Categories:

- harvesting types: 6 (thinning based on basal area, clear cutting, thinning based on number of stems, over story removal, seed tree cutting, shelterwood cutting)
- logging operation types: 3 (manual felling, mechanized felling, forest haulage)
- tree species: 3 (pine, spruce, deciduous species)
- timber assortment types: 2 (saw timber, pulpwood)

**Example B.60.** A definition of the TIME\_EXPENDITURE\_IN\_LOGGING parameter.

```

TIME_EXPENDITURE_IN_LOGGING

* Harvesting type
*   1   2   3   4   5   6
* MANUAL LOGGING
* Pine saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Pine pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0
* Spruce saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Spruce pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0
* Deciduous sp. saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Deciduous sp. pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0

* MECHANIZED LOGGING
* Pine saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Pine pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0
* Spruce saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Spruce pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0
* Deciduous sp. saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Deciduous sp. pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0

* FOREST HAULAGE
* Pine saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Pine pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0
* Spruce saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Spruce pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0
* Deciduous sp. saw timber
  1.0  1.0  1.0  1.0  1.0  1.0
* Deciduous sp. pulpwood
  1.0  1.0  1.0  1.0  1.0  1.0

```

NOTE: The time expenditures in Example B.59 are hypothetical.

## 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

**Valid since:** MELA96

### Legend

(1) Clearing of the unused growth estimates before storing simulation records into **smr** type files.

'0' don't clear unused growth estimates (default)

'1' clear unused growth estimates

**Example B.61.** 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

**Valid since:** MELA96

### 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.62.** 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, decision variables are collected and 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.62.

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 EVENT (the EVENT\_YEARS item), EVENT\_DEFAULTS, SIMULATION\_CONTROL and YEARS parameters.

**Generic name in Finnish:** VUODET

**Origin:** System parameter

**Program:** MELASIM

**Type:** Numerical

**Number of items:** 1 - 9 (- 20)

**Default values:** None

**Valid since:** MELA96

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) <b>year</b> [ 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 the 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 the `UNUSED_GROWTH_ESTIMATES` parameter.

**Example B.63.** 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

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### 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  
(binary)
- **mpu** type files data for stand management report generation (text)
- **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. You can find several examples of problem definitions in Appendix H.

### 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 be 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:

<b>xPvvv</b>
--------------

- |          |   |
|----------|---|
| <b>x</b> | 'x' (lower case 'x' referring to JLP x type variables).   |
| <b>P</b> | An identification number of the sub-period in question, see the YEARS parameter in the current application. |

**vvv** An 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:

<b>YEARS</b>	1995	2005	2015	2025	2035
	<u>decision variables describing states</u>				
	0vvv	1vvv	2vvv	3vvv	4vvv
	<u>decision variables describing events</u>				
	1vvv	2vvv	3vvv	4vvv	
<b>YEARS</b>	1	3	7	11	21
	<u>decision variables describing states</u>				
	0vvv	1vvv	2vvv	3vvv	4vvv
5vvv	<u>decision variables describing events</u>				
	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**

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 in binary form 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 information about the selected management schedules for management units in MELAOPT.

The stand management files may contain two types of records:

- management report records(see Appendix D.6) and
- optimum solution records (see Appendix D.9).

See also stand management text (**mpu** type) files.

NOTE: Either **mps** type files or **mpu** type files can be generated in the same MELAOPT session. For further information, see the STAND\_MANAGEMENT\_FILES parameter in Appendix B.2.

### Specifications

**File type:** system file

**Default naming:** forestry\_unit\_sub\_unit\_problem.MPS

**Default unit:** 26

**File parameters:** binary file, 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 (see Appendix B.2) selects the variables of management report records for storing into the **mps** type files. For the control of generating **mps** type files, see the STAND\_MANAGEMENT\_FILES parameter in Appendix B.2.

See also the MSD\_VARIABLES and MSR\_VARIABLES parameters in Appendix B.2 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 binary **m**ps 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.

## Stand Management Text (mpu type) Files

---

### Functions

Stand management text (**mpu** type) files are used to transfer management unit variables in text form 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 text files contain also information about the selected management schedules for management units in MELAOPT.

See also stand management (**mps** type) files.

NOTE: Either **mps** type files or **mpu** type files can be generated in the same MELAOPT session. For further information, see the STAND\_MANAGEMENT\_FILES parameter in Appendix B.2.

### Specifications

**File type:** system file

**Default naming:** forestry\_unit\_sub\_unit\_problem.MPU

**Default unit:** 70

**File parameters:** text file, sequential, variable length

**Valid records:** management report text records

**Output from:** MELAOPT

**Input for:** user programs

### Generation

The MELAOPT command REPORT SUMMARY is used to generate **mpu** type files. The MPS\_VARIABLES parameter (see Appendix B.2) selects the variables of management report text records (see Appendix D.10) for storing into the **mpu** type files. For the control of generating **mpu** type files, see the STAND\_MANAGEMENT\_FILES parameter in Appendix B.2.

See also the MSD\_VARIABLES and MSR\_VARIABLES parameters in Appendix B.2 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 text records.

### Instructions

For the order of the variables in management report text records, see Appendix D.10 and the MPS\_VARIABLES parameter in Appendix B.2.

## **Cost of Change Report (mrg type) Files**

---

### **Functions**

A cost of change (increase or decrease) report is generated from the JLP problem solved in a MELAOPT session and 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 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 schedule 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 summary data in a comparable form with management schedule data.

### Specifications

**File type:** system files

**Default naming:** forestry\_unit\_sub\_unit\_problem\_ **S.MSC/MSD** (MELASIM)

forestry\_unit\_sub\_unit\_problem\_ **O.MSC/MSD** (MELAOPT)

**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:** MELASIM or 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 can be generated by user programs or by MELA stand data extensions. 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 1 000 - 100 000). 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 in Appendix D.1.

## **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 the 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. See Example H.44.

## **Simulation Record (smr type) Files**

---

### **Functions**

MELA simulation records from MELASIM can be stored by request in **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 (re-simulation), 69 (management proposals)

**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. MELA stand data extensions help users in processing management proposals with stand data. For more information, contact the MELA Team.

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 display a forest level optimum solution directly from the JLP memory and 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:** 1

**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 applicable 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

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---

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

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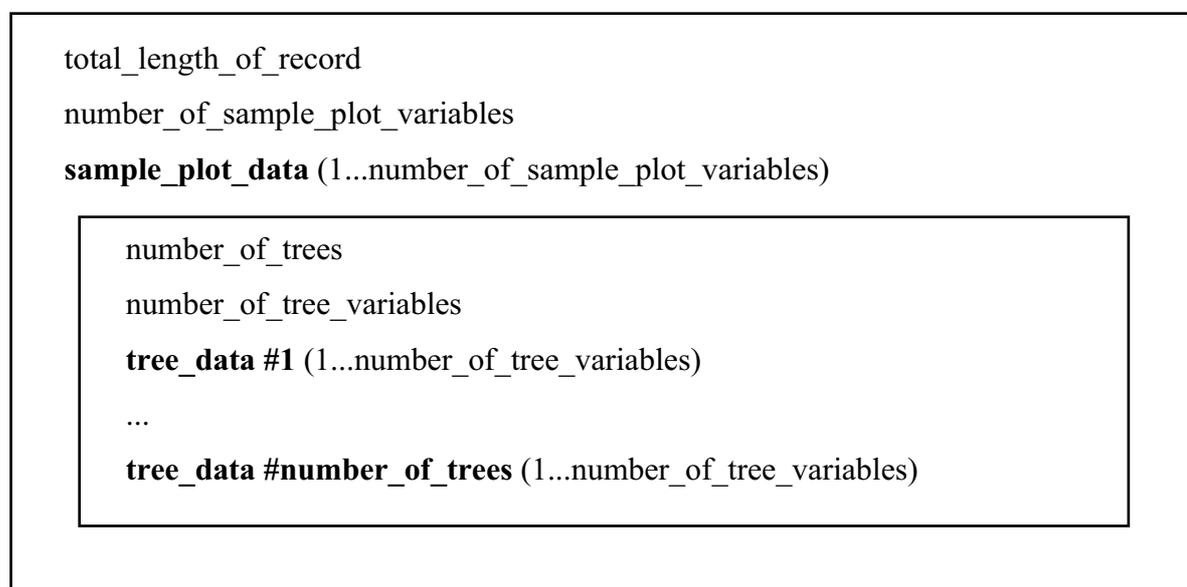
### D.1 Initial Data Record (sample plots in *rsd* type files)

#### 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) North, X coordinate, km (Finnish uniform coordinate system)  
(appropriate values in Finland from 6 600 to 7 800 km)
- (6) East, Y coordinate-3000, km (Finnish uniform coordinate system)  
(appropriate values in Finland from 0 to 800 km after the 3000 km subtraction)
- (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
	<ul style="list-style-type: none"> <li>1 very rich sites (OMaT in South Finland)</li> <li>2 rich sites (OMT in South Finland)</li> <li>3 damp sites (MT in South Finland)</li> <li>4 sub-dry sites (VT in South Finland)</li> <li>5 dry sites (CT in South Finland)</li> <li>6 barren sites (CIT in South Finland)</li> <li>7 rocky or sandy areas</li> <li>8 open mountains</li> </ul>
(14)	Reduction of forest taxation class
	<ul style="list-style-type: none"> <li>0 no reduction</li> <li>1 stony soils</li> <li>2 wet soils</li> <li>3 thick moss layer expressing low soil productivity (kunttaisuus in Finnish)</li> <li>4 unfavourable location (coastal areas, mountains)</li> </ul>
(15)	Finnish forest taxation class or site fertility category
	<ul style="list-style-type: none"> <li>1 IA respective to very rich or rich sites</li> <li>2 IB respective to damp sites</li> <li>3 II respective to sub-dry sites</li> <li>4 III respective to dry sites</li> <li>5 IV respective to barren sites or lower, if forest land</li> <li>6 scrub land</li> <li>7 waste land</li> </ul> <p>NOTE: Forest taxation class is a combination of variables (13) and (14).</p>
(16)	Drainage category
	<ul style="list-style-type: none"> <li>0 undrained mineral soils</li> <li>1 ditched mineral soils</li> <li>2 undrained mires</li> <li>3 ditched mires (unchanged productivity), (ojikko in Finnish)</li> <li>4 transforming mire (improved productivity), (muuttuma in Finnish)</li> <li>5 transformed mire (productivity comparable to mineral soils), (turvekangas in Finnish)</li> </ul>
(17)	Feasibility for drainage
	<ul style="list-style-type: none"> <li>0 drainage feasible and allowed</li> <li>1 drainage not feasible or not allowed</li> </ul>
-(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
	<ul style="list-style-type: none"> <li>0 natural regeneration feasible</li> <li>1 natural regeneration not feasible</li> </ul>
(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 Pirkkka-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)
production	1 forest land, <b>no restrictions</b> for timber production
	2 forest land, <b>administrational restrictions</b> for timber production
	3 scrub land, no restrictions or administrative restrictions for timber
	6 waste land, no restrictions or administrative restrictions for timber
	7 forest, scrub and waste land, <b>no timber production</b> 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 TIMBER\_PRODUCTION\_LAND and MANAGEMENT\_CATEGORY\_GROUPS parameters

in Appendix B.2. However, the users are responsible for the validity of initial data, event definitions, and headings and titles of reports (see **tab** type files in Appendix C.2). It is recommended to use default values for the MANAGEMENT\_CATEGORY\_GROUPS parameter 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 same 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 in use -
- (34) - not in use -

**Tree variables of initial data (Finnish version)**

- (1) Number of stems/ha (that the tree represents)
- (2) Tree species

1 Scotch pine ( <i>Pinus silvestris</i> )
2 Norway spruce ( <i>Picea abies</i> )
3 Silver birch ( <i>Betula pendula</i> )
4 Downy birch ( <i>Betula pubescens</i> )
5 Aspen ( <i>Populus tremula</i> )
6 Alder ( <i>Alnus incana</i> , <i>Alnus glutinosa</i> )
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 seeded
	2 planted
	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

- (15) Crown height (height of lower limit of live crown), m

- (16) Management category of the tree

	0 undefined
	1 no restrictions in forest management operations
	2 preserved (untouched in forest management operations)

- (17) - not in use -

## 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.

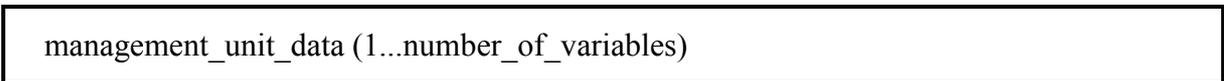
## D.2 Management Unit Record (c variables in rsd type files)

### 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).



**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

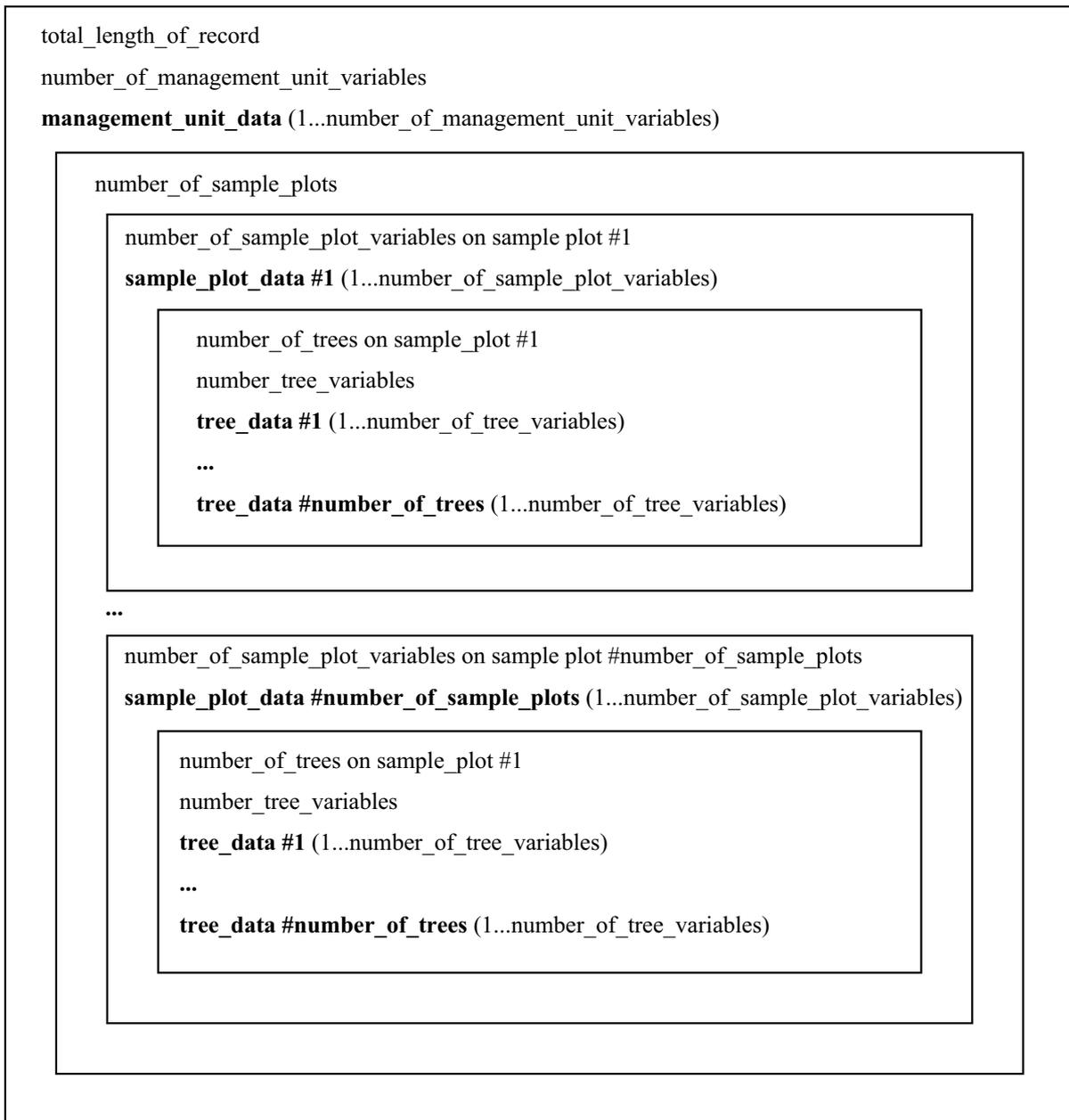
#### Management unit variables of simulation data (Finnish version)

(1..270) (see sample plot variables of simulation data and the NOTE below)

NOTE: Simulation data consist of 270 variables in total. The variables (1) - (90) are for the site and the whole growing stock. Variables (91) - (180) are used for variables derived from that part of the growing stock which is available for cuttings and silvicultural treatment. Variables (181) - (270) are used for variables derived from retained trees (ie not available for cuttings or other treatments).

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) North, X coordinate, km (Finnish uniform coordinate system)  
(appropriate values in Finland from 6 600 to 7 800 km)
- (6) East, Y coordinate-3000, km (Finnish uniform coordinate system)  
(appropriate values in Finland from 0 to 800 km after the 3000 km subtraction)
- (7) Identification number of the stand (see the sample plot variable (7) of the initial data record)
- (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 sample plot variable (10) of the initial data record)
- (11) Land-use category (see the sample plot variable (11) of the initial data record)
- (12) Soil and peatland category (see the sample plot variable (12) of the initial data record)
- (13) Site type category (see the sample plot variable (13) of the initial data record)
- \*(14) Reduction of forest taxation class (see the sample plot variable (14) of the initial data record)
- (15) Forest taxation class (see the sample plot variable (15) of the initial data record)
- \*(16) Drainage category (see the sample plot variable (16) of the initial data record)
- \*(17) Feasibility for drainage (see the sample plot variable (17) of the initial data record)
- (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 sample plot variable (22) of the initial data record)
- (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 (see the sample plot variable (29) of the initial data record)
- (30) Forest management category (see the sample plot variable (30) of the the initial data record)

DOMINANT STORY (variables (31) - (40))

- (31) Number of stems/ha (including small trees)
- (32) Dominant tree species (see the tree variable (2) of the initial data record)
- (33) Mean age, a
- (34) Volume, m<sup>3</sup>/ha
- (35) Basal area, m<sup>2</sup>/ha
- (36) Mean diameter, cm
- (37) Mean height, m
- (38) Saw log volume, m<sup>3</sup>/ha
- (39) Value, FIM/ha
- (40) Volume of commercial timber, m<sup>3</sup>/ha

SECONDARY STORY (variables (41) - (50))

- (41) Number of stems/ha (including small trees)
  - (42) Dominant tree species (see the tree variable (2) of the initial data record)
  - (43) Mean age, a
  - (44) Volume, m<sup>3</sup>/ha
  - (45) Basal area, m<sup>2</sup>/ha
  - (46) Mean diameter, cm
  - (47) Mean height, m
  - (48) Saw log volume, m<sup>3</sup>/ha
  - (49) Value, FIM/ha
  - (50) Volume of commercial timber, m<sup>3</sup>/ha
- (51) Basal area of pine, m<sup>2</sup>/ha (dominant story) - not in use -

- (52) Basal area of spruce, m<sup>2</sup>/ha (dominant story) - not in use -
- (53) Basal area of silver birch, m<sup>2</sup>/ha (dominant story) - not in use -
- (54) Basal area of downy birch, m<sup>2</sup>/ha (dominant story) - not in use -
- (55) Basal area of other deciduous, m<sup>2</sup>/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<sup>3</sup>/ha/a
- (62) Net value increment, m<sup>3</sup>/ha/a
- (63) Removal, m<sup>3</sup>/ha/a
- (64) Increment, dominant story, m<sup>3</sup>/ha/a
- (65) Increment, secondary story, m<sup>3</sup>/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. The integer part shows the method of the last artificial regeneration (see the tree variable (10) of the initial data record) and the first three decimals represent the actual event identification number (see the event identification line of the EVENT parameter in Appendix B.2).
- (70) Method of the last cutting. The integer part shows the method of the last cutting (see the sample plot variable (31) of the initial data record) and the first three decimals represent the actual event identification number (see the event identification line of the EVENT parameter in Appendix B.2).
- \*(71) (for system use only)
- (72) Municipality code (see the sample plot variable (32) of the initial data record)
- \*(73) - not in use -
- \*(74) - not in use -
- (75) Year of the last selection of retained trees, a
- (76) Volume of pine, m<sup>3</sup>/ha
- (77) Volume of spruce, m<sup>3</sup>/ha
- (78) Volume of birch, m<sup>3</sup>/ha
- (79) Volume of other deciduous, m<sup>3</sup>/ha
- (80) Total volume, m<sup>3</sup>/ha
- (81) Increment of pine, m<sup>3</sup>/ha/a
- (82) Increment of spruce, m<sup>3</sup>/ha/a
- (83) Increment of birch, m<sup>3</sup>/ha/a
- (84) Increment of other deciduous, m<sup>3</sup>/ha/a
- (85) Total increment, m<sup>3</sup>/ha/a
- (86) Cutting removal of pine, m<sup>3</sup>/ha/a
- (87) Cutting removal of spruce, m<sup>3</sup>/ha/a
- (88) Cutting removal of birch, m<sup>3</sup>/ha/a
- (89) Cutting removal of other deciduous, m<sup>3</sup>/ha/a
- (90) Total cutting removal, m<sup>3</sup>/ha/a
- (91)-(180) Sample plot variables for trees available for cuttings and silvicultural treatments

\*(91)-(120) (for system use only)

DOMINANT STORY (variables (121) - (130))

- (121) Number of stems/ha (including small trees)
- (122) Dominant tree species (see the tree variable (2) of the initial data record)
- (123) Mean age, a
- (124) Volume, m<sup>3</sup>/ha
- (125) Basal area, m<sup>2</sup>/ha
- (126) Mean diameter, cm
- (127) Mean height, m
- (128) Saw log volume, m<sup>3</sup>/ha
- (129) Value, FIM/ha
- (130) Volume of commercial timber, m<sup>3</sup>/ha

SECONDARY STORY (variables (131) - (140))

- (131) Number of stems/ha (including small trees)
- (132) Dominant tree species (see the tree variable (2) of the initial data record)
- (133) Mean age, a
- (134) Volume, m<sup>3</sup>/ha
- (135) Basal area, m<sup>2</sup>/ha
- (136) Mean diameter, cm
- (137) Mean height, m
- (138) Saw log volume, m<sup>3</sup>/ha
- (139) Value, FIM/ha
- (140) Volume of commercial timber, m<sup>3</sup>/ha

\*(141)-(179) (for system use only)

(181)-(270) Sample plot variables for retained trees.

\*(181)-(210) (for system use only)

DOMINANT STORY (variables (211) - (220))

- (211) Number of stems/ha (including small trees)
- (212) Dominant tree species (see the tree variable (2) of the initial data record)
- (213) Mean age, a
- (214) Volume, m<sup>3</sup>/ha
- (215) Basal area, m<sup>2</sup>/ha
- (216) Mean diameter, cm
- (217) Mean height, m
- (218) Saw log volume, m<sup>3</sup>/ha
- (219) Value, FIM/ha
- (220) Volume of commercial timber, m<sup>3</sup>/ha

SECONDARY STORY (variables (221) - (230))

- (221) Number of stems/ha (including small trees)

- (222) Dominant tree species (see the tree variable (2) of the initial data record)
- (223) Mean age, a
- (224) Volume, m<sup>3</sup>/ha
- (225) Basal area, m<sup>2</sup>/ha
- (226) Mean diameter, cm
- (227) Mean height, m
- (228) Saw log volume, m<sup>3</sup>/ha
- (229) Value, FIM/ha
- (230) Volume of commercial timber, m<sup>3</sup>/ha

\*(231)-(270) (for system use only)

**Tree variables of simulation data (Finnish version)**

NOTE: The values of the tree variables (2), (17) - (18) and (23) - (27) come directly from the initial data.

- |       |   |
|-------|---|
| (1)   | Number of stems/ha (that the tree represents)   |
| (2)   | Tree species (see the tree variable (2) of the initial data record)                                   |
| (3)   | Diameter at 1.3 m height, cm  |
| (4)   | Height, m   |
| (5)   | Basal area at 1.3 m height, m <sup>2</sup>  |
| (6)   | Age at 1.3 m height, a  |
| (7)   | Initial volume, m <sup>3</sup>  |
| (8)   | Current volume, m <sup>3</sup>  |
| (9)   | Biological age, a   |
| (10)  | Volume, saw timber, m <sup>3</sup>  |
| (11)  | Volume, pulpwood, m <sup>3</sup>  |
| (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) | Management category for the tree (see the tree variable (16) of the initial data record)              |
| (18)  | Origin (see the tree variable (10) of the initial data record)  |
| (19)  | Volume of commercial timber (saw log and pulpwood), m <sup>3</sup>                                    |
| (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<br>(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  |
| -(27) | Crown height, m.  |
| (28)  | - not in use -  |
| (29)  | - not in use -  |
| (30)  | - not in use -  |

**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, birch and alder)
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 in use -

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<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/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 the initial data record in Appendix D.1) (10), m<sup>3</sup>/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 the initial data record in Appendix D.1) (10), m<sup>3</sup>/a

121-195 Cutting removal by diameter classes (5), timber assortments (3) and tree species categories (5), m<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/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 the initial data record in Appendix D.1), m<sup>3</sup>/a

very rich or 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<sup>3</sup>/a
- 327 Increment of pulpwood volume, m<sup>3</sup>/a
- 328 Increment of logging residue, m<sup>3</sup>/a
- 329 Increment of commercial timber, m<sup>3</sup>/a
- 330 Increment of basal area, m<sup>2</sup>/a

331-335 Logging residue by tree species categories (5), m<sup>3</sup>/a

331	pine
332	spruce
333	birch
334	other deciduous
335	TOTAL

336-340 Cutting drain by tree species categories (5), m<sup>3</sup>/a

336	pine
337	spruce
338	birch
339	other deciduous
340	TOTAL

341-345 Waste wood by tree species categories (5), m<sup>3</sup>/a

341	pine
342	spruce
343	birch
344	other deciduous
345	TOTAL

346-350 Total drain by tree species categories (5), m<sup>3</sup>/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 the initial data record in Appendix D.1) (10), m<sup>3</sup>/a

361-365 Mortality by tree species categories (5), m<sup>3</sup>/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 the initial data record in Appendix D.1) (10), m<sup>3</sup>/a

381-384 Increment by owner categories (4), m<sup>3</sup>/a

381	private
382	company
383	state
384	TOTAL

385 Increment of secondary story, m<sup>3</sup>/a

386-390 Net increment by tree species categories (5), m<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/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 the initial data record in Appendix D.1), m<sup>3</sup>/a

very rich or 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<sup>3</sup>/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 the initial data record in Appendix D.1) and soil types (3), ha

mineral soil	peatland	TOTAL	
517	524	531	very rich or 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 in use -

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 the initial data record in Appendix D.1) (10), ha

551-555 Total volume on forestry land by tree species categories (5), m<sup>3</sup>

551	pine
552	spruce
553	birch
554	other deciduous
555	TOTAL

556-565 - not in use -

566-570 Total volume of retained trees by tree species categories (5), m<sup>3</sup>

566	pine
567	spruce
568	birch
569	other deciduous
570	TOTAL

571-575 Total value of retained trees by tree species categories (5), FIM

571	pine
572	spruce
573	birch
574	other deciduous
575	TOTAL

576-577 Total volume of retained trees by timber assortments (2), m<sup>3</sup>

576	saw logs
577	pulpwood

578 Area of selecting of retained trees, ha/a

579-583 Volume of selected retained trees by tree species categories (5), m<sup>3</sup>/a

579	pine
580	spruce
581	birch
582	other deciduous
583	TOTAL

584-588 Increment of retained trees by tree species categories (5), m<sup>3</sup>/a

584	pine
585	spruce
586	birch
587	other deciduous
588	TOTAL

589-593 Mortality of retained trees by tree species categories (5), m<sup>3</sup>/a

589	pine
590	spruce
591	birch
592	other deciduous
593	TOTAL

594-599 Area by dominant tree species categories (6), 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<sup>3</sup>

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<sup>3</sup>

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<sup>3</sup>

very rich or 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 in use -

771-785 Volume by soil types (3) and tree species categories (5), m<sup>3</sup>

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 the initial data record in Appendix D.1) (10), m<sup>3</sup>

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<sup>3</sup> (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 in use -

831-835 Basal area by tree species categories (5), m<sup>2</sup>

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<sup>3</sup>

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<sup>3</sup>

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<sup>3</sup>

pine	spruce	birch	other de- ciduous	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 by tree species categories (5) , m<sup>3</sup>

901	pine
902	spruce
903	birch
904	other deciduous
905	TOTAL

906-910 Actual volume of trees existing in initial data by tree species categories (5) , m<sup>3</sup>

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<sup>3</sup>

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<sup>3</sup>

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<sup>3</sup>

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 gross income 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<sup>3</sup>

936	pine
937	spruce
938	birch
939	other deciduous
940	TOTAL

941-970 - not in use -

971-975 Volume of dominant story by tree species categories (5), m<sup>3</sup>

971	pine
972	spruce
973	birch
974	other deciduous
975	TOTAL

976-980 Volume of secondary story by tree species categories (5), m<sup>3</sup>

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<sup>3</sup>

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<sup>3</sup>

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.

selected\_simulation\_data (1...number\_of\_variables)

**Figure D.4.** The structure of the management schedule record.

### 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 `MSR_VARIABLES` and `YEARS` parameters 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 *m<sub>ps</sub>* 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 binary **mps** type files (see Appendix C.2) 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 in 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 (see Appendix C.2). 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, the user can also control how the 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 the field inventory, and
- to control the re-simulation of the selected management schedules.

### Structure

The MELA simulation instruction record is a variable-length floating-point vector, see Figure D.6.

NOTE: Simulation instruction records may also contain 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.

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'
<u>repeated section(s)</u> 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
(4) relative or absolute year until which the simulation of natural processes continues (valid for natural processes or the basic event type 1 only, see the EVENT_CALL item of the EVENT parameter in Appendix B.2).	
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.

## 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 the 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 the 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.

VVVVEEEEETTTTtext
-------------------

- 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 at the columns of a report.

**text**

the 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 each management unit. 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 record 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

Optimum solution 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.

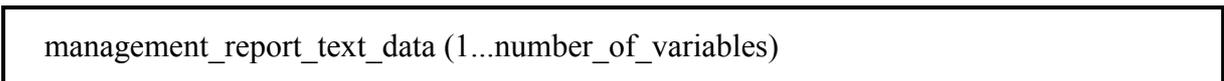
## D.10 Management Report Text Record (management unit variables in mpu type files)

### Functions

The management report text 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 text records are stored by request in **mpu** type files as text (see Appendix C.2) for further processing in user routines, for example for transferring into the forest database.

### Structure

The management report text record is a character string consisting of integer and floating-point values, see Figure D.8.



**Figure D.8.** The structure of the management report text record.

### Variables

- (1) unique management unit identifier (UID) - integer
- (2) simulation or decision variables (1) - floating point
- ..
- (n+1) simulation or decision variable (n) - floating point
- (n+2) proportion of the selected management schedule in the respective optimum solution in question - floating point

A management report text record contains always the unique management unit identifier (see Appendix G.2) and the proportion of the selected management schedule in the respective optimum solution. Other variables in a management report text record are simulation and decision variables selected by the user, see the `MPS_VARIABLES` parameter in Appendix B.2.

### Generation

Management report text records are generated and stored by MELAOPT in **mpu** type files (see Appendix C.2).

## Instructions

For the variables of management report text records stored in **mpu** 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 in the management schedule records are collected in the beginning of each year in question (before any events).

# Appendix E

## Some MELA Decision Variables

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Appendix E provides an introduction to a selection of MELA decision variables.

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# Appendix E

## Some MELA Decision Variables

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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 `ROADSIDE_PRICES` and `ROADSIDE_LOG_PRICE_ADJUSTMENT` parameters 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 ongoing 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 MIN\_REGENERATION\_AGE and MIN\_REGENERATION\_DIAMETER parameters 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 `ROADSIDE_PRICES` and `ROADSIDE_LOG_PRICE_ADJUSTMENT` parameters 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

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Appendix F provides the details of the tree selection procedure applied in MELASIM.

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# Appendix F

## Selection of Trees in Treatments

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### 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 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 of the simulation 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 of 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

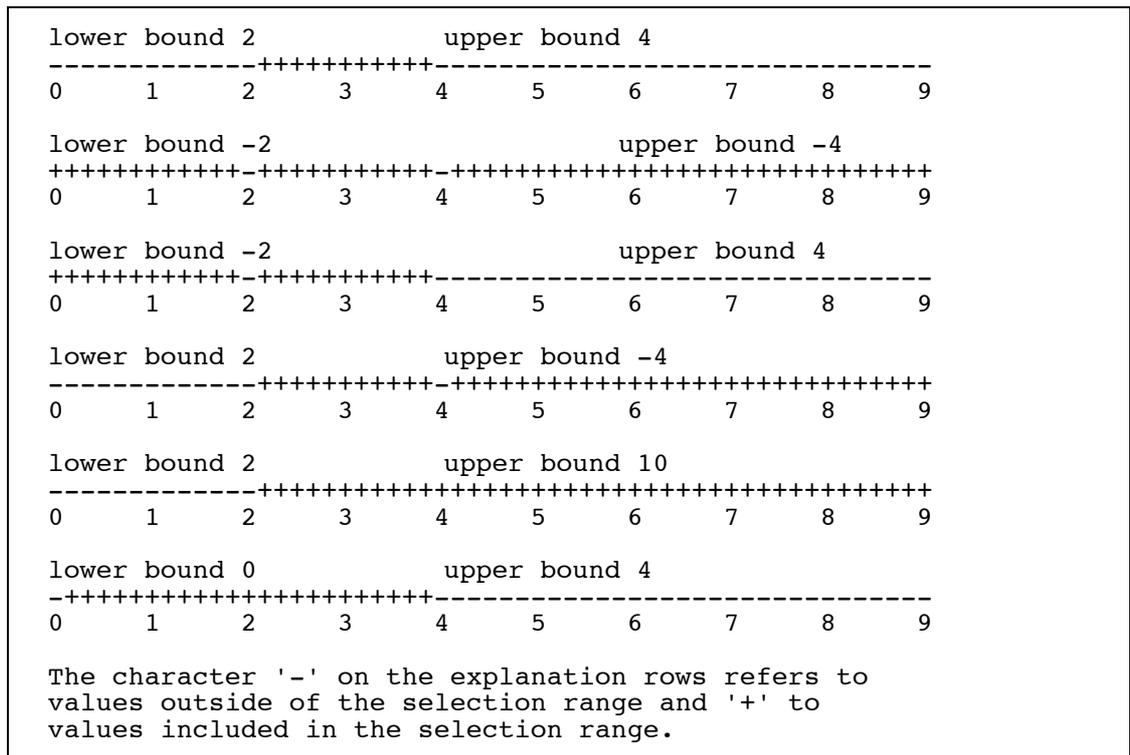
NOTE: All trees not included in the selection group definitions are excluded from the selection and left untouched.

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.



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.19):

```
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)

**Example F.3.** Default tree selection instructions for cuttings and tending of young stands.

<p><b>Basic event routine (identification number)</b>            default selection instruction</p>
<p><b>Thinning based on basal area instructions (2.1)</b>            1 3 6 99 2 2 -1 -1 8 -0.5 1 0 0 0 8 -0.5 1</p>
<p><b>Clear cutting (2.2)</b>            1 3 6 99 1 0 0 0 8 0 0</p>
<p><b>Thinning based on number of stems instructions (2.3)</b>            1 0 3 99 3 3 15 99 3 1 1 2 -1 -1 8 -0.5 1 0 0 0 8 -0.5 1</p>
<p><b>Over story removal (2.4)</b>            1 3 7 99 1 14 0.5 2.5 8 3 0</p>
<p><b>Seed tree cutting (2.5)</b>            1 3 6 99 2 2 1.5 10 4 0 1 0 0 0 4 -5 50</p>
<p><b>Shelterwood cutting (2.6)</b>            1 3 6 99 2 2 -2 999 4 0 1 0 0 0 4 -5 0</p>
<p><b>Tending of young stands (3)</b>            1 3 0 18 2 2 -1 -1 8 -0.5 1 0 0 0 8 -0.5 1</p>

When user-supplied tree selection instructions are not given (see specific EVENT\_CALL arguments of the EVENT parameter for each basic event in Appendix B.2), built-in default selection instructions in Example F.3 are used.

## **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

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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

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### 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.

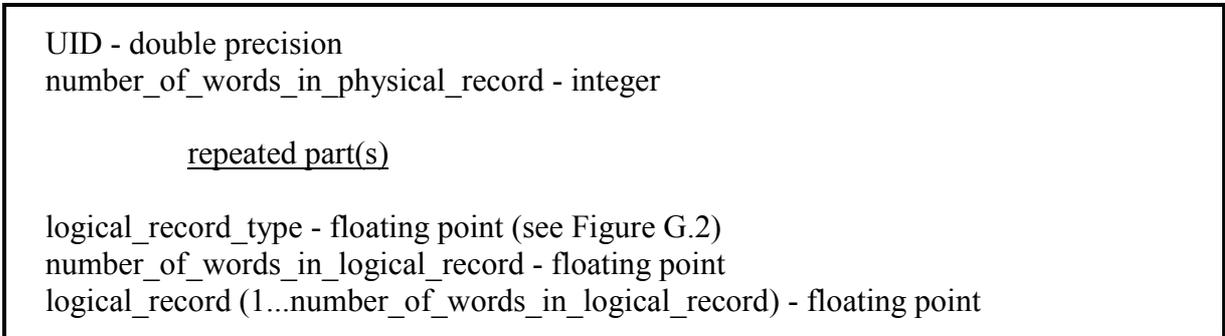
## **G.2 Unique Management Unit Identifier**

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 Figure G.2 and Appendices C and D.



**Figure G.1.** The structure of the MSB (MELA standard binary) record.

Type	Logical record	File types
1	initial data record (see Appendix D.1)	<b>rsd</b> type files
2	management unit record (see Appendix D.2)	<b>rsd</b> type files
3	simulation record (see Appendix D.3)	<b>msr</b> type files
4	management report record (see Appendix D.6)	<b>mps</b> type files
5	simulation instruction record (see Appendix D.7)	<b>sms</b> type files
6	optimum solution record (see Appendix D.8)	<b>mps</b> type files

**Figure G.2.** The types of the logical records and respective MSB format files.

## **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 r1,r2,r3

* number of words in logical records
      real d1,d2,d3

      integer nw1,nw2,nw3
      integer io
      data 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=d1+2
      write(io) uid,nwp,r1,d1,(data1(i),i=1,nw1)

* write three logical records into one physical MSB record
      nwp=d1+d2+d3+(2*3)
      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)
      data io, ip

* 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

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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

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### 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-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):

<b>C variable</b>	<b>Explanation</b>	<b>Possible values</b>
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
C_PARAMETERI=C_PARAMETER

* <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 parameter 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 Over story removal

* <clip> ... Part of the file was cut out ... <clip>

  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 a 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, m≥/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
261 0 -1 Pine
262 0 -1 Spruce
263 0 -1 Birch
264 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=
9999
* 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\_EVENT2000.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.MSC forest level summary files, see Appendix C.2  
 FX\_sub\_unit\_S.MSD forest level summary files, see Appendix C.2  
 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
SIMULATION_CONTROL 41 50 0 0 1000 0 1 999 0 0 500 0 0 0 151 0 0
INCLUDE MS_EVENT2000.PAR
```

**Example H.6.** An event definition file for the simulation of alternative management schedules.

```
* MS_EVENT2000.PAR * (excerpts)
*=====
* DEFAULT VALUES FOR THE 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 27 28 29 50
#FEASIBLE_PRECEDESSORS 70 71 99
#FOREST_CATEGORIES    3 30 0 -3.99999
#EVENT_CALL  2 1 3 1 0 800 800 8 12 0 1500 1 0.5 0 0 0 0
EVENT
#20 THINNING - BASAL AREA INSTRUCTIONS
*-----
*#EVENT_YEARS          0
#COMPARABLE_EVENTS    10 20 25 27 28 29 30
#FEASIBLE_PRECEDESSORS 70 71 99
#FOREST_CATEGORIES    3 30 0 -3.99999
#EVENT_CALL  2 1 1 1 0 4 2 10 1.5 0 1.5 0.9 0.5 0 0 0 0
#>>          0 0 0 0 1 1 1 1 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_EVENT2000.PAR file, see the MELA delivery package
```

## Example H.7. The log of the MELASIM session.

```

* MELASIM session log *   (excerpts)

MELA2000-23112000-V1

.. Reading user information from the file USER.PAR
.. Welcome to use MELA-programs !

MELASIM> SIMULATE MS2000 FX
MELASIM> .. 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
..     LUE MELA_SET.PAR
.. Parameter in: METSATALOUS YKSIKKO
.. Files of the FORESTRY_UNIT definition:
..     LUE FX.PAR
..     LUE MS.PAR
..     INCLUDE MS_EVENT2000.PAR
=====
.. Symbol in: ALIN_TASO <> LOWEST_LEVEL
.. Parameter ALIN_TASO was not found
.. in MELA forest resource data (rsd) F1.RSD
.. MELA standard binary (MSB) files are used

* <clip>... Part of the report was cut out... <clip>

.. The management schedule file (MSD) has been 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. 17 1.00    3    3.  8 1.00
      4    4. 24 1.00    5    5. 38 1.00    6    6. 14 1.00
      7    7. 44 1.00    8    8. 13 1.00    9    9. 13 1.00
     10   10.  6 1.00   11   11. 16 1.00   12   12. 89 1.00
     13   13. 24 1.00   14   14. 19 1.00

.. ** TOTAL:
.. ** CALCULATION UNITS      14
.. ** SIMULATED SCHEDULES   326
=====
.. <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 *
1<>mela<> 90401 132236
=====
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
Pine      1790.9    2393.5    1079.0    700.6    1225.6
Spruce    969.6     1211.5    1024.5    913.2    494.2
Birch     53.6      111.1     178.9     272.8    406.8
Other deciduous      15.3      35.6      85.2      93.9     56.1

Saw log   1224.6    1874.5    1188.8    739.4    868.4
Pulpwood  1472.8    1729.9    1084.6    1127.7    1126.5
-----
VALUE (roadside prices), FIM 525340    740627    468807    353469    389335
NET PRESENT VALUE (NPV) 3% 588443    754211    584606    539024    609238
-----
                1996      2006      2016      2026      2036
-----
INCREMENT, m3/a
Pine      69.4      52.7      30.0      53.5
Spruce    45.5      38.1      29.8      26.0
Birch     6.8       8.9       11.9      15.7
Other deciduous      2.2       5.6       8.7       4.2

TOTAL DRAIN, m3/a
Mortality 5.1       9.1       5.3       3.3
Cutting drain 26.6     234.6     113.8     75.9
-----
CUTTING REMOVAL, m3/a
Over story removal 0.0       4.3      48.0       0.0
Thinnings 25.9      0.0      24.3      72.5
Regeneration cuttings 0.0     221.6     40.3       0.0

Pine      8.1      175.9     66.6       0.0
Spruce    17.8     50.0     40.3      67.0
Birch     0.0      0.0      0.0       1.1
Other deciduous      0.0      0.0      5.7       4.4

Saw log   12.4     142.9     85.0      34.5
Pulpwood  13.5     82.9     27.5      38.0
-----
TOTAL CUTTING AREA, ha/a
Thinnings 0.3       0.0      0.2       0.6
Clear cuttings 0.0      0.2      0.1       0.0
Over story cuttings 0.0      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
Artificial regeneration 0.0      0.2      0.1       0.0
Natural regeneration 0.0      1.1      0.0       0.0

TENDING YOUNG STANDS, ha/a      0.2      0.1      1.1       0.1
-----
GROSS REVENUES, FIM/a      4883.8  48990.8  27827.1  13861.0
TOTAL COSTS, FIM/a      1726.1  11985.6  6552.0   3926.6
NET REVENUES, FIM/a      3157.7  37005.2  21275.1  9934.3
=====

```

## 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_EVENT2000.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
SIMULATION_CONTROL 41 50 0 0 1000 0 1 999 0 0 50 0 0 0 151 0 0
INCLUDE MS_EVENT2000.PAR
```





**Interpretation of the management schedule summary report**

The summary report for the monitoring of the generation of 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.

<u>state in the beginning of sub-period</u>		<u>events during sub-period</u>	
row	line number		fel
cutting drain, m <sup>3</sup> /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, m <sup>2</sup> /ha		a
artificial regeneration - 0/1			
vol	volume, m <sup>3</sup> /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,
m <sup>3</sup> /ha/a			
h	mean stand height, m		ivol
increment, m <sup>3</sup> /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 end of 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_EVENT2000.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 *  
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_EVENT2000.PAR
```



## 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_EVENT2000.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 file
F2.MSD	management schedule file
F2_F2_S.MSC	forest level summary file, see Appendix C.2
F2_F2_S.MSD	forest level summary file, see Appendix C.2
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 0 500 0 0 0 151 0 0
INCLUDE MS_EVENT2000.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 *
1<>mela<> 90401 133951
=====
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
Pine      2946.7  3327.2  2325.3  2258.4  2084.5
Spruce    1856.9  1921.7  1008.9   783.0  1104.4
Birch     1013.5  1249.4  1056.4  1145.5  481.9
Other deciduous      59.1   118.1   184.4   279.7  425.9

Saw log   17.2    38.0    75.5    50.2    72.3

Saw log   1305.9  1666.9  1167.4  1132.3  700.5
Pulpwood  1503.8  1525.1  1075.0  1004.5  1219.5

-----
VALUE (roadside prices), FIM  548343  662776  464104  442455  368498
NET PRESENT VALUE (NPV) 3%   596785  696394  575870  612558  573946
-----
                1997    2007    2017    2027    2037
-----
INCREMENT, m3/a
Pine      119.5    100.6    84.8    108.0
Spruce    64.7     48.4    34.7     60.8
Birch     45.4     38.6    33.5     28.5
Other deciduous      7.1     9.1    12.2     15.7
Other deciduous      2.4     4.5     4.5     3.1

TOTAL DRAIN, m3/a
Mortality  81.5    200.8    91.5    125.4
Cutting drain      5.1     5.5     4.6     3.0
Cutting drain      76.4   195.3    86.9   122.4

-----
CUTTING REMOVAL, m3/a
Over story removal      74.6   187.4    85.6   120.8
Thinnings      0.0    14.7    36.9     0.0
Regeneration cuttings  36.0     0.0    48.7     7.3
Regeneration cuttings  38.6   172.7     0.0   113.6

Pine      56.2   136.2    55.8    27.1
Spruce    18.5    51.2    24.0    93.7
Birch     0.0     0.0     0.0     0.0
Other deciduous      0.0     0.0     5.8     0.0

Saw log   37.5   125.8    49.0    92.7
Pulpwood  37.1    61.6    36.6    28.1

-----
TOTAL CUTTING AREA, ha/a
Thinnings      1.0     1.4     1.3     0.5
Clear cuttings      0.7     0.0     0.5     0.2
Over story cuttings      0.0     0.2     0.0     0.1
Seed tree cuttings      0.0     0.4     0.8     0.0
Shelterwood cuttings      0.3     0.8     0.0     0.2
Shelterwood cuttings      0.0     0.0     0.0     0.0

REGENERATION AREA, ha/a
Artificial regeneration      0.3     1.0     0.0     0.4
Natural regeneration      0.0     0.2     0.0     0.1
Natural regeneration      0.3     0.8     0.0     0.2

TENDING YOUNG STANDS, ha/a      0.2     0.4     0.8     0.4

-----
GROSS REVENUES, FIM/a      14270.2  41868.3  19161.1  27767.0
TOTAL COSTS, FIM/a      4884.6   9880.6   4824.2   5618.7
NET REVENUES, FIM/a      9385.6  31987.8  14336.9  22148.2
=====

```

## 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_EVENT2000.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	simulation record file, 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_EVENT2000.PAR
```



**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-CUTTING POTENTIAL-NPV 5 %   solution is optimum
-----
                1996    2006    2016    2026    2036
-----
805 NPV 5 %                2356194
537 Forestry land area      195.4
700 Volume, m3             18472.0 16744.6 14640.3 17353.4 19873.0
697 -saw log                7503.8  5879.2  5369.8  5969.7  6825.7
090 Increment, m3/a         785.4   728.3   833.2   974.3
195 Cutting removal, m3/a   894.4   865.2   527.4   671.4
193 -saw log                518.4   369.4   261.8   305.5
370 Net revenues, FIM/a     130771 109962 76067.9 87332.2
800 Roadside value,FIM     3413323                                3545271
803 NPV 3 %                 3888084                                4503477
=====

MELAOPT>

```

**Example H.18.** A MELAOPT summary report for the cutting potential problem.

```

* FX_FX_P5_O.SUM *
1<>mela<> 90401 135450
=====
FX - P5-CUTTING POTENTIAL-NPV 5 % - all:
-----
                1996      2006      2016      2026      2036
-----
FORESTRY LAND AREA, ha      195.4    195.4    195.4    195.4    195.4

TOTAL VOLUME, m3
Pine      18472.0  16744.6  14640.3  17353.4  19873.0
Spruce    9597.5   10577.2  8770.3   9948.7   10275.9
Birch     6490.1   3990.2   3909.6   4323.4   5444.6
Other deciduous 2073.7  1892.3  1620.0   2765.7   3659.8
          310.6   285.0   340.3    315.5    492.8

Saw log   7503.8   5879.2   5369.8   5969.7   6825.7
Pulpwood  9772.1   9662.2   8220.9  10315.0  11788.2

-----
VALUE (roadside prices), FIM 3413322 2937076 2619407 3093096 3545271
NET PRESENT VALUE (NPV) 3%   3888083 3709269 3710189 4104347 4503477
-----
                1996      2006      2016      2026      2036
-----
INCREMENT, m3/a
Pine      785.4    728.3    833.2    974.3
Spruce    462.4    443.1    456.4    513.0
Birch     218.9    177.7    203.0    242.5
Other deciduous 84.1    85.0    151.4    197.6
          19.9    22.5    22.3    21.2

TOTAL DRAIN, m3/a
Mortality 958.1    938.7    561.9    722.3
Cutting drain 27.4    28.0    19.4    33.1
          930.7    910.7    542.4    689.2

-----
CUTTING REMOVAL, m3/a
Over story removal 894.4    865.2    527.4    671.4
Thinnings 10.9     112.9    98.1     17.1
Regeneration cuttings 165.9    333.7    271.0    421.7
          717.6    418.5    158.3    232.5

Pine      344.5    584.7    327.4    458.9
Spruce    450.8    172.2    155.3    127.8
Birch     84.9     96.0     28.5     84.6
Other deciduous 14.3    12.3     16.1     0.1

Saw log   518.4    369.4    261.8    305.5
Pulpwood  376.0    495.8    265.6    365.8

-----
TOTAL CUTTING AREA, ha/a
Thinnings 7.1       9.3       6.4       7.4
Clear cuttings 2.8       4.3       3.5       5.9
Over story cuttings 2.2       0.6       0.3       1.0
Seed tree cuttings 0.2       2.4       2.0       0.4
Shelterwood cuttings 1.2       2.0       0.4       0.1
          0.7       0.0       0.2       0.0

REGENERATION AREA, ha/a
Artificial regeneration 4.4       2.6       0.9       1.1
Natural regeneration 2.5       0.6       0.3       1.0
          1.9       2.0       0.6       0.1

TENDING YOUNG STANDS, ha/a      2.3       2.6       3.1       1.4

-----
GROSS REVENUES, FIM/a      195234  167482  110521  131045
TOTAL COSTS, FIM/a      64463.4 57519.8 34453.5 43712.8
NET REVENUES, FIM/a      130771  109962  76067.9 87332.2
=====

```

## 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-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
/
```

**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-NPV 4% solution is optimum
-----
                1996      2006      2016      2026      2036
-----
804 NPV 4 %                2918755                                3502506
537 Forestry land area      195.4
700 Volume, m3              18472.0 18701.8 18154.7 18271.9 19019.4
697 -saw log                 7503.8 7307.8 7269.2 7012.5 7204.4
090 Increment, m3/a          813.9   796.4   832.4   888.7
195 Cutting removal, m3/a    727.6   777.0   777.0   777.0
193 -saw log                 405.0   405.0   405.0   420.0
370 Net revenues, FIM/a      103247 111682 114628 114628
800 Roadside value,FIM      3413323                                3456919
=====

MELAOPT>

```

**Example H.21.** A MELAOPT summary report for the problem of the maximum sustained yield.

```

* FX_FX_S4_O.SUM *
1<>mela<> 90401 141027
=====
FX - S4-MAXIMUM SUSTAINED YIELD-NPV 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	18701.8	18154.7	18271.9	19019.4
Pine	9597.5	11784.8	11577.3	10919.3	9921.8
Spruce	6490.1	4690.7	4648.8	4942.1	5886.1
Birch	2073.7	1929.0	1552.1	2133.1	2779.4
Other deciduous	310.6	297.3	376.5	277.4	432.0
Saw log	7503.8	7307.8	7269.2	7012.5	7204.4
Pulpwood	9772.1	10189.5	9876.4	10306.5	10649.5
VALUE (roadside prices), FIM	3413322	3405584	3322096	3372735	3456918
NET PRESENT VALUE (NPV) 3%	3940454	4098721	4213643	4333931	4495588
	1996	2006	2016	2026	2036
INCREMENT, m3/a	813.9	796.4	832.4	888.7	
Pine	480.0	505.2	501.1	477.4	
Spruce	228.9	197.0	213.7	267.7	
Birch	85.0	71.6	96.3	124.9	
Other deciduous	20.0	22.6	21.4	18.7	
TOTAL DRAIN, m3/a	790.9	851.1	820.7	813.9	
Mortality	27.7	32.1	25.2	20.6	
Cutting drain	763.2	819.0	795.5	793.3	
CUTTING REMOVAL, m3/a	727.6	777.0	777.0	777.0	
Over story removal	10.9	108.3	86.9	66.3	
Thinnings	185.6	271.6	349.4	432.6	
Regeneration cuttings	531.1	397.1	340.7	278.1	
Pine	241.5	488.3	549.5	556.8	
Spruce	390.4	187.1	178.4	170.0	
Birch	82.4	91.6	27.4	50.2	
Other deciduous	13.2	10.0	21.8	0.0	
Saw log	405.0	405.0	405.0	420.0	
Pulpwood	322.6	372.0	372.0	357.0	
TOTAL CUTTING AREA, ha/a	6.7	8.0	6.7	7.9	
Thinnings	3.2	3.4	3.6	5.3	
Clear cuttings	1.6	1.0	0.3	0.9	
Over story cuttings	0.2	2.3	1.3	1.4	
Seed tree cuttings	1.1	1.1	1.4	0.2	
Shelterwood cuttings	0.7	0.2	0.2	0.0	
REGENERATION AREA, ha/a	3.6	2.3	1.8	1.2	
Artificial regeneration	1.8	1.0	0.3	0.9	
Natural regeneration	1.8	1.3	1.5	0.2	
TENDING YOUNG STANDS, ha/a	2.2	2.6	2.3	2.7	
GROSS REVENUES, FIM/a	156658	162894	160261	161410	
TOTAL COSTS, FIM/a	53411.1	51212.8	45633.2	46782.5	
NET REVENUES, FIM/a	103247	111682	114628	114628	

```

=====

```

## 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-NPV 3 %      solution is optimum
-----
                1996      2006      2016      2026      2036
-----
803 NPV 3 %                3659036                                6740013
537 Forestry land area    195.4
700 Volume, m3            18472.0 21773.8 25217.2 29446.6 33810.9
697 -saw log              7503.8  9112.7 11134.3 13728.7 17468.2
090 Increment, m3/a       845.4   892.1   972.9  1016.1
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   136.4
184 --spruce saw log      136.3   135.0   136.5   127.6
189 -birch, m3/a          30.9    24.2    20.7    95.9
192 -other deciduous, m3/a  4.1     10.8    14.3    32.6
370 Net revenues, FIM/a   62878.4 71342.9 69758.5 72976.9
800 Roadside value,FIM   3413323                                6924530
=====

MELAOPT>

```

**Example H.24.** A MELAOPT summary report for the problem of the assumed harvests.

```

* FX_FX_A3_O.SUM *
<>mela<> 90401 141649
=====
FX - A3-ASSUMED CUTTINGS-NPV 3 % - 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	21773.8	25217.2	29446.6	33810.9
Pine	9597.5	12311.9	15145.1	18574.4	21938.9
Spruce	6490.1	6570.7	6625.0	6603.9	7619.7
Birch	2073.7	2481.9	2950.0	3750.6	3953.2
Other deciduous	310.6	409.3	497.1	517.6	299.1
Saw log	7503.8	9112.7	11134.3	13728.7	17468.2
Pulpwood	9772.1	11375.3	12928.3	14664.9	15392.9
VALUE (roadside prices), FIM	3413323	4075808	4841921	5826960	6924531
NET PRESENT VALUE (NPV) 3%	3659035	4188504	4801939	5644711	6740012
	1996	2006	2016	2026	2036
INCREMENT, m3/a	845.4	892.1	972.9	1016.1	
Pine	483.8	534.3	586.7	605.6	
Spruce	251.7	244.2	238.0	241.1	
Birch	88.5	88.6	122.7	151.4	
Other deciduous	21.4	25.1	25.5	18.0	
TOTAL DRAIN, m3/a	515.3	547.8	550.0	579.7	
Mortality	30.1	63.7	74.1	104.1	
Cutting drain	485.1	484.1	475.9	475.6	
CUTTING REMOVAL, m3/a	460.0	460.0	460.0	460.0	
Over story removal	10.9	109.7	0.0	0.0	
Thinnings	123.5	272.7	302.3	292.4	
Regeneration cuttings	325.5	77.6	157.7	167.6	
Pine	195.0	195.0	195.0	195.0	
Spruce	230.0	230.0	230.0	136.4	
Birch	30.9	24.2	20.7	95.9	
Other deciduous	4.1	10.8	14.3	32.6	
Saw log	245.0	245.0	245.0	245.0	
Pulpwood	215.0	215.0	215.0	215.0	
TOTAL CUTTING AREA, ha/a	4.7	5.4	4.0	3.9	
Thinnings	2.4	3.4	3.3	3.4	
Clear cuttings	0.9	0.3	0.5	0.4	
Over story cuttings	0.2	1.7	0.0	0.0	
Seed tree cuttings	0.5	0.0	0.0	0.1	
Shelterwood cuttings	0.7	0.0	0.1	0.0	
REGENERATION AREA, ha/a	2.4	0.3	0.6	0.5	
Artificial regeneration	1.2	0.3	0.5	0.4	
Natural regeneration	1.2	0.0	0.1	0.1	
TENDING YOUNG STANDS, ha/a	2.2	2.3	0.4	0.6	
GROSS REVENUES, FIM/a	98662.9	100571	98904.2	100133	
TOTAL COSTS, FIM/a	35784.5	29227.9	29145.7	27156.0	
NET REVENUES, FIM/a	62878.4	71342.9	69758.5	72976.9	

```

=====

```

## 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
x1195-0.90*x1090=0
x2195-0.90*x2090=0
x3195-0.90*x3090=0
x4195-0.90*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 %                2913026                                3594729
537 Forestry land area      195.4
700 Volume, m3              18472.0 18673.5 18760.8 19198.3 19623.3
697 -saw log                 7503.8 6896.8 7416.6 7228.9 7654.6
090 Increment, m3/a          813.1   804.6   851.9   896.4
195 Cutting removal, m3/a    731.8   724.1   766.7   806.7
193 -saw log                 438.4   342.3   405.0   405.2
035 Regeneration area, ha/a   2.9     2.4     1.7     1.3
370 Net revenues, FIM/a      108953 99163.6 115157 112928
800 Roadside value,FIM      3413323                                3600550
=====

MELAOPT>

```

**Example H.27.** A MELAOPT summary report for the problem of harvests bound to increment.

```

* FX_FX_D4_O.SUM *
1<>mela<> 90401 142140
=====
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	18471.9	18673.5	18760.8	19198.3	19623.3
Pine	9597.5	11972.1	11658.7	11268.3	9745.3
Spruce	6490.1	4433.0	5148.6	5110.1	6648.4
Birch	2073.7	1983.5	1613.4	2415.7	2914.4
Other deciduous	310.6	284.9	340.1	404.3	315.0
Saw log	7503.8	6896.8	7416.6	7228.9	7654.6
Pulpwood	9772.1	10552.8	10294.7	10948.5	10876.0
VALUE (roadside prices), FIM	3413322	3354874	3423431	3511443	3600549
NET PRESENT VALUE (NPV) 3%	3934128	4024080	4258449	4388011	4587977
	1996	2006	2016	2026	2036
INCREMENT, m3/a	813.1	804.6	851.9	896.4	
Pine	483.3	508.5	497.6	465.5	
Spruce	225.1	197.1	220.0	272.6	
Birch	84.8	76.5	111.2	140.2	
Other deciduous	19.9	22.5	23.1	18.0	
TOTAL DRAIN, m3/a	793.0	795.8	808.1	853.9	
Mortality	27.7	30.4	26.6	24.3	
Cutting drain	765.3	765.5	781.5	829.5	
CUTTING REMOVAL, m3/a	731.8	724.1	766.7	806.7	
Over story removal	10.9	78.3	90.2	56.4	
Thinnings	204.0	288.0	353.0	479.9	
Regeneration cuttings	516.9	357.8	323.4	270.4	
Pine	227.1	501.9	519.7	597.4	
Spruce	414.0	111.5	217.4	115.6	
Birch	76.4	98.5	21.8	76.5	
Other deciduous	14.3	12.3	7.8	17.1	
Saw log	438.4	342.3	405.0	405.2	
Pulpwood	293.4	381.8	361.7	401.5	
TOTAL CUTTING AREA, ha/a	6.8	7.5	6.8	8.5	
Thinnings	4.0	3.6	3.6	6.1	
Clear cuttings	1.7	0.8	0.4	0.8	
Over story cuttings	0.2	1.5	1.6	1.1	
Seed tree cuttings	0.7	1.4	1.1	0.6	
Shelterwood cuttings	0.2	0.2	0.2	0.0	
REGENERATION AREA, ha/a	2.9	2.4	1.7	1.3	
Artificial regeneration	2.0	0.8	0.4	0.8	
Natural regeneration	1.0	1.6	1.3	0.6	
TENDING YOUNG STANDS, ha/a	2.3	2.0	2.6	2.3	
GROSS REVENUES, FIM/a	160637	147981	159986	163303	
TOTAL COSTS, FIM/a	51684.0	48817.8	44829.4	50375.2	
NET REVENUES, FIM/a	108953	99163.6	115157	112928	

```

=====

```

## 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\_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:
          S4R-MAXIMUM SUSTAINED YIELD,4%  solution is optimum
-----
          1996    2006    2016    2026    2036
-----
804 NPV 4 %                2918755                                3502506
537 Forestry land area      195.4
700 Volume, m3              18472.0  18701.8  18154.7  18271.9  19019.4
697 -saw log                7503.8  7307.8  7269.2  7012.5  7204.4
090 Increment, m3/a         813.9    796.4    832.4    888.7
195 Cutting removal, m3/a   727.6    777.0    777.0    777.0
193 -saw log                405.0    405.0    405.0    420.0
370 Net revenues, FIM/a     103247  111682  114628  114628
800 Roadside value,FIM     3413323                                3456919

=====
<>MELA<>  FX - REGION=WR:
          S4R-MAXIMUM SUSTAINED YIELD,4%  solution is optimum
-----
          1996    2006    2016    2026    2036
-----
804 NPV 4 %                591726                                533062
537 Forestry land area      29.6
700 Volume, m3              3285.0  4286.3  3868.1  3063.3  2455.6
697 -saw log                1009.3  1371.9  1637.7  1284.1  544.2
090 Increment, m3/a         195.0    189.5    177.7    159.6
195 Cutting removal, m3/a   86.4    213.5    245.2    215.5
193 -saw log                53.5     83.0    127.1    139.6
370 Net revenues, FIM/a     13102.5  27217.3  34694.1  36197.3
800 Roadside value,FIM     592238                                419406

=====
<>MELA<>  FX - DISTRICT=F2:
          S4R-MAXIMUM SUSTAINED YIELD,4%  solution is optimum
-----
          1996    2006    2016    2026    2036
-----
804 NPV 4 %                439587                                359845
537 Forestry land area      24.1
700 Volume, m3              2829.4  2763.3  2447.5  2078.2  1683.8
697 -saw log                1224.6  1242.5  1223.7  812.4  371.7
090 Increment, m3/a         112.5     96.0     89.2     99.7
195 Cutting removal, m3/a   111.9    112.3    119.7    133.8
193 -saw log                67.3     65.9     84.0     85.0
370 Net revenues, FIM/a     16222.5  17111.5  21628.2  21763.5
800 Roadside value,FIM     525340                                271306

=====
* <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_SQ.SOL *

SQ FX
=====
<>MELA<>  FX - REGION=SR:
          S4R-MAXIMUM SUSTAINED YIELD,4%  solution is optimum
-----

```

	1996	2006	2016	2026	2036
804 NPV 4 %	1863292				1988850
537 Forestry land area	82.4				
700 Volume, m3	10066.0	8644.3	8108.1	7957.9	8671.1
697 -saw log	5271.4	4258.0	3673.2	3287.3	3776.6
090 Increment, m3/a	408.3	400.1	431.8	472.0	
195 Cutting removal, m3/a	519.0	421.0	428.8	385.4	
193 -saw log	322.5	264.1	235.4	212.8	
370 Net revenues, FIM/a	82149.6	68001.2	66230.4	58322.1	
800 Roadside value,FIM	2012435				1633556

```

-----

```

## 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:

* minimum 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

* maximum 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/SD,4% solution is optimum
-----
                1996    2006    2016    2026    2036
-----
804 NPV 4 %                2905046                3612876
537 Forestry land area    195.4
700 Volume, m3           18472.0 18895.6 18503.6 18816.6 19703.7
697 -saw log              7503.8 7386.7 7441.3 7299.4 7812.8
090 Increment, m3/a       816.3 803.1 843.5 896.6
002 -clear cutting        1.6    1.1    0.3    0.8
195 Cutting removal, m3/a 710.9 768.2 768.2 768.2
193 -saw log              398.6 403.3 398.6 401.6
370 Net revenues, FIM/a   100715 111089 112624 112624
800 Roadside value,FIM   3413323                3620521

=====
<>MELA<>   FX - DISTRICT=F2:
           SD-MAXIMUM SUSTAINED YIELD/SD,4% solution is optimum
-----
                1996    2006    2016    2026    2036
-----
804 NPV 4 %                431499                517799
537 Forestry land area    24.1
700 Volume, m3           2829.4 2903.0 2752.0 2663.8 2711.1
697 -saw log              1224.6 1297.6 1388.8 1177.2 1129.5
090 Increment, m3/a       114.3 101.8 100.7 114.9
002 -clear cutting        0.1    0.0    0.1    0.0
195 Cutting removal, m3/a 100.1 101.6 102.8 104.1
193 -saw log              62.5 62.5 70.2 64.0
370 Net revenues, FIM/a   14630.4 16046.6 18184.4 18184.4
800 Roadside value,FIM   525340                504240

=====
<>MELA<>   FX - DISTRICT=F3:
           SD-MAXIMUM SUSTAINED YIELD/SD,4% solution is optimum
-----
                1996    2006    2016    2026    2036
-----
804 NPV 4 %                422577                797880
537 Forestry land area    22.0
700 Volume, m3           2119.4 2509.6 3261.4 3081.2 3705.8
697 -saw log              1157.5 1379.7 1579.7 1534.9 2182.8
090 Increment, m3/a       114.7 147.2 148.9 145.9
002 -clear cutting        0.1    0.1    0.1    0.1
195 Cutting removal, m3/a 68.8 69.0 162.9 80.5
193 -saw log              34.6 49.8 76.5 48.2
370 Net revenues, FIM/a   8417.9 11986.2 23618.0 12646.0
800 Roadside value,FIM   417273                801256

=====
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/SD,4%  solution is optimum
=====

```

	1996	2006	2016	2026	2036
804 NPV 4 %	854076				1315680
537 Forestry land area	46.1				
700 Volume, m3	4948.8	5412.6	6013.4	5745.0	6416.9
697 -saw log	2382.1	2677.3	2968.5	2712.2	3312.4
090 Increment, m3/a	229.0	249.1	249.6	260.7	
002 -clear cutting	0.3	0.1	0.2	0.2	
195 Cutting removal, m3/a	168.8	170.6	265.7	184.6	
193 -saw log	97.0	112.3	146.7	112.2	
370 Net revenues, FIM/a	23048.3	28032.8	41802.4	30830.5	
800 Roadside value,FIM	942614				1305496

## 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
WR_WR_P5_O.RSD	initial data file (a copy from WR.RSD)

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 files
FZ_sub_unit_S4_O.MSD	forest level summary files
FZ_sub_unit_S4.SMS	standwise simulation instruction files
MELAOPT session log	see Example H.37
FZ_S4.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 I, the definitions of the C\_VARIABLES parameter must not present in your **MELA\_SET.PAR** file. Before step II, you have to copy the initial data file **WR.RSD** to **WR\_WR\_P5\_O.RSD**.

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_0 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 *
1<>mela<> 90401 143610
=====
WR - P5-CUTTING POTENTIAL-NPV 5 % - 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	3908.6	2711.1	2751.4	2770.5
Pine	2658.5	3641.2	2430.2	2360.0	1837.9
Spruce	506.5	155.3	38.2	142.9	540.5
Birch	81.8	32.1	25.5	35.5	43.0
Other deciduous	38.1	80.0	217.2	213.0	349.1
Saw log	1009.3	1109.6	1021.3	1053.5	569.3
Pulpwood	2065.8	2509.5	1515.1	1542.3	2053.4
VALUE (roadside prices), FIM	592238	651451	479928	500890	468166
NET PRESENT VALUE (NPV) 3%	792543	851870	762008	804042	758385
	1996	2006	2016	2026	2036
INCREMENT, m3/a	189.0	166.0	155.8	182.1	
Pine	159.2	142.0	124.5	126.0	
Spruce	16.1	6.8	15.7	39.8	
Birch	4.3	2.8	2.2	1.9	
Other deciduous	9.3	14.4	13.4	14.3	
TOTAL DRAIN, m3/a	126.7	285.8	151.8	180.2	
Mortality	4.4	4.3	4.1	2.9	
Cutting drain	122.3	281.4	147.7	177.2	
CUTTING REMOVAL, m3/a	117.8	269.0	141.5	175.8	
Over story removal	0.0	6.6	23.6	13.8	
Thinnings	15.8	141.0	62.3	23.4	
Regeneration cuttings	102.0	121.4	55.6	138.5	
Pine	57.9	252.2	128.7	175.1	
Spruce	49.6	15.9	4.1	0.0	
Birch	7.3	0.8	0.4	0.7	
Other deciduous	3.1	0.0	8.4	0.0	
Saw log	73.6	95.2	70.1	110.7	
Pulpwood	44.2	173.8	71.4	65.0	
TOTAL CUTTING AREA, ha/a	0.9	2.2	1.9	1.3	
Thinnings	0.3	1.4	1.0	0.2	
Clear cuttings	0.5	0.0	0.0	0.6	
Over story cuttings	0.0	0.2	0.6	0.3	
Seed tree cuttings	0.1	0.6	0.3	0.1	
Shelterwood cuttings	0.0	0.0	0.0	0.0	
REGENERATION AREA, ha/a	0.6	0.6	0.3	0.7	
Artificial regeneration	0.5	0.0	0.0	0.6	
Natural regeneration	0.1	0.6	0.3	0.1	
TENDING YOUNG STANDS, ha/a	0.2	0.2	0.6	0.3	
GROSS REVENUES, FIM/a	28094.3	50009.9	28732.5	38728.6	
TOTAL COSTS, FIM/a	9699.8	16986.4	9752.4	10937.0	
NET REVENUES, FIM/a	18394.4	33023.6	18980.1	27791.6	

```

=====

```

**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 *
1<>mela<> 100401 95239
=====
FZ - S4-MAXIMUM SUSTAINED YIELD-NPV 4% - all:
-----
                1996    2006    2016    2026    2036
FORESTRY LAND AREA, ha      195.4   195.4   195.4   195.4   195.4

TOTAL VOLUME, m3
Pine          18472.0  18748.1  18209.9  18231.8  18963.5
Spruce        9597.5   11687.0  10953.8  10724.6  9782.3
Birch         6490.1   4875.7   5143.3   5023.1   5998.2
Other deciduous 2073.7   1900.4   1667.3   2169.4   2716.2
Saw log       310.6     284.9    445.5    314.7    466.7
Pulpwood      7503.8   7352.2   7273.3   6998.8   7193.6
              9772.1  10186.5  9902.0  10260.7  10635.6
-----
VALUE (roadside prices), FIM 3413323 3417490 3330339 3360431 3453438
NET PRESENT VALUE (NPV) 3%   3926802 4085209 4186881 4311575 4479153
-----
                1996    2006    2016    2026    2036
INCREMENT, m3/a
Pine          813.2     792.5    821.4    885.9
Spruce        478.0     490.9    479.4    476.6
Birch         231.0     204.8    219.6    263.8
Other deciduous 84.3      72.4     98.5    125.3
              19.9      24.3     24.0     20.2

TOTAL DRAIN, m3/a
Mortality     785.6     846.3    819.2    812.7
Cutting drain 27.8      32.3     24.3     20.1
              757.8     814.1    794.9    792.6
-----
CUTTING REMOVAL, m3/a
Over story removal 722.6     775.5    775.5    775.5
Thinnings    10.9      106.6     84.3     60.9
Regeneration cuttings 185.4     233.1    349.1    439.4
              526.3     435.9    342.1    275.2

Pine          249.1     526.5    486.8    551.1
Spruce        374.8     164.5    225.0    163.3
Birch         84.4      80.4     36.7     59.8
Other deciduous 14.3      4.2      27.0     1.3

Saw log       399.5     399.5    399.5    414.8
Pulpwood      323.1     376.0    376.0    360.7
-----
TOTAL CUTTING AREA, ha/a
Thinnings     6.6       7.7      6.8      7.7
Clear cuttings 3.2       3.1      3.7      5.4
Over story cuttings 1.4       0.9      0.4      0.9
Seed tree cuttings 0.2       2.3      1.4      1.1
Shelterwood cuttings 1.2       1.2      1.1      0.2
              0.5       0.2      0.2      0.0

REGENERATION AREA, ha/a
Artificial regeneration 3.5       2.3      1.7      1.2
Natural regeneration 1.7       0.9      0.4      0.9
              1.8       1.4      1.3      0.2

TENDING YOUNG STANDS, ha/a
              2.3       2.5      2.3      2.4
-----
GROSS REVENUES, FIM/a      155229  162357  159871  160197
TOTAL COSTS, FIM/a        52398.5 49933.8 46417.5 46743.0
NET REVENUES, FIM/a       102830  112423  113454  113454
=====

```

**Example H.37.** A MELAOPT session log for a sub-unit in the problem dealing with the imported summary data as a part of the solution.

```

* MELAOPT session log * (excerpts)

* <clip>... Part of the report was cut out ... <clip>

MELAOPT> REPORT SOLUTION DISTRICT=F2:

=====
<>MELA<>   FZ - DISTRICT=F2:
           S4-MAXIMUM SUSTAINED YIELD-NPV 4% solution is optimum
-----
                1996      2006      2016      2026      2036
-----
804 NPV 4 %                434367                                324554
537 Forestry land area      24.1
700 Volume, m3              2829.4  3106.1  2834.0  2110.2  1334.9
697 -saw log                1224.6  1532.9  1442.7   878.3  341.3
090 Increment, m3/a          116.9   105.8    90.3   83.7
195 Cutting removal, m3/a    82.4   117.5   155.7  155.3
193 -saw log                 42.8    80.6   103.8   94.7
370 Net revenues, FIM/a     10856.1 20243.5 27326.4 24712.8
800 Roadside value,FIM      525340                                215717
-----
MELAOPT>
    
```

**Example H.38.** A MELAOPT solution report for the imported sub-unit.

```

* FZ_S4.SOL *

S4 FZ

=====
<>MELA<>   FZ - REGION=WR WR P5 O:
           S4-MAXIMUM SUSTAINED YIELD-NPV 4% solution is optimum
-----
                1996      2006      2016      2026      2036
-----
804 NPV 4 %                593901                                565163
537 Forestry land area      29.6
700 Volume, m3              3285.0  3908.6  2711.1  2751.4  2770.5
697 -saw log                1009.3  1109.6  1021.3  1053.5  569.3
090 Increment, m3/a          189.0   166.0   155.8  182.1
195 Cutting removal, m3/a    117.8   269.0   141.5  175.8
193 -saw log                 73.6    95.2    70.1  110.7
370 Net revenues, FIM/a     18394.4 33023.6 18980.1 27791.6
800 Roadside value,FIM      592238                                468166
-----
    
```

## JLP mode in MELAOPT

### Commands

```
>MELAOPT
MELAOPT>SOLVE SD FX
MELAOPT>JLP
jlp>include cc.prb
jlp>solve
jlp>mrep SOLUTION
jlp>end
MELAOPT>EXIT
```

### Arguments

SD	see SD.MDL
FX	see FX.PAR
cc.prb	see cc.prb

### 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
FX_FX_SD.SOL	solution report file, see e.g. Examples H.20 and H.37

### 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 cuttings 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 *
> * MAXIMUM SUSTAINED YIELD - NO CLEAR CUTTING IF OWNER =2
> * exclude management schedules with clear cutting if owner =2
> xtran
> clearcut=x1002+x2002+x3002+x4002
> if OWNER.eq.2.and.clearcut>0 then reject
> /
> prob cc - MAXIMUM SUSTAINED YIELD, 4%
making x-variables: clearcut,reject
number of rejected schedules: . . . . . 382
> 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	2.898505	1705134.	2666625.	
2	0.1624846E-02	-664.6153	1494.858	
3	0.2151557E-02	-1424.974	1979.432	
4	0.2759729E-02	-1896.011	2538.951	
5	0.7747741E-03	-262.8968	712.7922	
6	0.1069062E-02	-299.1159	983.5372	
7	0.1498531E-02	-299.1159	1378.649	
8	0.2279979	-75997.44	209758.1	
9	0.3074256	-197760.1	282831.5	
10	0.4316268	-272548.9	397096.7	
11	6.978792	732482.0	6420489.	

```
> * domains for reporting
> show/domain
> OWNER=0:
> OWNER=2:
> /
```

```

* JLP session log (page 2/3) *

jlp> solve
starting optimization...
ok(1)  constr.   2:  55.930994    w+z basics:   0   0
ok(1)  constr.   3: 108.85703    w+z basics:   0   0

* <clip>... Part of the report was cut out... <clip>

ok(1)  constr.   9: 11944.817    w+z basics:   0   0
ok(1)  constr.  10: 40578.129    w+z basics:   0   0
ok(1)  constr.  11: 2573620.4    w+z basics:   0   0
**FEASIBLE
**OBJECT VARIABLE:  2328329.5    w+z basics:   0   0
unit=   1, OBJ VAR= 2334918.3    w+z basics:   0   0
unit=   1, OBJ VAR= 2593573.8    w+z basics:   1   0
* <clip>... Part of the report was cut out... <clip>

unit=   1, OBJ VAR= 2651047.9    w+z basics:   4   0
unit=   1, OBJ VAR= 2651190.4    w+z basics:   4   0
**SOLUTION, OBJ VAR= 2651190.4    w+z basics:   4   0 unit=  53
*s* solution,

```

---

```

DOMAIN all: 92 units

```

row	value	shadow price	lower bound	upper bound
1) x0804 . . . . .	2651190.39	1.00000000	max	
2) x2195-x1195 . . . . .	131.558103	0.00000000	0.000000	
3) x3195-x2195 . . . . .	0.00000000	-20.257440	0.000000	L
4) x4195-x3195 . . . . .	0.00000000	-4.5652446	0.000000	L
5) x2193-x1193 . . . . .	110.332789	0.00000000	0.000000	
6) x3193-x1193 . . . . .	105.425532	0.00000000	0.000000	
7) x4193-x1193 . . . . .	126.734029	0.00000000	0.000000	
8) x2370-x1370 . . . . .	34876.9760	0.00000000	0.000000	
9) x3370-x2370 . . . . .	0.00000000	-0.1730322	0.000000	L
10) x4370-x3370 . . . . .	0.00000000	-0.2427731	0.000000	L
11) x4804-1.2*x0804 . . . . .	1449776.87	0.00000000	0.000000	

---

x-variable	value	shadow price	cost of decrease	cost of increase
x0804 . . . . .	2651190.39	1.00000000	1.00000000	INF
x4804 . . . . .	4631205.48	0.00000000	0.00595266	0.00847312
x0537 . . . . .	195.398999		INF	INF
x0700 . . . . .	18471.9526		INF	INF
x1700 . . . . .	20871.4784		2.25866120	0.28262969

```

* <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 . . . . .	1137044.23	0.15398325	0.03948194
x4804 . . . . .	1455408.82	0.01653785	0.01758922
x0537 . . . . .	72.2099992	INF	INF
x0700 . . . . .	6845.22051	INF	INF
x1700 . . . . .	7668.85659	2.25866120	0.51086201

\* <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 %                2651191                4631206
537 Forestry land area      195.4
700 Volume, m3              18472.0 20871.5 21999.3 23502.7 24986.1
697 -saw log                7503.8 9286.5 10471.3 11655.2 13285.1
090 Increment, m3/a         839.2   856.1   864.6   872.5
002 -clear cutting          0.6     0.0     0.2     0.2
195 Cutting removal, m3/a   539.4   671.0   671.0   671.0
193 -saw log                231.4   341.7   336.8   358.1
370 Net revenues, FIM/a     63502.6 98379.5 98379.5 98379.5
800 Roadside value,FIM     3413323                5268624
-----

<>MELA<>  FX - OWNER=0:
          cc-MAXIMUM SUSTAINED YIELD,4%  solution is optimum
-----
          1996    2006    2016    2026    2036
-----
804 NPV 4 %                1137044                1455409
537 Forestry land area      72.2
700 Volume, m3              6845.2 7668.9 8233.7 7454.6 8042.0
697 -saw log                2451.9 2772.7 3421.5 2671.2 3116.0
090 Increment, m3/a         335.1   345.2   361.2   367.3
002 -clear cutting          0.6     0.0     0.2     0.2
195 Cutting removal, m3/a   234.3   255.6   420.7   285.6
193 -saw log                141.4   121.7   231.6   169.1
370 Net revenues, FIM/a     34027.7 36460.2 64182.1 43804.3
800 Roadside value,FIM     1249014                1450474
-----

```

```

=====
<>MELA<>   FX  - OWNER=2:
              cc-MAXIMUM SUSTAINED YIELD,4%   solution is optimum
-----
              1996      2006      2016      2026      2036
-----
804 NPV 4 %                1514146                                3175797
537 Forestry land area      123.2
700 Volume, m3              11626.7 13202.6 13765.6 16048.2 16944.1
697 -saw log                 5051.9 6513.8 7049.8 8984.0 10169.1
090 Increment, m3/a         504.1   510.9   503.4   505.2
002 -clear cutting           0.0     0.0     0.0     0.0
195 Cutting removal, m3/a    305.2   415.4   250.3   385.4
193 -saw log                 90.0    220.1   105.2   189.1
370 Net revenues, FIM/a     29474.9 61919.4 34197.5 54575.3
800 Roadside value,FIM      2164309                                3818150
-----
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

### 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 price	lower bound	upper bound
1) x0804 . . . . .	.2918754.81	1.00000000		max
2) x2195-x1195 . . . .	49.4703418	0.00000000	0.000000	
3) x3195-x2195 . . . .	0.00000000	-48.405486	0.000000	L
4) x4195-x3195 . . . .	0.00000000	-5.2443650	0.000000	L
5) x2193-x1193 . . . .	0.00000000	-34.962821	0.000000	L
6) x3193-x1193 . . . .	0.00000000	-39.213253	0.000000	L
7) x4193-x1193 . . . .	15.0160574	0.00000000	0.000000	
8) x2370-x1370 . . . .	8434.24599	0.00000000	0.000000	
9) x3370-x2370 . . . .	2946.28865	0.00000000	0.000000	
10) x4370-x3370 . . . .	0.00000000	-0.3022395	0.000000	L
11) x4804-1.2*x0804 . .	0.00000000	-0.0093488	0.000000	L

---

x-variable	value	shadow price	cost of decrease	cost of increase
x0804 . . . . .	.2918754.81	0.98878140	1.00000000	INF
x4804 . . . . .	3502505.93	0.00934882	0.83328289	0.00945489
x0537 . . . . .	195.398999		INF	INF
x0700 . . . . .	18471.9526		INF	INF
x1700 . . . . .	18701.8460		1.41433883	1.32966016
x2700 . . . . .	18154.7224		1.93058047	0.17164908
x3700 . . . . .	18271.8790		1.06456623	0.16719858
x4700 . . . . .	19019.3900		0.08472887	0.14725968
x0697 . . . . .	7503.83376		INF	INF
x1697 . . . . .	7307.83851		4.93045979	1.71707885
x2697 . . . . .	7269.19357		4.11864939	1.26278054
x3697 . . . . .	7012.48957		0.03172299	0.24215248
x4697 . . . . .	7204.35261		0.06570819	1.01298973
x1090 . . . . .	813.913593		59.5998199	218.264896
x2090 . . . . .	796.377049		45.9394877	7.50789161
x3090 . . . . .	832.416385		1.25857370	4.64449447
x4090 . . . . .	888.658910		0.77669223	21.9861338
x1195 . . . . .	727.561234	0.00000000	13.8390678	18.9517709
x2195 . . . . .	777.031576	-48.405486	2.02152977	6.67689042
x3195 . . . . .	777.031578	43.1611210	2.02153102	6.67689795
x4195 . . . . .	777.031570	5.24436500	2.02153468	6.67689759
x1193 . . . . .	404.985531	-74.176074	20.9539184	140.188212
x2193 . . . . .	404.985529	34.9628217	20.9539270	50.9238794
x3193 . . . . .	404.985531	39.2132531	20.9538897	57.3019562
x4193 . . . . .	420.001588	0.00000000	0.50382541	4.73724329
x1370 . . . . .	103247.317	0.00000000	0.09235041	0.26517710
x2370 . . . . .	111681.563	0.00000000	0.02371426	0.30498889
x3370 . . . . .	114627.852	-0.3022395	0.43195106	0.03105364
x4370 . . . . .	114627.853	0.30223955	0.43195093	0.03105359
x0800 . . . . .	3413322.47		INF	INF
x4800 . . . . .	3456918.63		0.00032619	0.00154849

---

>

## Example H.42. A MELAOPT MARGINALS report.

```

* FX_S4.MRG *
=====
<>MELA<>  FX - all:
           S4-MAXIMUM SUSTAINED YIELD-NPV 4%      ratkaisu on optimi
-----
                1996      2006      2016      2026      2036
-----
- cost of incr.      *****
804 NPV 4 %          2918755                                3502506
- cost of decr.      1.000                                0.833
-----
- cost of incr.      *****
537 Forestry land area 195.4
- cost of decr.      *****
-----
- cost of incr.      *****      1.330      0.172      0.167      0.147
700 Volume, m3      18472.0 18701.8 18154.7 18271.9 19019.4
- cost of decr.      *****      1.414      1.931      1.065      0.085
-----
- cost of incr.      *****      1.717      1.263      0.242      1.013
697 -saw log          7503.8 7307.8 7269.2 7012.5 7204.4
- cost of decr.      *****      4.930      4.119      0.032      0.066
-----
- cost of incr.      218.265      7.508      4.644      21.986
090 Increment, m3/a      813.9      796.4      832.4      888.7
- cost of decr.      59.600      45.939      1.259      0.777
-----
- cost of incr.      18.952      6.677      6.677      6.677
195 Cutting removal, m3/a 727.6 777.0 777.0 777.0
- cost of decr.      13.839      2.022      2.022      2.022
-----
- cost of incr.      140.188      50.924      57.302      4.737
193 -saw log          405.0      405.0      405.0      420.0
- cost of decr.      20.954      20.954      20.954      0.504
-----
- cost of incr.      0.265      0.305      0.031      0.031
370 Net revenues, FIM/a 103247 111682 114628 114628
- cost of decr.      0.092      0.024      0.432      0.432
-----
- cost of incr.      *****
800 Roadside value, FIM 3413323                                3456919
- cost of decr.      *****                                0.000
=====

```

**Example H.43.** A MELAOPT SCHEDULES report.

```

* FX_S4.SCH * (excerpts)
-----
SCHEDULES OF OPTIMUM SOLUTION                                98
      #FU  #SU  #MU  #SS  S/M
FX      1   1   1    6  1.00
FX      1   1   2    9  1.00
FX      1   1   3   23  1.00
FX      1   1   4    1  1.00
FX      1   1   5   10  1.00
FX      1   1   6    1  1.00
FX      1   1   7    5  1.00
FX      1   1   8    2  1.00
FX      1   1   9    1  1.00
FX      1   1  10    1  1.00
FX      1   1  11    8  1.00
FX      1   1  12    1  1.00
FX      1   1  13    5  1.00
FX      1   1  14   10  1.00
FX      1   1  15    1  1.00
FX      1   1  16    1  1.00
FX      1   2  17    5  1.00
FX      1   2  18    1  1.00
FX      1   2  19   21  1.00
FX      1   2  20    5  1.00

* <clip>... Part of the report was cut out ... <clip>

      FX      1   5  73    1  1.00
      FX      1   5  74    5  1.00
      FX      1   5  75    1  1.00
      FX      1   5  76   14  1.00
      FX      1   5  77    1  1.00
      FX      1   5  78    2  1.00
      FX      1   6  79    1  1.00
      FX      1   6  80   13  1.00
      FX      1   6  81    3  1.00
      FX      1   6  82   17  1.00
      FX      1   6  83   25  1.00
      FX      1   6  84    9  1.00
      FX      1   6  85   27  1.00
      FX      1   6  86    1  0.66
      FX      1   6  86    4  0.34
      FX      1   6  87    1  1.00
      FX      1   6  88    4  1.00
      FX      1   6  89    1  1.00
      FX      1   6  90    2  1.00
      FX      1   6  91    5  1.00
      FX      1   6  92    3  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_S4.SHP *
S4 FX
=====
<>MELA<>   FX - all:
            S4-MAXIMUM SUSTAINED YIELD-NPV 4% solution is optimum
-----

```

	1996	2006	2016	2026	2036
804 NPV 4 %	2918755				3502506
- shadow price	0.989				0.009
537 Forestry land area	195.4				
- shadow price	0.000				
700 Volume, m3	18472.0	18701.8	18154.7	18271.9	19019.4
- shadow price	0.000	0.000	0.000	0.000	0.000
697 -saw log	7503.8	7307.8	7269.2	7012.5	7204.4
- shadow price	0.000	0.000	0.000	0.000	0.000
090 Increment, m3/a	813.9	796.4	832.4	888.7	
- shadow price	0.000	0.000	0.000	0.000	
195 Cutting removal, m3/a	727.6	777.0	777.0	777.0	
- shadow price	0.000	-48.405	43.161	5.244	
193 -saw log	405.0	405.0	405.0	420.0	
- shadow price	-74.176	34.963	39.213	0.000	
370 Net revenues, FIM/a	103247	111682	114628	114628	
- shadow price	0.000	0.000	-0.302	0.302	
800 Roadside value, FIM	3413323				3456919
- shadow price	0.000				0.000

```

-----
row                value                shadow price
-----
OBJ                2918754.818                1.000
x2195-x1195        49.470                    0.000
x3195-x2195        0.000                    -48.405
x4195-x3195        0.000                    -5.244
x2193-x1193        0.000                    -34.963
x3193-x1193        0.000                    -39.213
x4193-x1193        15.016                    0.000
x2370-x1370        8434.246                  0.000
x3370-x2370        2946.289                  0.000
x4370-x3370        0.000                    -0.302
x4804-1.2*x0804    0.000                    -0.009
-----

```

## 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_EVENT2000.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 0 500 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_EVENT2000.PAR
```

**Example H.46.** A MELASIM session log from the re-simulation of the selected management schedules.

```

* MELASIM session log * (excerpts)

MELASIM> SIMULATE/MELA_TABLE#USER.TAB MSR FX S4
.. Original command: SIMULATE/MELA_TABLE#USER.TAB MSR FX S4
.. Parameter interpretation: MELA_TABLE#USER.TAB
.. Command to be returned: SIMULATE/MELA_TABLE#USER.TAB MSR FX S4

* <clip>... Part of the report was cut out ... <clip>

.. in MELA forest resource data (rsd) F1.RSD 9
.. MELA standard binary (MSB) files are used
.. in simulation instructions for stands (sms) FX_F1_S4.SMS 13

.. -> out summary of management schedules (MSC): FX_F1_S4_S.MSC
.. -> out summary of management schedules (MSD): FX_F1_S4_S.MSD
.. -> out summary report (SUM): FX_F1_S4_S.SUM
.. Symbol in: TILAVUUDEN_TASOKORJAUS <> VOLUME_CALIBRATION

* <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 1.00
  4      4.  1 1.00   5      5.  1 0.95   6      5.  1 0.05
  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 1.00
 16    15.  1 1.00  17    16.  1 1.00

.. ** TOTAL:
.. ** CALCULATION UNITS          17
.. ** SIMULATED SCHEDULES       17

* <clip>... Part of the report was cut out ... <clip>

.. in MELA forest resource data (rsd) WR.RSD 9
.. in simulation instructions for stands (sms) FX_WR_S4.SMS 13

* <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 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 0.53   9      8.  1 0.47
 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 1.00

.. ** TOTAL:
.. ** CALCULATION UNITS          15
.. ** SIMULATED SCHEDULES       15

=====
.. <MELASIM> end of execution of the command: MSR FX S4
MELASIM>

```



**Example H.48.** A user-defined summary report from the re-simulation of the selected management schedules.

```

* FX_F2_S4_S.SUM *
l<>mela<> 100401 104310
=====
MSR2000 FX S4 F2
-----
CUTTING REMOVALS, m³/a          1996    2006    2016    2026    2036
-----
TOTAL CUTTING REMOVAL          111.9    112.3    119.7    133.8
Saw logs                       67.3     65.9     84.0     85.0
Pulpwood                       44.6     46.3     35.7     48.8

PINE                            49.5    112.3    78.9     74.4
  ... 10 cm                     0.8       2.4       0.0       0.0
  11 ... 20 cm                  18.6     20.0     14.0       8.2
  21 ... 30 cm                  26.5     89.9     40.7     51.1
  31 ...      cm                   3.6       0.0     24.2     15.1
Saw logs                       25.2     65.9     51.6     51.1
Pulpwood                       24.2     46.3     27.4     23.3

SPRUCE                          62.4     0.0     35.1     56.0
  ... 10 cm                      0.5       0.0       0.0       0.0
  11 ... 20 cm                   12.1     0.0       0.0     19.2
  21 ... 30 cm                   33.2     0.0       0.0     27.2
  31 ...      cm                   16.6     0.0     35.1     9.6
Saw logs                       42.1     0.0     32.5     33.3
Pulpwood                       20.4     0.0       2.6     22.6

BIRCH                           0.0     0.0     0.0     3.4
  ... 10 cm                      0.0       0.0       0.0       0.0
  11 ... 20 cm                   0.0     0.0       0.0       2.1
  21 ... 30 cm                   0.0     0.0       0.0       1.3
  31 ...      cm                   0.0     0.0       0.0       0.0
Saw logs                       0.0     0.0     0.0     0.6
Pulpwood                       0.0     0.0     0.0     2.8

OTHER DECIDUOUS                 0.0     0.0     5.7     0.0
  ... 10 cm                      0.0       0.0       0.0       0.0
  11 ... 20 cm                   0.0     0.0     5.7     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     5.7     0.0
-----
THINNINGS                       32.0     0.0     24.6     34.7
Pine                           8.1     0.0     18.6     0.8
Spruce                         23.9     0.0     0.4     30.5
Birch                          0.0     0.0     0.0     3.4
Other deciduous                 0.0     0.0     5.7     0.0

REGENERATION CUTTINGS          79.9     97.7     65.7     91.0
Pine                           41.4     97.7     30.9     65.5
Spruce                         38.6     0.0     34.7     25.5
Birch                          0.0     0.0     0.0     0.0
Other deciduous                 0.0     0.0     0.0     0.0

OVERSTORY CUTTINGS             0.0     14.6     29.4     8.1
Pine                           0.0     14.6     29.4     8.1
Spruce                         0.0     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_EVENT2000.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 file
F2.MSD	management schedule file
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 file
F2.MSD	management schedule file

### Step II:

MELAOPT session log	
F2_F2_S4.MPS	stand management file
F2_F2_S4_O.MSC	forest level summary file
F2_F2_S4_O.MSD	forest level summary file
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 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.46.

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
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_EVENT2000.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)

STAND_MANAGEMENT_FILES 0 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
```

NOTE: You can also write **mpu** type files using the parameter definition "STAND\_MANAGEMENT\_FILES 1 0". See more information about **mpu** type files in Appendix C.2 and the STAND\_MANAGEMENT\_FILES parameter in Appendix B.2.

**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 '
- , ' voll 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 voll yr_c c fel revs vol2 prop

1 1996 1.8 1 3 0.0 0.0 0 0 0.0 0 2.3 1.00
2 1996 0.9 1 28 5.9 0.0 0 0 0.0 0 0.0 1.00
3 1996 1.4 1 46 15.3 103.9 0 0 0.0 0 168.2 0.68
4 1996 1.1 1 43 14.2 43.4 0 0 0.0 0 86.8 1.00
5 1996 3.8 1 71 20.4 132.2 0 0 0.0 0 188.5 1.00
6 1996 1.1 1 73 18.4 174.2 2001 1 81.1 10164 155.7 0.35
7 1996 1.0 1 66 21.5 128.3 0 0 0.0 0 182.4 1.00
8 1996 0.2 2 86 27.2 242.6 0 0 0.0 0 298.8 0.12
9 1996 0.6 2 3 0.0 120.0 0 0 0.0 0 182.5 0.42
10 1996 0.9 1 70 19.5 50.5 0 0 0.0 0 50.2 1.00
11 1996 3.3 1 110 20.3 125.0 2001 5 114.7 14768 27.9 1.00
12 1996 2.2 4 38 10.9 71.0 0 0 0.0 0 125.3 1.00
13 1996 1.7 2 45 15.6 115.4 0 0 0.0 0 185.2 1.00

.. Management report records in total 13

```

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  
voll volume in the beginning of the first sub-period (in 1996), m<sup>3</sup>/ha  
yr\_c cutting year in the middle of the first sub-period  
c cutting method  
fel cutting removals, m<sup>3</sup>/ha  
revs net revenues, FIM/ha  
vol2 volume at the end of the first sub-period (in 2006), m<sup>3</sup>/ha  
prop proportion of this management schedule in the solution



# List of Examples

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# List of Examples

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## List of Examples

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# Glossary

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In the glossary, some concepts and terms are explained such as they are used in the MELA context and in the MELA Handbook.



# Glossary

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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.

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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 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.
FORTTRAN	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 administrative 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	<p>The land area is divided into forestry and non-forestry land in the FNFI (see Salminen 1993). Definitions of the forestry land categories are as follows:</p> <ul style="list-style-type: none"> <li>• Forest land has the potential stemwood production capacity at least 1 m<sup>3</sup>/ha/a on the average during the recommended rotation period.</li> <li>• Scrub land has the potential stemwood production capacity from 0.1 to 1.0 m<sup>3</sup>/ha/a.</li> <li>• Waste land, if not naturally treeless, has lower potential stemwood production capacity than 0.1 m<sup>3</sup>/ha/a.</li> <li>• Other forestry land cannot be used for timber growing for permanent or temporary reasons (for example forest roads and timber depots).</li> </ul> <p>Non-forestry land is divided into the following categories:</p>

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	<ul style="list-style-type: none"> <li>• Agricultural land consists of arable and pasture land as well as associated waste land and farm tracks.</li> <li>• Built-up areas consist of urban, semi-urban and other settlement areas as well as industrial areas.</li> <li>• Roads, power lines, etc. are roads, railways, airfields, power lines and similar areas outside urban and semi-urban areas.</li> <li>• Lakes and rivers.</li> <li>• Sea.</li> </ul>
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	Felling and forest haulage of timber from the forest to roadside.
logging residue	Parts of stems suitable in size or quality neither for pulpwood nor for 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.

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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 the definition of a optimization problem in the JLP problem paragraph (or in the respective 'prob' section of a MELA <b>mdl</b> type file).
production program	An 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	A 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	A terminal for timber before the long-distance transportation to the mill.
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 the tree distribution) on a sample plot. See also management unit and sample plot.
saw log	The part of a stem 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	A 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	An (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 the 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: <ul style="list-style-type: none"> <li>• Very rich sites on mineral soil or peatland.</li> <li>• Rich sites on mineral soil or peatland.</li> <li>• Damp sites on mineral soil or peatland.</li> <li>• Sub-dry sites on mineral soil or peatland.</li> <li>• Dry sites on mineral soil or peatland.</li> </ul>

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	<ul style="list-style-type: none"><li>• Barren sites on mineral soil or peatland.</li><li>• Rocky or sandy areas.</li><li>• Open mountains.</li></ul>
solution	The result of the 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 x variables or management schedule ( <b>msc</b> and <b>msd</b> type) files respectively in MELA.
xtran	A JLP command for transformations of x variables. See transformation and x variable.
xvar	A JLP command for the definition of x variables (or decision variables) to be read in (from the management schedule ( <b>msc</b> and <b>msd</b> type) files) for the subsequent JLP problem definitions (in the respective 'prob' section of a MELA <b>mdl</b> 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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# Finnish Terms

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H50\_KALIBROINTI; 210  
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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.

Please, send your message to: **MELA Team, The Finnish Forest Research Institute  
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This is ( ) an inquiry, ( ) a suggestion or ( ) the description of an error encountered concerning ( ) the MELA software or/and ( ) the MELA Handbook.

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