Pan-European Criteria and Indicators for Sustainable Forest Management: Networking Structures and Data Potentials of International Data Sources

DISSERTATION

zur Erlangung des Doktorgrades

des Departments Biologie

der Fakultät für Mathematik, Informatik und Naturwissenschaften

der Universität Hamburg

vorgelegt von

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HAMBURG, 2007

Genehmigt vom Department Biologie
der Fakultät für Mathematik, Informatik und Naturwissenschaften
an der Universität Hamburg
auf Antrag von Professor Dr. M. KÖHL
Weiterer Gutachter der Dissertation:
Herr Professor Dr. R. PÄIVINEN
Tag der Disputation: 30. Juli 2007

Hamburg, den 10. Juni 2007

Professor Dr. Reinhard Lieberei
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Acknowledgements

A few people have made very important contributions to this PhD thesis. I am grateful to all of them.

First and foremost, I would like to thank my primary advisor, PROF. MICHAEL KÖHL (Head of the Institute for World Forestry, University of Hamburg, Germany). His wealth of expertise and his constructive comments and guidance have been of great value for me and my thesis. I am indebted to PROF. KÖHL for providing me with the fantastic opportunity to work in his institute and to be – in addition to the PhD – involved in several interesting research projects and to cooperate with several other national and international research partners.

In this context, I especially would like to thank my second advisor, PROF. RISTO PÄIVINEN (Director of the European Forest Institute (EFI), Joensuu, Finland). The cooperation with the EFI has been very important to my study. I had the great chance to spend three month at the EFI in autumn 2005, concentrating on my thesis. For this opportunity I would like to thank EFI staff for their enthusiasm, their assistance and fantastic working environment. Special acknowledgements go to ANDREAS SCHUCK (EFI) and JO VAN BRUSSELEN (EFI) for their inspiring discussions and inputs during my stay. Furthermore, I would like to thank TIM GREEN (EFI) for his excellent final English review.

I am also very grateful to my fellow colleagues at the Institute of World Forestry. Their assistance and companionships were very important in many phases of my PhD. From the Institute of World Forestry, I especially would like to thank DR. THOMAS SCHNEIDER for his valuable information and fruitful discussions about international processes relevant to my study backgrounds. I also thank RICHARD FISCHER from the PCC of the ICP Forests, for taking some valuable time and providing profound input to analyse C&I data potentials of the joint monitoring programme of ICP Forests/ Forest Focus. Many thanks go also to DR. JUTTA POKER for her motivating comments on my thesis introduction and final discussion.

From the international community, I especially would like to thank two persons: ALEXANDER KOROTKOV from the UNECE Timber Section in Geneva, and ROMAN MICHALAK from the MCPFE Liaison Unit in Warsaw. Their interest and encouragement in my research was always motivating and inspiring – especially when starting this thesis.

Finally, I would like to express my deepest gratitude to ANNETTE MEYER for everything – from very important editorial support to encouraging emotional support. I know that reading my thesis was surely not the biggest fun in your life, but your support was highly important for accomplishing it. Thank you for always being there for me and following my research activities with immense patience from the very beginning.

Executive Summary

At the fourth Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 2003, a revised set of pan-European Criteria and Indicators (C&I) were adopted as a common policy instrument for evaluating and reporting on Sustainable Forest Management (SFM) at the pan-European and national levels. To support and to improve C&I implementation, this study shows different approaches to describe and analyse C&I data potentials and data flows of international data sources – which is relevant for the improvement of pan-European monitoring, assessment and reporting on SFM. In addition, this study gives insights into the theory of C&I network correlations, pointing out and discussing new aspects relevant for the implementation of C&I as an instrument for identifying different cause-effect mechanisms and conflicts of interests within SFM. With respect to the general objective of minimising national reporting burdens, this study shows that a large number of datasets according to the pan-European C&I are already available at the international level. The study highlights the current capacities and deficits within the pan-European monitoring, assessment and reporting on SFM. By taking C&I as a baseline, different information preferences are structured according to different sources and responsible institutions, providing some general overview about different data potentials at international level. A detailed analysis of data potentials and future capacities for supplementing current monitoring towards MCPFE requirements is demonstrated for the joint monitoring programme of the ICP Forests/ Forest Focus. In addition the study Outlook demonstrates some further options for how to analyse data flows and networking structures between different sources and data managing institutions at different levels – which again helps to harmonise and streamline international and national monitoring, assessment and reporting activities. Besides aspects mainly related to the issue of monitoring, assessment and reporting on SFM, the theory and relevance of C&I correlation networks for implementing C&I for management purposes and concept development is demonstrated. By applying approaches of network analysis and linking and setting pan-European indicators into relation, different cause-effect mechanisms between different SFM aspects are illustrated. It is shown that the understanding of cause-effect mechanisms between different SFM aspects is fundamental to identifying appropriate management, but also to monitoring concepts in consideration of various policy objectives at different levels.

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1 Introduction

Good information is hard to get. It is even harder to use it appropriately. (Sir Arthur Conan Doyle, 1859 - 1930)

The origin of "*Sustainability*" has its roots in forestry. It was first mentioned in a Saxonian forest law in the 17th century and later described by H.C. von Carlowitz in 1713 (see Speidel, 1984). Today sustainability is a term utilised in the entire environmental and economic context. Sustainability is accepted as a general principle of forest management also at the global policy level, last but not least since it was laid down in the Agenda 21 of the United Nations Conference on Environment and Development (UNCED, 1992).

However, as different views and concepts on Sustainable Forest Management (SFM) developed in different regions over time, the formulation of a common definition of SFM and its assessment and valuation according to this definition is complex and challenging. To improve SFM implementation at all levels, the UNCED called for the formulation of scientifically sound criteria and guidelines for the management and sustainable development of all types of forests (UNCED, 1992). In order to facilitate the implementation of the forest related UNCED decisions, several regional processes were launched.

In Europe the Ministerial Conference on the Protection of Forests in Europe (MCPFE) is the political initiative for cooperation of about 40 European countries and the European Union. At the second MCPFE in 1993, a common definition of SFM was agreed in Resolution H1 "*General Guidelines for the Sustainable management of Forests in Europe*" (MCPFE, 1993; MCPFE, 2000b). Based on that, pan-European Criteria and Indicators (C&I) were developed as a common policy instrument for evaluating and reporting on progress towards defined SFM at the pan-European and national levels. At the fourth MCPFE in 2003, six pan-European criteria and a revised

set of 35 quantitative indicators were officially adopted (MCPFE, 2002a; MCPFE, 2003).

The monitoring, assessment and reporting on SFM[1] according to the pan-European C&I is conducted at the national level, meaning that countries are asked to supply several national datasets according to a list of specific indicators. As countries have to fulfil several reporting obligations towards various international commitments (see EEA[2] Reporting Obligation Database (ROD)[3]), a tremendous amount of data and information on the *ecological*, *economic* or *socio-cultural* aspects of SFM are already available at the international level.

Due to the various SFM aspects that are concerned and described by the pan-European C&I, the implementation of C&I either for monitoring, assessment and reporting on SFM, but also as a baseline for forest management concepts, is restricted by different objectives and conflicts of interests. Different objectives of monitoring are, for example, described by different applied definitions or methodologies of data assessment (see e.g. EC EFICS, 1997; Päivinen and Köhl, 2005). Within forest management, conflicts of interests might arise due to different objectives of SFM, such as between increasing net revenue of forest enterprises by timber production and maintaining forest biodiversity by increasing the amount of deadwood (see Glück, 1982; McNeely, 1994).

To support and to improve C&I implementation, the **Concept of a C&I Network** is developed and described in this study by different approaches. By applying this concept the **major objectives** of this study are:

a) to support any initiatives to harmonise and streamline the pan-European monitoring, assessment and reporting on SFM at national and international levels

b) to describe the different cause-effect mechanisms between different SFM aspects relevant for developing and defining different forest management and monitoring concepts in consideration of different objectives at different levels.

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[1] "Monitoring, assessment and reporting on SFM" is a term officially used by UNFF, FAO and UNECE (see e.g.: UNFF 2003; UNFF 2004; FAO/UNECE 2006)
[2] EEA: European Environment Agency
[3] EEA Reporting Obligation Database, see: http://rod.eionet.europa.eu/index.html

The main objective of this study is to analyse *data potentials*, *data flows* and *networking structures* of international data, data collection systems and data services respective to the pan-European C&I, in order to minimise the national reporting burden. The analysis of data potentials in this study reveals in how far international sources are able to provide data according to the MCPFE C&I requirements. Data potentials describe in differentiated detail in how far data are available to fulfil certain data requirements. Within this study **data potential**[4] is defined as the following:

Data potential characterise in different categories in how far available data or available data assessments (e.g. methodologies of data assessment, analysis and evaluation) or data storage and maintenance fulfil specific data requirements, defined by applied nomenclature, definitions, data classifications, reporting units and data format as well as by the temporal and spatial resolution of data.

Data flows and *networking structures* describe the different linkages between different data sources or data managing institutions, specifically considering the processes of data collection, data maintenance and data dissemination.

Following the main objectives, this study comprises **three Approaches** and **one Outlook**:

Approach 1 provides a comprehensive overview of "*Where to find which forest data*" at the pan-European level. By using the pan-European C&I as a baseline a large amount of various internationally relevant data sources are structured, organised and analysed according to their C&I data potentials (see Chapter 4). Due to the limited framework of this study, Approach 1 presents an overview of whether an indicator is potentially covered or not. Thus, differences in applied definitions, and temporal and spatial resolutions, etc. are not considered (see also Approach 3). The overview answers the questions of which indicators are mainly covered by which international sources, and where the data deficits are with regard to the reporting on pan-European C&I.

Approach 2 analyses and evaluates the multiple facets of C&I correlations and network linkages by means of network analysis. Correlations or network linkages describe certain relationships or cause-effect mechanisms between certain SFM aspects, such as

[4] Defined by the author.

between the effects of *deposition of air pollutants* on *timber increments* or the correlation between *wood consumption* and *trade in wood*. By taking into account the MCPFE background document (MCPFE, 2002a), where each of the 35 quantitative indicators is described, the different correlations between the 35 indicators and also between the six criteria are visualised and analysed (see Chapter 5). On this basis, Approach 2 questions the assumption that all six SFM criteria are mutually interlinked with each other as it is generally presumed in the theory of mutual balanced SFM (see e.g. Wolfslehner et al., 2005).

Based on the joint monitoring programme of ICP Forests[5]/Forest Focus[6] as a case study, **Approach 3** demonstrates the complexity of analysing *detailed data potentials* with regard to the specific MCPFE data requirements. In line with currently ongoing discussions and processes related to the new European Commission (EC) strategy to monitor forests in Europe (see Landmann, 2006), detailed data potentials and future capacities of the joint monitoring programme towards MCPFE C&I reporting are analysed and described (see Chapter 6).

The **Outlook** outlines and discusses three different options to model a multi-level pan-European C&I Information Network – a network that could help to organise and improve the understanding of the complexity of pan-European monitoring, assessment and reporting on SFM (see Chapter 7).

Although major findings are partly discussed in each approach, the outputs and conclusions of this study are summarised and considered in a final **Discussion** (see Chapter 8). On the one hand, the discussion takes into account C&I as a baseline for forest management and concept development. On the other hand, it focuses on different aspects of C&I implementation for improving pan-European monitoring, assessment and reporting on SFM, keeping in mind the study **Backgrounds** (see Chapter 2).

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[5] International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests operating under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP).
[6] Community scheme for harmonised, broad-based, comprehensive and long-term monitoring of European forest ecosystems (see EC Regulation No. 2152/2003 Forest Focus).

2 Backgrounds

2.1 Sustainable Forest Management – an international challenge

2.1.1 The concept of Sustainable Forest Management (SFM)

Sustainability, sustainable development, sustainable management and sustainable use have become frequently used terms within today's vocabulary in almost all fields of human activities such as politics, economics and natural science.

The term sustainability has its origins in the European forestry literature of the 17th and 18th centuries. The term "*Nachhaltigkeit*" was first related to the sustainable yield of forest resources and first mentioned in the literature by the German Hanss Carl von Carlowitz. He stressed that "*forest resources should be used with caution to achieve continuity between increment and fellings*" (von Carlowitz, 1713). Later, the idea of sustainability of wood use was extended to several other aspects of forestry (see Speidel, 1967; Speidel, 1984) and defined as the following: "*Sustainability describes the ability of forestry to utilise wood continuously and optimally and provide infrastructural services and other goods for the benefit of present and future generations*" (Speidel, 1972). Nowadays "*Sustainability*" describes a general concept which aims to ensure that goods and services derived from any resource meet present-day needs while at the same time securing continuing availability of these goods and services. Based on that common understanding the Brundtland Commission (1987) defined sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*".

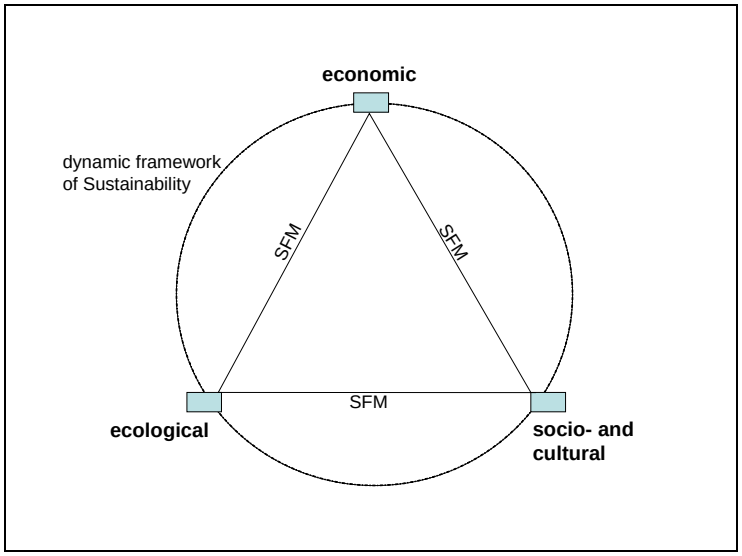
Forests are seen as multifunctional systems serving society with a multitude of goods and services (see Dieterich, 1953). Traditionally, the most important function of forests has been (and still is in many parts of the world) their use as a renewable source of timber, but also of other non-wood goods such as resin, cork, mushrooms and berries.

Environmental benefits of forests – such as biodiversity and landscape conservation, impact on global and regional climates, and water and soil protection – are highly valued, even if not necessarily expressed in monetary terms (FAO, 2000). Besides their economic and ecological role, forests offer also many other benefits, which are increasingly being re-discovered as useful to society. In Europe, increasing leisure time, for instance, has made the recreational use of forests important socially. Over the last decade, increasing attention has been paid to the role of the world's forests in the carbon cycle and the issue of climate change (EU, 2003).

Forests are generally managed in order to fulfil several functions simultaneously considering the principles of sustainability. According to the FAO (2005a) *Sustainable Forest Management (SFM)* implies various degrees of deliberate human intervention, ranging from actions aimed at safeguarding and maintaining the forest ecosystem and its functions, to favouring specific social and economic functions such as favouring certain tree species for the improved production of goods and services.

The concept of SFM aims to find the balance between the various economic, environmental and social aspects of the conservation and multiple uses of forests. As the meaning and interpretation of sustainability changes over time, depending on the various and changing goals of society, sustainability can be regarded as a dynamic framework rather than a static one (see Fig. 1). The dynamic character influences the implementation and long-term achievement of SFM, but also its monitoring, assessment and reporting on international, national and sub-national levels.

Fig. 1: The concept of SFM



Sustainability as a general principle of forest management at the global level was laid down in Agenda 21 of the United Nations Conference on Environment and Development (UNCED, 1992a). Within the so-called "*Forest Principles*"[1] the UNCED declared "*to support the management, conservation and sustainable development of all types of forests, both natural and planted, in all geographical regions and climatic zones*" (UNCED, 1992b). The Forest Principles are a non-legally binding, but authoritative statement of principles which were meant to be a global approach.

Following the UNCED decision to apply the Forest Principles, but also other decisions of the UNCED at regional and national levels, the Ministerial Conferences on the Protection of Forests in Europe (MCPFE) continued its dialogue and process to foster the understanding and promotion of SFM at the European level (see also Chapter 2.2). At the 2nd MCPFE, which was held in Helsinki in 1993, a central theme was SFM and discussions resulted in Resolutions H1[2] and H2[3] which set out general guidelines for the sustainable management of forests in Europe and the protection of their biodiversity. Resolution H1 was of particular importance as it contained for the first time a European commonly accepted definition of SFM:

"*Sustainable management means the stewardship and use of forests and forest lands in such a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems*" (MCPFE, 1993 (p. 5)).

2.1.2 The development of Criteria and Indicators for SFM

Although the concept of SFM has been discussed and defined by several initiatives and experts, the debates on SFM, which have taken place on national, regional and global levels over the last decade, have centred around two questions (UNECE/FAO, 2001, p.12):

- *What is SFM and how should it be measured*?

[1] Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of all Types of Forests, UN A/CONF.151/26 (Vol. III).
[2] H1: General Guidelines for the Sustainable Management of Forests in Europe.
[3] H2: General Guidelines for the Conservation of Biodiversity of European Forests.

- *How to verify and demonstrate that a particular forest is managed sustainably*?

In addition to the Forest Principles, the UNCED called for the formulation of scientifically sound criteria and guidelines for the management and sustainable development of all types of forests (UNCED, 1992c). Generally in Chapter 40.4 of the Agenda 21 (UNCED, 1992c) the UNCED declares:

"…*indicators of sustainable development need to be developed to provide solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems*."

Already in 1991 the International Tropical Timber Organisation (ITTO) developed a set of criteria and indicators (C&I) for SFM on the Forest Management Unit (FMU) level within the tropics. Within that process, representatives from (tropical) producer- but also consumer- countries were involved (ITTO, 1997). After UNCED, the interest in C&I as a tool to monitor, evaluate and report on progress towards SFM increased rapidly all over the world (Eoronheimo, 2002), and a number of other international (regional) initiatives emerged with the goal of identifying criteria and defining specific indicators corresponding to those criteria (see also below).

In 1993 in consideration of the MCPFE Helsinki resolutions H1 and H2, the Conference on Security and Cooperation in Europe (CSCE) convened a seminar of experts on the subject of "*Sustainable Development of Boreal and Temperate Forests*". The seminar was attended by 150 representatives of 44 countries representing North America, Europe, the former Soviet Union, and Japan. The meeting was designed to examine the concept of sustainable development of forests. The working sessions focused on defining environmental as well as socio-economic criteria for sustainable forest development, and providing potential indicators to assess country-level performance against those criteria. The meeting produced two summary documents – one on possible environmental C&I, and one on possible socio-economic C&I. While these were not consensus documents, participants agreed they would form a useful basis for further discussion. The success of the CSCE seminar led many participating countries to call

for a follow-up, and they continued to work towards specifying a comprehensive *definition of sustainable development of boreal and temperate forests*.[4]

In order to ensure effective follow-up, Canada hosted a small meeting at its embassy in Washington DC in December 1993. At the time, both Canada and the US were interested in bringing the MCPFE (formerly the Helsinki Process) and the post-Montreal C&I process together, but were surprised when representatives of the governments of France, Germany and the UK expressed their preference to remain primarily within the MCPFE.[5] From that point forward the Montreal and Helsinki Processes developed in parallel, but with observers invited from governments to attend each others meetings.[6] [7]

At the pan-European level the MCPFE developed and adopted a catalogue of specific pan-European C&I as a common policy instrument for evaluating and reporting on progress towards SFM as defined by the Helsinki resolution H1 (see MCPFE, 1993). A first draft C&I catalogue was presented at the MCPFE Expert Level Meeting in Geneva 1994. The catalogue was modified and improved up to 2003. The final work resulted in 6 criteria and 35 associated indicators for SFM (see Annex 1), which were officially adopted by the MCPFE in Vienna 2003 (for further details, see Chapter 2.2.2).

By now worldwide C&I are commonly seen as an important instrument to monitor, assess and report progress towards SFM on the international, national and local levels. C&I in addition to National Forest Programmes, support activities and play an important role towards the realisation and implementation of a long-term SFM (MCPFE, 2000a). Approximately 150 countries are active and involved in one or more of the nine regional initiatives for the development and implementation of C&I for SFM (see Table 1). Some countries may be involved in two or more processes, as the activities and interests are overlapping. This counts, for example, for the ITTO

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[4] See: http://www.mpci.org/meetings/01_e.html

[5] Especially the consideration of differences in forest related environmental and social conditions between Europe and North-America lead to a different understanding of what SFM should consider in Europe or within the other temperate and boreal zones such as the United States, Canada or Russia.

[6] See: http://www.iisd.ca/forestry/mont.html

[7] Cooperation has been given within the "*Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests*", or also within the UNECE/FAO "*Team of Specialists on Forest Resources Assessment (1994-2004)"*. At present, both processes jointly cooperate e.g. within the UNECE/ FAO "*Team of Specialists on Monitoring Forest Resources for Sustainable Forest Management in the UNECE Region 2005-2008*".

initiative, where also countries importing tropical timber are involved. These countries are also active within the MCPFE or Montreal Process.

Table 1: International/ regional C&I Initiatives (after FAO 2000 and 2001a)

C&I Process	Number of Countries involved	Number of Criteria	Number of Indicators
ITTO	55	7	66
MCPFE	45	6	35
Montreal-Process	12	7	67
Dry Zone African Process	29	7	47
Tarapoto Proposal of C&I for Sustainability of the Amazon Forest	8	1 global 7 national	7 global 47 national
Near East Process	30	7	65
Lepaterique Process of Central America	7	4 regional 8 national	40 regional 53 national
African Timber Organisations (ATO)	13	28	60
Regional Initiative of Dry Forests in Asia	9	8	49

At the International Conference on the Contribution of Criteria and Indicators for SFM (CICI) in Guatemala in 2003 (FAO, 2003), as well as at the Expert Consultation on Criteria and Indicators for SFM (ECCI) in the Philippines in 2004 (FAO, ITTO, 2004) participants identified seven thematic themes of SFM common to all nine regional and international C&I processes (see Table 2). At the fourth Session of the UNFF held in Geneva 2004, the participants agreed on a resolution which acknowledges these seven thematic themes as a reference framework for SFM and invites countries to consider these elements in the development of national C&I (UNFF, 2004; IISD, 2004). The agreed seven themes cover the six pan-European criteria of the MCPFE (Rametsteiner, 2004)[8]. The FAO have already integrated the seven themes as a common reporting framework for the Forest Resources Assessment 2005 (FAO, 2004 Working Paper, Holmgren).

Table 2: Seven global themes of SFM (UNFF, 2004)

1. Extent of forest resources.
2. Biological diversity.
3. Forest health and vitality.
4. Productive functions of forest resources.
5. Protective functions of forest resources.
6. Socio-economic functions.
7. Legal, policy and institutional framework.

2.1.3 The three Rio-Conventions and the linkage to SFM

Despite the Forest Principles and the call for the formulation of scientifically sound criteria and guidelines for the management and sustainable development of all types of forests, the UNCED in Rio 1992 adopted three conventions relevant for forest management and politics: the *United Nations Framework Convention on Climate Change (UNFCCC)*[9], the *Convention on Biological Diversity (CBD)*[10] and the *Convention to Combat Desertification (CCD)*[11]. The UNCED conventions, coordinated and fostered by their Conferences of the Parties (COP), have given effect to many subsequent regional, national and sub-national policy processes and forest relevant activities.

The UNFCCC concerns the issue of climate change and atmospheric pollution. The primary objective of the UNFCCC is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interfaces with the climate system. The supplementing *Kyoto Protocol* aims to bring Parties closer to achieving the primary objective of the UNFCCC convention. It aims to contribute to this objective by promoting: the reduction of emissions of greenhouse gases; and the removal from the atmosphere and the storage of carbon in long-lasting sinks – e.g. in forests and timber products (see Kyoto Protocol, Articles 3.3 and 3.4). One of the key

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[8] The seventh theme is covered by the pan-European qualitative indicators, covering the national policy, legal, financial and institutional frameworks of SFM.
[9] http://unfccc.int
[10] http://www.biodiv.org/convention/

agreements within the UNCED strategy for sustainable management was the CBD, the main objective of which is the protection of biological diversity and reduction of the current rate of biodiversity loss at the global, regional and national levels. The CCD instead focuses on unsustainable land use, whether it is through deforestation or improper agricultural practices. The CCD concerns the Mediterranean, Sub-Tropical and Tropical countries rather than the Temperate and Boreal zones, where desertification is generally of less relevance.

While it seems that these conventions differ in their main objectives, there are several interlinkages between them. For instance the COP of the CBD has called for strengthened collaboration with the UNFCCC on issues such as the impact on climate change on forest biodiversity and the integration of biodiversity considerations in the implementation of the Kyoto Protocol (CBD, 2003). To foster a common understanding and to find cross-cutting issues between the three conventions, the secretaries of the UNFCCC, the CBD and the CCD held a workshop in Italy in 2004 on *"Forests and Forest Ecosystems: Promoting Synergy in the Implementation of the three Rio Conventions"* (UNCCD, CBD 2004). Although the UNFCCC and its Kyoto Protocol impose the most stringent information requirements on their Parties[12], the three conventions, but also other related policy foundations and programmes like the EU Council Regulation Forest Focus, often require identical information (van Brusselen and Schuck, 2005).

All conventions and their objectives directly or indirectly influence the various objectives and ways of implementing SFM. Although the *Ecosystem Approach*[13] is the primary framework for action under the CBD, the CBD addresses forests directly through the *Expanded Programme of Work on Forest Biological Diversity* (CBD COP 6

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[11] http://www.unccd.int/

[12] Non-delivery of information could be regarded as non-compliance, and that could lead to a legal procedure with possible (direct and indirect) financial implications (van Brusselen and Schuck, 2005).

[13] The **Ecosystem Approach** has been prominent on the agenda of the CBD since the first SBSTTA and the second meeting of the COP in Jakarta in 1995. The CBD definition of the Ecosystem Approach is as follows:
The Ecosystem Approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Application of the ecosystem approach will help to reach a balance of the three objectives of the Convention. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompasses the essential structures, processes, functions and interactions among organisms and their environment. It recognises that humans, with their cultural diversity, are an integral component of many ecosystems (CBD, COP 5 Decision V/6, see: http://www.biodiv.org/).

Decision VI/22, 2002). The CBD Forest Work Programme constitutes a broad set of goals, objectives and activities aimed at the conservation of forest biodiversity, the sustainable use of its components and the fair and equitable use of the benefits arising from the use of forest genetic resources.[14] But also the Ecosystem Approach has several interlinkages to the issue of forests and its sustainable development. The FAO discussion paper *"Sustainable Forest Management and the Ecosystem Approach"* (Wilkie et al., 2003) carries the subtitle "*Two Concepts, one goal*". Wilkie et al. conclude that the Ecosystem Approach and SFM are basically different ways of expressing the same ideas, and that they only differ because they evolved from different origins. On the other hand the paper suggests that the two concepts are not simply different ways of saying the same thing but that there are differences in the scope of application. More or less this has been also concluded between the MCPFE and the *Pan-European Biological and Landscape Diversity Strategy (PEBLDS)*, which is a running strategy under the Ministerial Process *Environment for Europe (EfE)*.[15]

Similar to the CBD, the objectives of UNFCCC have a tremendous influence on the concept developments and understanding of SFM as well. Forests as a sink for carbon dioxide from the atmosphere and the modalities for carbon accounting initiated by the *Kyoto Protocol* where *afforestation, reforestation* and *deforestation* are accountable activities (KP Article 3.3), gave a new impetus to the understanding of the ecologic, economic and social objectives and benefits of SFM. Parameters like *Forest area*, *growing stock and biomass*, *increment and fellings* as well as *tree species composition*, *deadwood* and *forest soils* are becoming a totally new dimension within the management but also within the assessment and monitoring of forests (see Schulze et al., 2002; Frühwald et al., 2002; Karjalainen et al. 2002; Mund, 2004).[16]

2.1.4 The United Nations Forum on Forests (UNFF) and its global challenge

The debate on the conservation and sustainable management of forests worldwide takes place in various processes and initiatives which are jointly called *"the international*

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[14] https://biodiv.org/programmes/areas/forest/default.asp
[15] see output of the MCPFE/ PEBLDS Ad-hoc Working Group meeting in Krakow 2004: Joint position of the MCPFE and the EfE/PEBLDS on the pan-European Understanding of the linkage between the Ecosystem Approach and Sustainable Forest Management (MCPFE/ PEBLDS, 2006).
[16] See also http://www.carboeurope.org/ or also http://www.waldundklima.net

forest regime"[17]. This includes global processes such as the UNFF, the conventions (e.g. UNFCCC, CCD and CBD) and also regional processes such as the MCPFE.[18]

At the global level, the UNFF[19] is the current international forum for the enhancement of the discussions on SFM - specifically to continue the United Nations dialogue with respect to the adoption of a *Non-Legally Binding Instrument (NLBI) on all types of forests* in 2007[20], with the option to negotiate on a *Legally Binding Instrument (LBI)* in the future (see Schneider, 2006).

In order to monitor implementation and achievements respective SFM, the UNFF strongly supports the establishment of monitoring programmes based on C&I (UNFF, 2001; UNFF, 2004). Within the UNFF negotiations on a NLBI the use of C&I are considered as a substantive element of monitoring, assessment and reporting on SFM (UN, ECOSOC E/CN.18/AC.1/2006/2).

The IPF/IFF/UNFF process supports the development and implementation of regional and national C&I for SFM as a basis for common reporting, but also as a tool to promote the understanding of the various dimensions and objectives of SFM on global, national and local levels (see also Chapter 2.2.2).

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[17] *Regime* in this context means the totality of norms, rules, standards and procedures, as expressed in international instruments and other acts (Tarasofsky, 1999).

[18] EU and the "*International Forest Regime*", see:
http://ec.europa.eu/agriculture/fore/various/international_en.htm

[19] The UNFF was established by Economic and Social Council of the United Nations (ECOSOC) in 2000 (Resolution/2000/35) as a subsidiary body of ECOSOC to carry on the work building on the Intergovernmental Panel on Forests (IPF) and Intergovernmental Forum on Forests (IFF) processes. In order to support all forest policy intergovernmental negotiations with respect to the UNCED aftermath, the CSD established in 1995 the IPF. The work of IPF has been continued and supplemented by the IFF which has been launched by the ECOSOC in 1997. The negotiations by IPF and IFF culminated in 2000 in the establishment of the International Arrangement on Forests (IAF). Today UNFF in support of the Collaborative Partnership on Forests (CPF) are the two implementing pillars of the IAF. The CPF comprises about 14 different international organisation and agencies like the FAO, CIFOR, ITTO, World Bank and IUCN but also the Secretaries of UNFCCC, CBD and CCD.

[20] At UNFF-6 the Chairman's Text/Resolution emphasised the importance of strengthening political commitment and action at all levels to implement effectively the sustainable management of all types of forests. The resolution also requested that in order to achieve the global objectives set out in the resolution, the UNFF should conclude and adopt at its seventh session a Non-Legally Binding Instrument (NLBI) on all types of forests.

2.2 The MCPFE and the pan-European C&I for SFM

2.2.1 The MCPFE in brief[21]

To address the most important issues on forests and forestry and to declare recommendations in favour of the protection and sustainable management of forests in Europe, the MCPFE was launched in 1990 as a continuing process and dialogue platform on pan-European level. The MCPFE is a high level political initiative to facilitate co-operation between about 45 MCPFE signatory states and the European Community, and also several national and international stakeholders and organisations of forest policy and science.

The MCPFE has a role in facilitating the development of forest related resolutions, but also in implementing global resolutions and commitments on the management, conservation and sustainable development of forest at a European-wide scale. This concerns in particular all forest related decisions and agreements of the UNCED and its follow-up processes within IPF, IFF and UNFF. There are also strong ties to the United Nations conventions (UNFCCC, CBD and CCD).

Relevant documents of the MCPFE process are adopted resolutions. Implementations of the resolutions concern the signatory states and the European Union. All MCPFE resolutions are Non-Legally Binding Instruments which are put into action at the national and regional levels. Although all resolutions are non-legally binding they have high political relevance in that they facilitate a common understanding, development and implementation of actions towards the protection and sustainable management of forests on the pan-European level. The dialog framework of the MCPFE has strongly supported the communication between forest politics and forest science, and therefore has contributed to a better understanding and cooperation regarding questions relevant to forests and forestry.

So far four Ministerial Conferences have already taken place, which are considered as milestones of European forest policies (MCPFE, 2001c):

- 1990 First Ministerial Conference in Strasburg

- 1993 Second Ministerial Conference in Helsinki
- 1998 Third Ministerial Conference in Lisbon
- 2003 Fourth Ministerial Conference in Vienna

The fifth MCPFE will be held in Warsaw in November 2007. Besides the Liaison Unit and the General Coordinating Committee of the MCPFE, the MCPFE is supported by Expert Level Meetings, Round Table Meetings and Ad hoc Working Groups.[22]

2.2.2 Development and purpose of the pan-European C&I

As already mentioned in Chapter 2.1.2, in 1993, the second MCPFE adopted the Helsinki Resolutions H1 and H2 which contain the general principles for the sustainable management of European forests and the protection of their biodiversity (MCPFE, 1993; MCPFE, 2000b). Resolution H1 contains the definition of SFM. For the purpose of monitoring the implementation of the Helsinki resolutions, the C&I for SFM were developed and adopted at the MCPFE Expert Level Meeting in Geneva in 1994. This first catalogue was presented at the conference of the United Nations Commission on Sustainable Development (CSD) in 1995. This created an important basis, together with the ITTO C&I (1991), and also encouraged and animated other regional processes similar to the MCPFE (e.g. Montreal Process) to develop C&I for SFM. After some improvements the pan-European C&I were officially endorsed as "*a basis for international reporting and the further development of national indicators*" by the third Ministerial Conference in Lisbon in 1998 in the Resolution L2: *Pan-European Criteria, Indicators and Operational Level Guidelines for SFM*.

The following six pan-European Criteria were endorsed (MCPFE, 1998):

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[21] See: http://www.mcpfe.org

[22] *Expert Level Meetings* are attended by representatives of the European states, the European Community and by observers from non-European countries, international organisations and NGOs in the fields of research, forest industry and environment. The representatives of the signatories have a mandate to take decisions regarding the ongoing work between two Ministerial Conferences. Informal *Round Table Meetings* aim at an exchange of information and opinions, providing essential guidance for the Ministerial Process. *Ad hoc Working Groups* are convened to discuss specific subjects, usually of scientific or technical nature. The results are then presented for consideration in the subsequent Expert Level Meeting.

Criterion 1:
Maintenance and Appropriate Enhancement of Forest Resources and their Contribution to Global Carbon Cycles

Criterion 2:
Maintenance of Forest Ecosystem Health and Vitality

Criterion 3:
Maintenance and Encouragement of Productive Functions of Forests (Wood and Non-Wood)

Criterion 4:
Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystems

Criterion 5:
Maintenance and Appropriate Enhancement of Protective Functions in Forest Management (notably Soil and Water)

Criterion 6:
Maintenance of Other Socio-Economic Functions and Conditions

After the first set of pan-European indicators had been developed, experiences had shown that the implementation and the further development of C&I had to be seen as an ongoing process. Knowledge and data collection systems, as well as information needs, have gradually developed further. Thus, initiated through the Lisbon Conference in 1998, the MCPFE decided to improve the existing set of indicators.

An MCPFE Advisory Group[23], representing relevant organisations and experts in Europe, was formed to ensure that broad use is made of existing knowledge on indicators and data collection aspects in Europe and assisted the MCPFE during the improvement process. After four Advisory Group Meetings[24] and one Expert Level Meeting in Vienna 2002 the work resulted in an **improved C&I catalogue – containing 6 criteria and 35 associated quantitative indicators** as well as additional qualitative indicators. The improved catalogue was officially adopted by the MCPFE

[23] Members of the Advisory Group were: Mr. Michael Köhl (IUFRO/ UNECE Team of Specialists TBFRA 2000), Mr. Thomas Haußmann (ICP Forests), Mr. Tor-Björn Larsson (European Environmental Agency), Mr. Risto Päivinen (European Forest Institute), Mr. Derek Peare (IWGFS/Eurostat) and Mr. Christopher Prins (UNECE/FAO).
[24] Triesenberg Liechtenstein, March 2001; Copenhagen Denmark, September 2001; Budapest Hungary, January 2002; Camigliatello Silano Italy, May 2002

Vienna Conference in 2003 (see Annex 1). Two related background documents were compiled by the MCPFE Liaison Unit Vienna:

The *Background Information for Improved Pan-European Criteria and Indicators for SFM* (MCPFE, 2002a) gives detailed information on rationales, international data provider, measurement units, current periodicity of data availability, and reporting notes. In the document on *Relevant definitions Used for the Improved Pan-European Indicators for SFM* (MCPFE, 2002b) all terms of the improved indicators are defined.

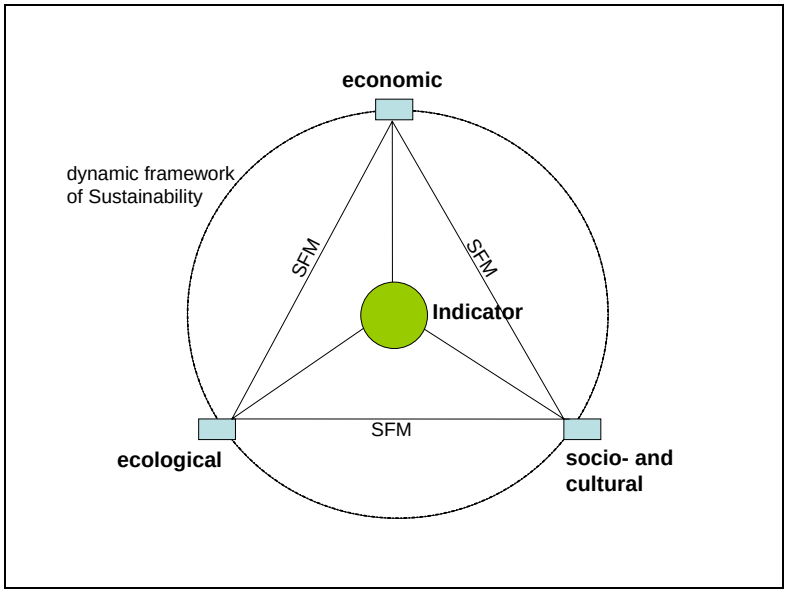
The MCPFE defines Criteria and Indicators as the following (MCPFE, 2002a):

- ***Criteria*** characterise or define the essential elements or set of conditions or processes by which SFM may be assessed.
- ***Indicators*** show changes over time for each criterion and demonstrate the progress made towards its specified objective.

In principle, C&I were developed as a common policy instrument – a common tool to monitor, evaluate and report progress towards SFM covering the economic, ecological and social-cultural aspects. The **six criteria** represent the common consensus achieved by the MCPFE member states and the European Commission on the most important aspects of SFM (FAO, 2003). The fulfilment of the six criteria can be evaluated through the **35 quantitative indicators**. By collecting and reporting national data regarding the specific information requirements of the quantitative indicators, these indicators show changes over time for each explicit criterion and demonstrate the progress made towards its specified objectives (MCPFE, 2000a). Additionally **17 qualitative indicators** describe the overall policies, institutions and instruments regarding national SFM. They provide information of the existence, but also effective implementation, of a SFM policy framework. Such a policy framework could be expressed, for example, in a National Forest Programme. After the Lisbon Resolution L2 it was postulated that the national forest policy and its strategy has to be articulated in a National Forest Programme. The pan-European C&I are seen as means to formulate, implement, monitor and evaluate the implementation of a National Forest Programme (see MCPFE 2000a; MCPFE 2000c). National Forest Programmes in combination with pan-European C&I are nowadays seen as effective tools to support SFM relevant activities at national and pan-European levels, and therefore help to implement and realise a common strategy and policy of a long-term SFM within Europe (see MCPFE, 2003a).

In general terms it can be said, that a criterion describes a characteristic objective by which the explicit achievement of the objective can be judged. The indicator is only a quantitative measure by which the achievement of the criterion can be measured (see Schneider, 1995). The indicator does not necessarily show anything about whether the change or status is positive or negative. An important characteristic of an indicator is the ability to sensitise and measure changes over time in an objective way. Within the concept of SFM, the indicator role is to reflect its explicit status and changes between the economic, ecological and socio-cultural dimensions and objectives of SFM (see Fig. 2). Some SFM indicators describe the economic rather than the ecological or purely socio-cultural dimensions of SFM, and some only the ecological or socio-cultural dimension. Some indicators are of more undefined character. As some of the 35 indicators are strongly correlated to each other (see Chapter 5) they may describe all three dimensions of SFM equally.

Fig. 2: The concept of SFM and the functionality of SFM indicators



To define the individual purpose and to describe the dynamics and interactions of an indicator in more detail the European Environmental Agency (EEA) for example defined its environmental indicators either as *Driving Forces*, *Pressure, State, Impact* or *Response* indicators (EEA, 2004). The *DPSIR*-concept was originally initiated and developed by the Organisation for Economic Cooperation and Development (OECD) and later enhanced by the CSD (see also Chapter 5).

In additionally to the principal definition of *what is a pan-European criteria and indicator*, the MCPFE furthermore underlines the following characteristics of indicators (MCPFE, 2001a):

- *uniform across Europe*
- *applicable on national level*
- *coherent with the Ministerial Conference Resolutions, especially H1 and H2*
- *comprehensive and simple*
- *reportable*
- *adjustable*

The major purpose of C&I to monitor, assess and report on SFM at sub-national, national and international levels has been also clearly stressed by the IPF in 1998. In addition the IPF saw a range of various further roles for the C&I (IPF, 1997; FAO, 2003):

- *a complementary instrument of a sectoral diagnostic framework*
- *a conceptual framework for policy formulation and evaluation, including a role in defining the goals of national forest programs and policies, and evaluating the effectiveness with which they are implemented*
- *an instrument to identify enabling conditions and mechanisms, including financial and technical resources that affect national implementation of C&I*
- *a potentially important tool to clarify issues related to forest certification and marketing of forest products even though C&I are not performance standards*

According to Rametsteiner (2001), two areas of the use of SFM indicators are most relevant in forest policy: (i) the *collection of information*, and (ii) the *use of information for policies*. Prins (2002) suggests that by the implementation of pan-European C&I as a common system for measuring and reporting national data two major objectives can be achieved. On the one hand it provides a pan-European overview representing the state and trends of European forests, and on the other hand it allows demonstration to the public of whether progress is being made towards achieving certain commitments. To achieve these purposes and to guarantee an optimal and functional working indicator

catalogue on a pan-European level, the MCPFE focuses on three aspects in its work-program (MCPFE, 2000a):

- *improving the existing indicator-set under consideration of the six pan-European criteria;*
- *exploration of further possibilities to harmonise forest relevant data and information assessments;*
- *elaborating a uniform and common reporting format for national data reporting*.

In order to allow comparable pan-European forest monitoring, assessment and reporting, it is necessary to standardise and harmonise the definitions and nomenclature used in the C&I (see Köhl et al., 2000).

The development and the improvement of pan-European C&I for SFM can be regarded as an important milestone of the ongoing harmonisation and standardisation processes (see also Chapter 2.5). It is the result of a process which was influenced by many different forest stakeholders and experts representing different backgrounds, views and information requirements.

This work aimed to consider the variety of experiences of European countries with the instrument of C&I for SFM. In addition to classical forest indicators (such as *forest area, forest growth, increment and fellings* or *round wood production*), also rural development aspects were part of the discussion, and were ultimately incorporated in several indicators. Furthermore, topics such as climate change, biodiversity and socio-economic aspects influenced the discussion and the results of the improvement process. Finally, the work of other processes like the Montreal Process on C&I for SFM was also taken into consideration in the improvement process of the pan-European Indicators for SFM.

Terms and definitions used within the pan-European C&I[25], are in compliance with the terminology of the UNECE/FAO Temperate and Boreal Forest Resource Assessment (TBFRA 2000) (see also below). In addition, as an outcome of the MCPFE and the

[25] MCPFE Liaison Unit Vienna: Relevant Definitions used for the Improved Pan-European Indicators for Sustainable Forest Management, MCPFE Expert Level Meeting, Vienna October 2002.

Ministerial Conference on Environment for Europe (EfE) joint "*Work-Programme on the Conservation and Enhancement of Biological and Landscape Diversity in Forest Ecosystems 1997-2000*"[26], an MCPFE Classification of *Protected* and *Protective Forests and Other Wooded Land* in Europe was established in accordance to the classifications of the IUCN and the Common Database on Designated Areas (CDDA) of the EEA (MCPFE, 2001b).

In accordance with this achieved harmonisation basis, all MCPFE signatory states and the European Community officially agreed to share the pan-European C&I for SFM as a common basis for both data collection and reporting on SFM at the pan-European level and the development of national SFM indicators. The pan-European C&I can be regarded as key-references for the scientific, political and operational work undertaken with regard to SFM.

2.3 The challenge of C&I implementation

2.3.1 The implementation of resolution L2 – an overall view from the MCPFE

In 2001 the MCPFE initiated an analysis which focused on questions like: *How exactly have MCPFE decisions and commitments been implemented? Which activities, measures and actors have been involved in this process? What are the lessons that can be learned from the huge amount of work done in Europe in relation to forests?* (MCPFE, 2003a)

In particular, the development and the integration of C&I for SFM and the implementation of National Forest Programmes were considered to be important for new forest policies, programmes or guidelines on the sustainable management of forests.[27]

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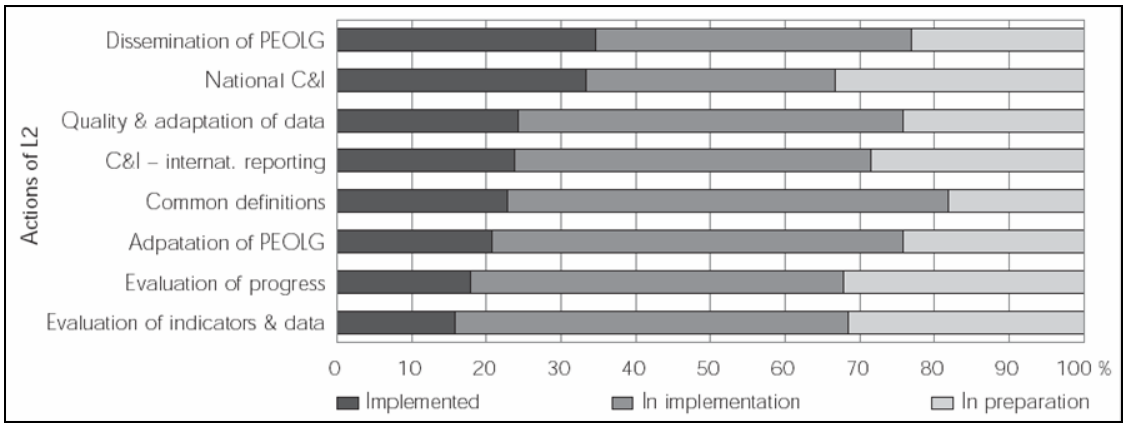
[26] As a contribution to the implementation of the CBD, the MCPFE cooperates with the Ministerial Process on "Environment for Europe" (EfE) and its Pan-European Biological and Landscape Diversity Strategy (PEBLDS). PEBLDS is lead by the Council of Europe (CoE) and was endorsed by 54 countries in 1995 at the third Conference on the Environment for Europe. PEBLDS provided the basis for the development of a European Biodiversity Monitoring and Indicator Framework which aims to support sustainable development by creating synergies in monitoring and developing biodiversity indicators.

[27] 26 European countries participating in the MCPFE and the European Commission reported on the implementation of actions of Resolution L2.

Overall, the implementation of Resolution L2 appeared in 2001/2002 still to be in its early stages in many areas (see Fig. 3). About one-half of the reported measures to implement actions of Resolution L2 were in the implementation phase, more than one-quarter were in a state of preparation, and about one-quarter had already been implemented (MCPFE, 2003a). Some national respondents saw problems in the implementation of Resolution L2 due to the necessary additional parameters in guidelines or amended monitoring systems, as well as in the growing costs or difficulties with financial support. In particular, the collection of data outside or even within the forestry sector at national and sub-national levels, or of indicators related to multifunctional forestry or biodiversity meant a great effort for some countries. Obstacles in implementing Resolution L2 were seen in the lack of institutional, informational or financial facilities (MCPFE, 2003a).

Fig. 3: State of implementation and measures taken to implement actions of L2 (MCPFE, 2003a (p.25))[28]



Regarding to the action "*development and implementation of national C&I*", the pan-European C&I for SFM were seen as a useful framework for the management, monitoring and reporting on SFM and related policies. The pan-European C&I also proved to be an effective instrument to evaluate existing sets of national or sub-national C&I, and also newly established guidelines. For the successful implementation of the action "*quality and adaptation of data*", the main future policy needs were seen in more cooperation and harmonisation of data collecting systems and international definitions. Furthermore it was stressed that the continuous updating of data and inventories is seen as essential. It was also stated that it is important to assess the value of information by

[28] PEOLG: Pan-European Operational Level Guidelines for Sustainable Forest Management

distinguishing particular interests influencing the quality of information. Regarding the implementation, some concerns were made regarding difficulties in data availability but also regarding applicability towards the fulfilment of national and international demands. Concerning the action "*C&I – international reporting*", most respondents recalled the cooperation with relevant organisations like UNECE or FAO and the work undertaken under the agenda of FRA and TBFRA. Also here some countries mentioned a strong need for more adaptation and harmonisation of national standards and definitions to comply with international reporting formats. Others were critical and commented that the international reporting of C&I is not in the responsibility of national level organisations (MCPFE, 2003a (p.29)).

2.3.2 Implementation on the National Level – selected examples

Without considering the MCPFE overall view on L2 implementation as an approved benchmarking report where the exact implementations of C&I between the European countries are listed and analysed[29], Finland and Switzerland are two examples where the pan-European C&I are established and used to a high degree – either within national reporting or the formulation of national forest policy.

Shortly after the second MCPFE in Helsinki 1993 the Finnish Ministry of Agriculture and Forestry (MAF) launched a national project to develop C&I for SFM on national, sub-national and local (forest management unit) levels in 1995. The six pan-European criteria were adopted as such on a national level, and quantitative indicators were further developed to characterise the specific conditions in Finland (Suoheimo, 2000). In 1996 the Finnish Forest Research Institute (METLA) was assigned to compile information for the developed national indicators and in April 1997 the report "*Criteria and Indicators for Sustainable Forest Management in Finland*" was published. An essential part of the data on the Finnish quantitative indicators was taken by the Finnish Forest Statistical Yearbook and the National Forest Inventory. In 1998 the MAF appointed a new working group whose main tasks were to revise the Finnish set of indicators and to take into account recent developments (e.g. the proposals for action by IPF and the MCPFE Lisbon Resolution L2). Furthermore it was of interest to promote

and strengthen the necessary adaptations of monitoring methods to fulfil the needs of information for indicators and to use C&I in the follow-up of Finland's National Forest Programme and Sub-National Forest Programmes. First experiences have shown that the collection and compiling of information was (and still is) more complicated and expensive than anticipated and that the process of implementation of C&I on national, sub-national and local levels was much slower than expected (Suoheimo, 2000). For the year 2000 the MAF published their national forest report "*State of Forestry in Finland 2000*" structured according to the pan-European criteria and national indicators for SFM (Ministry of Agriculture and Forestry in Finland, 2001).

In Switzerland C&I build the framework for the National Forest Programme. Furthermore they are the framework for the reporting format for the Swiss National Forest Inventory and the Swiss National Forest Report (BUWAL, WSL 2005) and the reporting on SFM at the cantonal level (BUWAL, 2003). Already in 1997 the Swiss Agency for Environment, Forests and Landscape (BUWAL) developed a set of national C&I for SFM (BUWAL, 1997). In 1999 the Agency conducted a study in which an independent recognised international expert team assessed the sustainability of Swiss Forest Policy (BUWAL, 1999). The pan-European C&I were taken as a concept to structure the analysis and its results. All forest and forest-related laws and regulations have been reviewed in this process, and strengths and weaknesses were identified. The results were integrated among others into the formulation of the Swiss National Forest Programme (BUWAL, 2003).

Similar to the Swiss Forest Policy Assessment, Ziegenspeck (2004) shows within a first study a benchmarking approach, where governmental subsidies and expenditures relevant to National Forest Programmes (from 1990-1999) are listed and compared to the six pan-European Criteria (see Fig. 4). National financial programmes relevant to forests and the forestry sector were evaluated according to their relevance for each of the six criteria for different selected countries. It has been shown that the targets of national expenditures – independently from the total budget – are different between the evaluated countries. Each of the selected countries has different preferences with regard to how the available budget is spent (see Fig. 4). Problematic was that some national

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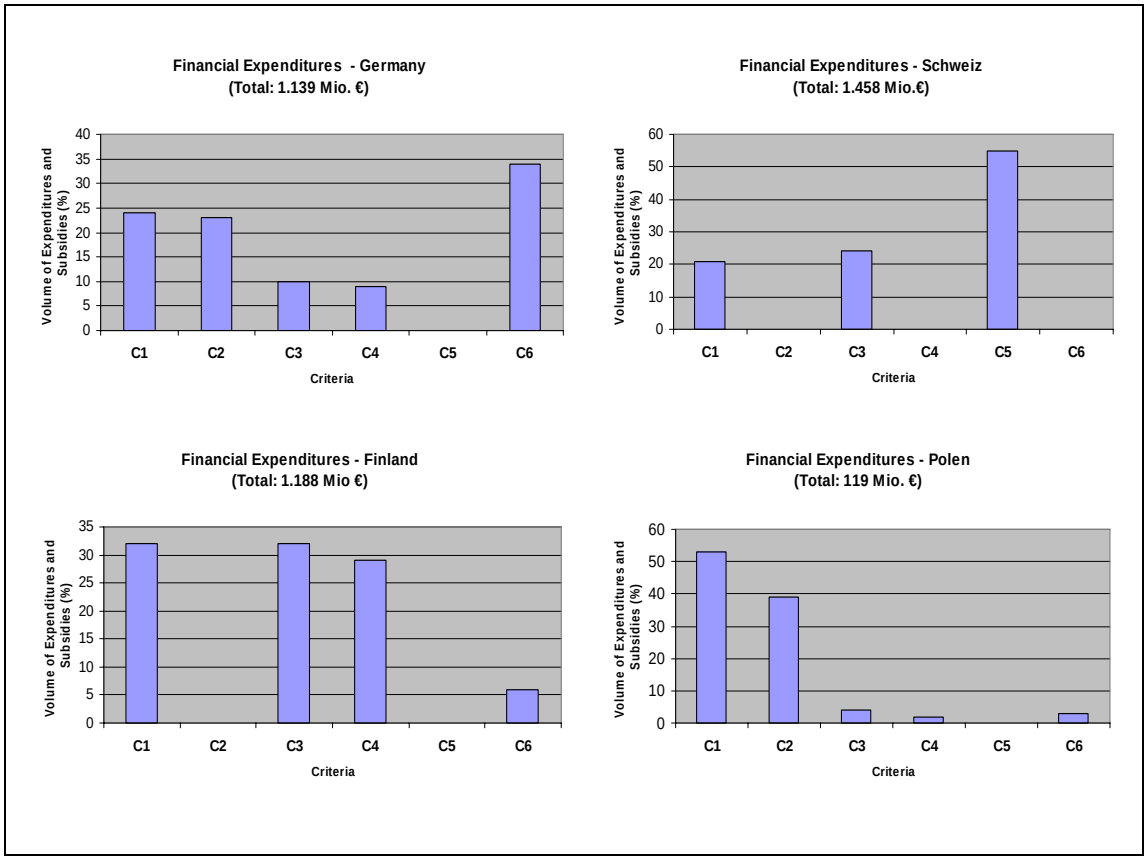
[29] The MCPFE Report "Implementation of the MCPFE Commitments – National and Pan-European Activities 1998-2003" provides only a overall conclusion without listing the different performances and achievements of explicit MCPFE signatory states.

financial programmes are partly relevant for more than one theme of each of the pan-European criteria. The study of Ziegenspeck gives a good example in how far C&I can be used for conducting national comparative analysis – e.g. comparing different national or regional preferences in political and financial programmes towards the achievements of SFM.

Fig. 4: Expenditures of selected countries from 1990-1999 listed according to the six pan-European criteria (after Ziegenspeck, 2004).



2.3.3 The challenge of C&I reporting

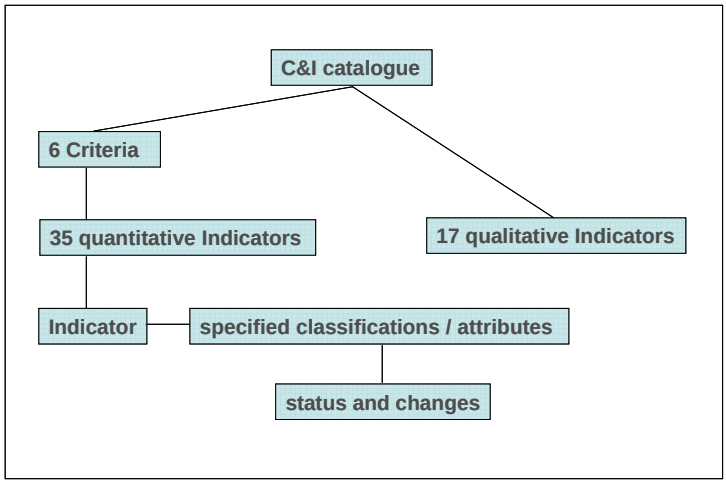
Data collection and reporting of the pan-European C&I is carried out at national-level (MCPFE, 2000a; MCPFE, 2000c; MCPFE, 2003a). The quantitative indicators are to be reported not only as total figures on current state and changes, but further classifications are also requested (see Fig. 5). These further classifications inevitably lead to an enormous amount of various figures to be reported for quantitative indicators.

The following example of the indicator *1.1 Forest area* provides an indication of the reporting complexity. The MCPFE (2002a) defines the reporting of "*Forest area*" as:

"*Area of forest and other wooded land, classified by forest type and by availability for wood supply, and share of forest and other wooded land in total land area*"

Even without taking into consideration the category *other wooded land*, at least eight different attributes are to be reported for status and changes of the indicator *1.1 Forest area*. Considering all requested classifications for the 35 indicators more than 200 single attributes are to be reported by each member country.[30]

Fig. 5: Structure of the improved pan-European C&I – complexity of information demands (after MCPFE, 2002a)



National forest assessments and inventories are a primary source of information on indicators. In addition to classic forest related sources and measurements, studies such as the Gap-Analysis (Sollander, 2001) or the Liechtenstein Case Study (Requardt, 2003) have shown that other sources than NFIs are also essential for reporting, especially with regard to indicators that cover cultural or socio-economic aspects.

The *Gap-Analysis* of Sollander (2001) was an integral part of the EU-Life project "*Demonstration of methods to monitor sustainable forestry*"[31] conducted from 1998-2002. The aim of the project was to review, demonstrate and develop methods to monitor the sustainability of forestry on the basis of the pan-European C&I (former

[30] The combinations of additional to be reported indicator attributes are not always clearly defined. According to the new MCPFE/UNECE C&I Enquiry (see Chapter 2.3.3) for the accomplishment of the next MCPFE Report on the State of European Forests, far more than 200 single indicator attributes and reporting units are requested.

[31] Agencies from Denmark, Finland, France, Germany and Sweden participated in the project. The lead agency was the National Board of Forestry in Sweden.

catalogue).[32] The analysis focused both on determining which information is crucial in order to monitor the sustainability of forestry, and on pinpointing gaps in the existing information systems represented by the selected local test area.[33] It was of interest to determine the validity of each pan-European criterion and indicator, but also to assess the reliability of the method used to collect the information, the availability of data, weaknesses and possibilities to improve the methods, etc.

The overall conclusion of the analysis was that all six criteria were considered as "important" or "very important" for monitoring forests sustainability. Also most indicators received relatively high degrees of validity for their respective test areas, although there were many proposals on new quantitative indicators. It was also concluded that there were large needs to improve monitoring on forest sustainability. Many of the methods used to collect data for individual indicators on the local level do have reliability problems on the national level. However, indicators that need improved monitoring methods, vary between countries. The reliability problems appear quite evenly distributed between the criteria. This indicates that the assumption that *traditional forest data* (e.g. classical forest resource information) are in a significantly better state than relatively *new aspects* (i.e. biodiversity or social-cultural factors) is wrong. Although conclusions were mainly made for selected case study countries, the Gap-Analysis and its major findings were of particular relevance for the improvement process of the pan-European C&I (see Chapter 2.2).

Within the Liechtenstein Case Study, Requardt (2003) presented a detailed comparison between pan-European C&I data demands on the one hand, and national data availability on the other hand. In total, almost 200 data attributes of the 35 improved pan-European indicators were analysed with respect to data availability and data potential.[34] The priority of the analysis of data potential was to reveal whether: (a)

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[32] The EU-Life project "Demonstration of methods to monitor sustainable forestry" focused on the former MCPFE C&I catalogue, which consisted of six criteria and 27 indicators containing and describing both quantitative and qualitative indicators.

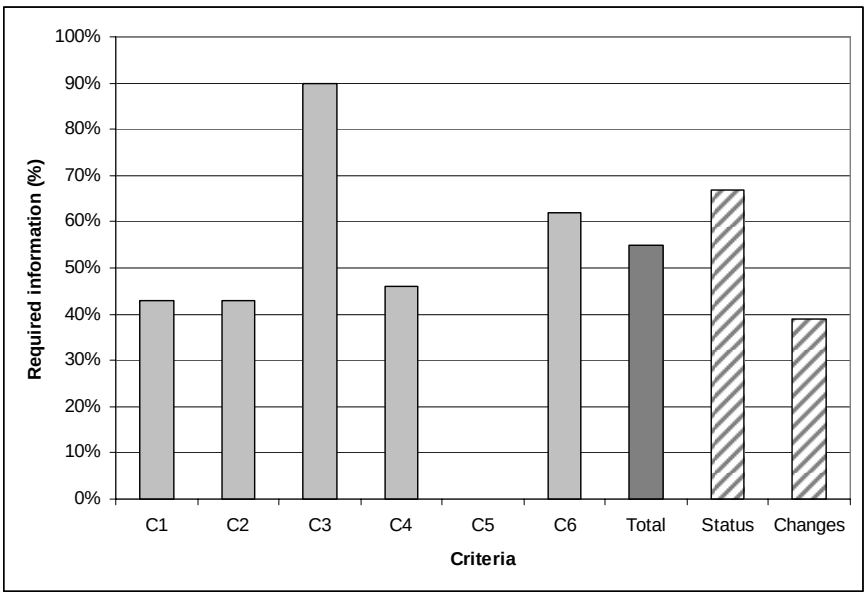
[33] The survey was based on local case studies on selected test areas – e.g. the German Partner, represented by the Forest Research Centre of Lower Saxony took the *Lüneburger Heide* as a representative test example.

[34] Within the Liechtenstein Case Study it was of utmost interest to orientate the analysis of national data potential exactly according to the data requirements of the improved pan-European Criteria and Indicators. The following two MCPFE documents were the basis for this study:

- MCPFE 2002: Background Information for Improved Pan-European Indicators for Sustainable Forest Management

national data are available and can be reported, (b) available data (raw data) can be used but new data evaluations are necessary, or (c) completely new methods of data collection and assessment have to be implemented to report required information. The results have shown large discrepancies between data demands and data availability. Data were available for only 55% of the required attributes. Reported data and information were partly subject to certain restrictions and did not always completely fulfil the data requirements. The data availability (and also the reasons for no data being available) varied from indicator to indicator, and from criterion to criterion (see Fig. 6).

Fig. 6: Data availability of Liechtenstein according to MCPFE Criteria in 2002/2003 (Requardt, 2003)



Despite the low rate of data availability, the study has also shown that a certain data potential exists for most of the required data – either in the form of available raw data or that methods of data collection or data processing are known. Within the Liechtenstein case study it was shown that it would often be just a matter of slightly modifying existing datasets or data evaluations in order to explicitly fulfil C&I information requirements. It was concluded that national authorities have to consider whether new methods of data collection and assessment are necessary, and whether it is in their interest to improve data availability towards the requirements of pan-European C&I. The Liechtenstein case study resulted not only in a first example of a National Forest

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- MCPFE 2002: Relevant Definitions used for the Improved Pan-European Indicators for Sustainable Forest Management

Report structured exactly according to the pan-European C&I, it also demonstrated in how far pan-European C&I can be used to analyse and evaluate structure and content of national data sources and information systems.

Almost all European countries or even counties[35] within a country regularly publish National Forest Reports. Although it becomes more and more common, most of these reports are not yet structured according to the pan-European C&I. Just a few examples like the Finnish[36], the French[37], the Swiss[38] or the Austrian[39] Forest Reports present the data and information in the context of the six pan-European criteria. In addition to a few selected and reported pan-European indicators they also list other indicators of national relevance (see also below).

On the international (pan-European) level, reporting structures are already in place. One important step in reporting on C&I at the pan-European level was performed by the UNECE and FAO. The UNECE/FAO already started to gather information about Europe's forests during the middle of the last century. The FAO, at the request of the member nations and the world community, regularly reports to the state of the world forests through the Forest Resource Assessment Programme covering approximately 230 countries (see latest assessments FRA2000 in FAO, 2001; and FRA2005 in FAO, 2005b). Within this global assessment, the coverage of the temperate and boreal forests (in the UNECE region) has been carried out under the auspices of the UNECE Timber Committee and the FAO Regional Forestry Commission for Europe. The latest explicitly regional assessment is the Temperate and Boreal Forest Resources Assessment (TBFRA 2000) (see UNECE/FAO 2000).

Based on these assessments the UNECE/FAO provided a first overall European-wide picture on the status of forest resources and management for the third MCPFE in 1998.

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[35] County Report Rheinland-Pfalz (Germany): Ministerium für Umwelt und Forsten des Landes Rheinland-Pfalz: Nachhaltige Waldbewirtschaftung – Nachhaltigkeitsbericht, Kriterien und Indikatoren – Eine Europäische Initiative zum Schutz der Wälder, Mainz 1998.

[36] Ministry of Agriculture and Forestry: The State of Forestry in Finland 2000 – Criteria and Indicators for Sustainable Forest Management in Finland, Helsinki 2001

[37] Ministere de lágriculture et de la peche, Direction deléspace rural et de la foret und Inventaire forestier national: Indicators for the sustainable management of French forests – 2000 edition, Paris 2001

[38] Bundesamt für Umwelt, Wald und Landschaft (BUWAL): Kriterien und Indikatoren für eine nachhaltige Bewirtschaftung des Schweizer Waldes, Bern 1997; sowie:
Bundesamt für Umwelt, Wald und Landschaft (BUWAL), Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft (WSL): Waldbericht 2005 – Erste Gesamtschau zum Schweizer Wald, Bern 2005

This was repeated for the fourth MCPFE in April 2003 for the report "*State of Europe´s Forests 2003*" (MCPFE, 2003b). Data were mainly provided through the TBFRA 2000 and the FRA 2000 based on partly harmonised definitions. Additionally new data on protected and protective forest areas were collected by UNECE and MCPFE in 2002 according to the "*MCPFE assessment Guidelines for Protected and Protective Forests and Other Wooded Land in Europe*". Efforts have been made to provide data for every indicator, although data quality and the comprehensiveness of the information vary significantly, depending on the specific variable and country conditions (Linser, 2005). It was noted that although some of the indicators are not exactly equivalent to the variables reported in the FRA or TBFRA processes, those data provide the best approximation of MCPFE indicators. Closest connectivity is given to the TBFRA 2000 as the TBFRA assessment was modified to reflect the information needs as represented by the MCPFE indicators. There were fewer synergies with the FRA 2000 (Prins, 2002).

As the latest MCPFE report - "*State of Europe´s Forests 2003*" - was mainly based on the previous set of the MCPFE indicators (MCPFE, 1998), the new indicators or changes in the indicator set were not considered.

For the next Ministerial Conference in Warsaw 2007 a new report – structured according to the improved criteria and indicator catalogue – is in preparation.[40] This report will also be prepared by the Liaison Unit of the MCPFE in strong cooperation with the UNECE/FAO. Advice and support is provided by the UNECE/FAO *Team of Specialists on Monitoring Forest Resources for Sustainable Forest Management in the UNECE Region* as well as by the MCPFE *ad hoc* Scientific Advisory Group on C&I. For the reporting in 2007 the MCPFE Liaison Unit Warsaw together with the UNECE Timber Section in Geneva has elaborated an enquiry for collecting national data related to the requirements of the pan-European C&I.[41] The next MCPFE Report on the "*State of Forests and Sustainable Forest Management in Europe 2007*" will be significantly based on the countries' reporting to this enquiry. The enquiry was sent in summer 2006

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[39] Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft: Nachhaltige Waldwirtschaft in Österreich – Österreicher Waldbericht 2001, Vienna 2002.

[40] "*Report on the State of Forests and Sustainable Forest Management in Europe 2007*", forthcoming and published at the fifth MCPFE in Warsaw, 2007.

to all FRA National Correspondents and MCPFE focal points. The recently published FRA 2005 Report (FAO, 2005b) is widely acknowledged as an important and helpful reference for the reporting to the MCPFE/UNECE enquiry. When accommodating the FRA 2005 reported data, national correspondents were asked to take into full account the compatibility of classifications and definitions applied correspondingly for the FRA 2005 and MCPFE processes. In addition to the data national correspondents were asked to provide explanations and descriptions of the explicit applied data adjustment processes.

The national enquiry covers only 23 of the 35 quantitative indicators. In addition to the national enquiry, international data providers (such as the JRC, ICP Forests, Eurostat, EEA, etc.) were specified as potential data provider for certain indicators – 12 indicators which are not covered by the national enquiry (see Table 3).

Table 3: MCPFE indicators not covered by the enquiry but by international data providers (MCPFE, UNECE/FAO, 2006).

Indicator	International data provider
2.1 Deposition of air pollutants	JRC/ENV (Level I and Level II) for EU countries ICP Forests (Level II) for non-EU countries EMEP
2.2 Soil condition	JRC/ENV (Level I and Level II) for EU countries ICP Forests (Level I, Level II) for non EU countries
2.3 Defoliation	JRC/ENV (Level I and Level II) for EU countries ICP Forests (Level I) for non-EU countries
4.6 Genetic resources	REFORGEN (FAO) EUFORGEN (FAO/IPGRI)
4.7 Landscape pattern	EEA JRC
6.2 Contribution of forest sector to GDP	Eurostat (Economic accounts/Forestry accounts)
6.3 Net revenue	Eurostat (Economic accounts/Forestry accounts)
6.4 Expenditures for services	MCPFE/UNECE preliminary study (enquiry) related to national expenditures for services from forests (report forthcoming 2007)
6.5 Forest sector workforce	Eurostat (Social Statistics, Community Labour Force Survey) UNIDO (data for ISIC 20 and 21)

[41] MCPFE and UNECE/FAO Enquiry and Data Collection for the "*Report on the State of Forests and Sustainable Forest Management in Europe 2007*", forthcoming and published at the fifth MCPFE in Warsaw, 2007.

6.6 Occupational safety and health	ILO
6.7 Wood consumption	UNECE/FAO Eurostat
6.8 Trade in wood	UNECE/FAO Eurostat

In addition to the assessment of the quantitative indicators, two further enquiries were elaborated by the UNECE and the MCPFE. These are an enquiry on *Non-wood Goods and Services (NWGS)*, and an enquiry covering multiple data of the *Private Forest Ownership*. Both additional enquiries are regarded as pilot studies which might provide additional input to the MCPFE report in 2007.

2.3.4 C&I implementation – other selected examples

2.3.4.1 C&I and Certification

Certification and C&I are closely linked as C&I can serve as a basis for developing performance and reference standards for explicit certification schema. Forest certification was introduced in early 1990 as a voluntary market-based response to address public concerns related to deforestation in the tropics (see UNECE/FAO, 2005; Perera and Vlosky, 2006). Soon many different certification schemes developed and became implemented (see below). In 2002, there were 32 national, regional or global certification systems in use in Europe (van Brusselen and Schuck, 2005, p. 81). Most popular within Europe are the Forest Stewardship Council (FSC)[42] and the Programme for the Endorsement of Forest Certification schemes (PEFC)[43]. Contrary to the concept of SFM, the aims of which are clearly supported and implemented by governments world-wide since UNCED, forest certification has been much less incorporated into policy and legal frameworks (van Brusselen and Schuck, 2005, p. 81). According to the MCPFE (MCPFE ELM, 2006), forest certification has been mentioned in the same context as C&I for SFM, but it has been clearly emphasised that C&I are tools for

[42] FSC 2004: 15% of all forests in Europe.
[43] PEFC 2004: 34% of all forests in Europe.

governments in promoting SFM while forest certification is a voluntary, market driven mechanism.

However, there are close connections between the C&I for SFM and forest certification. The broad objectives of certification and C&I are identical: to promote best practice, sustainable management of forests. However, there are also important differences between these two concepts, especially regarding scale, purpose and participating actors. According to Parviainen (2003) the primary differences rest in the degree to which the procedures are binding and the thresholds of the C&I are set. C&I for SFM are supposed to work rather on a national level as a descriptive approach for information sharing, and are used by governments and policy makers. In contrast, forest certification schemes rather refer to the forest management unit level or sub-national level as a prescriptive instrument, where standards and requirements are set to proove implementation and performance of SFM, and are used by market players (Parviainen et al., 2003).

Forest certification is defined as *a procedure which consists of the verification, by an independent third party, that the forests in question are managed in a sustainable way* (Forest Strategy for the European Union, p. 24). Therefore it is of high interest to have reliable up-to-date information about status and trends of particular forests and their management. Sustainability according to certification schemes is verified in an audit report by an independent third party which is measured against a set of indicators for a number of criteria, which are specific to a certification scheme. Finally the certifications labels are issued for forests that meet these conditions (see Parviainen, 2002).

In many countries and in many certification schemes, regional or national C&I have been used as the basis or starting point for certification, when developing performance standards. This guarantees that the certification is comparable and compatible with internationally agreed principles. The PEFC uses the MCPFE C&I as a basis for its certification scheme as well as the *Pan-European Operational Level Guidelines for Sustainable Forest Management (PEOLG)*. The FSC instead uses 10 Principles and Criteria for SFM that are not based on any international C&I process (Parivianen et al., 2003), although FSC recently started to consider also the agreed seven global themes on SFM (see Chapter 2.1.2). Thoroe (2001) showed within a case study that there are

basically no differences between FSC and PEFC standards and their general description of SFM.

2.3.4.2 C&I on Forest Management Unit level

This section does not intent to discuss all relevant outcomes of explicit C&I activities on the Forest Management Unit (FMU) level, it rather highlights aspects most relevant in the context of this study. At the Intergovernmental Seminar on Criteria and Indicators for Sustainable Forest Management (ISCI), hosted by the MAF Finland in 1996, it was already concluded that C&I can be applied at a range of spatial scales. However, until today C&I were developed as a top-down approach.

Early emphasis in all C&I activities was placed on the development and implementation on the national level. Their impact on the FMU level has been less apparent (see Cassells and Hall 2000). Nowadays there are several activities in policy and research ongoing in order to assist policy makers and forest managers to assess the sustainability of forest management by using C&I at both the national and FMU levels.[44]

It is widely agreed that many of the national-level indicators are not sufficiently sensitive to be useful at the FMU level (e.g. Brunnel, 1997; Ellenberg, 1997; Raison, 2001; Brang, 2002; Vacik and Wolfslehner, 2004). Just to name one example: Wolfslehner and Vacik (2004; 2003) developed an indicator catalogue for assessing SFM at the FMU level on the basis of the MCPFE PEOLG and the six pan-European Criteria. The final FMU indicator catalogue consisted of 43 indicators including some similar to the pan-European indicators. An expert panel consisting of representatives of science, administration, forest enterprises and non-governmental organisations evaluated the C&I set with regard to validity, practicality, relevance and importance of

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[44] See studies as:

- "Pirkanmaa Project - applicability of national C&I in the planning and evaluation of forest management at the regional level", Ministry of Agriculture and Forestry in Finland (MAF), 1995
- "Bringing C&I to Ground", C.Y. Freezailah, Don Wijewardana and Marco Vinueza Rojas; ITTO Tropical Forest Update 10/4 2000
- "Development and Testing of a Criteria and Indicator System for Sustainable Forest management at the Local Level – Case Study at the Haliburton Forest&Wild Life Reserve Ltd., Canada", Thorsten Mrosek, European University Studies, Series XLII Ecology, Environmental Studies Vol. 29, 2002

the indicators. Possible threshold values for the quantitative indicators and the relative importance of the indicators had been derived from expert opinions. It has been shown that not every indicator is applicable for each size of a forest management unit. Especially small size units, as predominately occurring in the private forest sector, have other requirements and indicators to assess and describe SFM. Furthermore it was underlined that the data availability is of high importance for the applicability and usability of any indicator catalogue – even on the FMU level (see also Brang et al., 2002).

2.4 The complexity of National Reporting Obligations

Countries already provide a tremendous amount of various data to several international data collection systems and initiatives in order to fulfil certain reporting obligations with respect to certain international commitments or so called "*gentlemen's agreements*"[45]. One key aspect for an effective C&I implementation – specifically considering its national reporting – is to analyse and evaluate the complexity of reporting obligations in order to identify synergies and to minimise the national, but also the international, data collection and reporting burden.

Reporting obligations are requirements to provide information agreed between countries and international bodies or international conventions. All adopted legislative instruments like conventions, resolutions or directives, require their parties to report at irregular or regular intervals on the national implementation status and progress. According to UNEP-WCMC (2005, p.4) a number of purposes for reporting are provided, namely:

- enabling assessment and monitoring of progress in implementation;
- providing information to the members or signatory states for decision-making;
- identifying priorities for further work;

- "Local level criteria and indicators: an Aboriginal perspective on Sustainable Forest Management", Erin Sherry, Regine Halseth, Gail Fondahl, Melanie Karjala and Beverly Leon, Forestry, Vol. 78 No. 5, 2005

[45] The term *gentlemen's agreement* is used as a synonym for voluntary agreement. See also ECOSOC Statistical Commission and Economic Commission for Europe, 2004: Coordination of Environment Statistics, p.3:…*the legally based required reporting naturally takes priority over reporting based on voluntary or "gentlemen's agreements."*

- providing opportunities for information exchange and regional cooperation;
- providing information for self-assessment of the implementation by Parties.

Environmental reporting obligations agreed between the EU and international bodies and countries provide the framework for most environmental information flows (EEA, 2005). This framework has grown in Europe as reporting requirements for separate laws or sectors that have been agreed to, often independently from one another. Duplication of efforts, together with a lack of a transparent, needs-based approach to information flows, has contributed to poor response rates in many reporting obligations.

The Reporting Obligation Database (ROD)[46] maintained by the EEA provides an overview of most relevant environmental reporting obligations (EEA, 2005). The database is helpful in assisting in the analysis of the reporting obligations burden of member countries, and in supporting member countries in planning and fulfilling explicit reporting obligations. Furthermore it assists in streamlining the flow of data, which is a fundamental part of reducing the national reporting burdens (see also Chapter 7.3 and 7.4).

According to the EEA ROD, *Germany* for example has to fulfil more than 350 different environmental reporting obligations relevant for the reporting of about 105 legal instruments (covering various environmental issues e.g. on Natural resources, Biodiversity Change and Nature, Air quality, Climate Change, Water, Noise, Soil, etc). Taking Albania as another example, only 99 obligations have to be fulfilled. Most of the legislative instruments are separated into more than one explicit reporting obligation. The joint monitoring of ICP Forest/Forest Focus (see Chapter 6), for example, has to collect data according to 15 individual reporting obligations relevant for the UNECE *Convention on Long-range Transboundary Air Pollution (CLRTAP)*.

Unfortunately the EEA ROD has no explicit reporting obligations listed on *forests* and *forestry* issues. Trying to select only those reporting obligations and legislative instruments relevant for and linked to the German forest monitoring, assessment and

[46] ROD contains records describing environmental reporting obligations that countries have towards international organisations. It includes all environmental reporting obligations that EEA member countries have towards the Environment DG, European marine conventions, Eurostat, OECD, UN, UNECE as well as the EEA itself. Excluded from ROD are non-environmental reporting obligations. See http://rod.eionet.eu.int.

reporting activities, Germany has to report on about six legislative instruments explicitly relevant for forest and forestry[47], and on about 14 other nature and environmental reporting obligations which have cross linkages to other specific forest issues such as climate change or biodiversity (see Table 4). In addition to the legislative obligations there are also several on non-legally binding obligations or so-called gentlemen's agreements which have to be fulfilled by the countries, e.g. the reporting on the MCPFE C&I.

Although the EEA ROD has only listed environmental reporting obligations, there are also several forest economic or socio-economic data covered by the reporting to, for example, Eurostat or FAO.

Table 4: Forest relevant legislative instruments and reporting obligations – example of Germany.

Explicit forest relevant legislative instruments	Report to
Regulation (EC) No. 2152/2003 of the European Parliament and of the Council of 17 November 2003 concerning monitoring of forests and environmental interactions in the Community (Forest Focus)	EU (DG Env.)
Decision No. 2367/2002/EC of the European Parliament and of the Council of 16 December 2002 on the Community Statistical Programme 2003 to 2007 (e.g. OECD/Eurostat JQ on the State of the Environment: Forest data)	Eurostat (OECD)
International Tropical Timber Agreement (ITTO/UNECE/FAO/Eurostat Joint Forest Sector Questionnaire)	Eurostat
International Tropical Timber Agreement (Report for Indicators at the National/ FMU Level)	ITTO
Global Forest Resources Assessment	FAO
Convention on Long-range Transboundary Air Pollution (ICP Forests)	PCC (UNECE)
Other forest relevant legislative instruments	Report to
Convention on the Protection of the Alps	Alpine Convention Sec.
Convention on the Conservation of European Wildlife and Natural Habitats	Bern Convention
Convention on Biological Diversity	CBD
Convention on International Trade in Endangered Species of Wild Fauna and Flora	CITES
Agenda 21	CSD
EEA Annual Management Plan (Nationally designated areas CDDA-1)	EEA
Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol	EEA (DG Env.)
Council Directive 92/43/EEC of 21 May 1992 on the conservation of	EEA (DG Env.)

[47] Selected are only those legislative instruments in which the word "*forest*" or "*timber*" occurs

natural habitats and of wild fauna and flora	
Council Regulation (EC) No. 338/97 of 9 December 1996 on the protection of species of wild fauna and flora by regulating trade therein	EEA (DG Env.)
Directive 2001/18/EC of the European Parliament and of the Council of 12 March 2001 on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC	EEA (DG Env.)
Decision No. 2367/2002/EC of the European Parliament and of the Council of 16 December 2002 on the Community Statistical Programme 2003 to 2007 (e.g. Land data, Wildlife data)	Eurostat
Convention on Wetlands of International Importance Especially as Waterfowl Habitat	Ramsar Convention
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	UNCCD/ CST
Convention concerning the Protection of the World Cultural and Natural Heritage	UNESCO
United Nations Frameworks Convention on Climate Change (Greenhouse gas inventories)	UNFCCC

It is widely acknowledged that most of the reporting processes have served to strengthen coordination and dialogue between government agencies and also between the processes themselves. On the other hand, the momentum or political interest to provide adequate information on the part of some Governments has gradually been declining (CSD, 2002). According to UNEP-WCMC, and taking the reporting on biodiversity as an example, the reporting rate of Parties varies considerably between the conventions. Although most conventions have, to various degrees, been moving towards a better explanation of the backgrounds and reporting formats, it was acknowledged that in some cases, a lack of clear structured guidance on the information required seems to have resulted in missing information or provision of inadequate information (UNEP-WCMC, 2005).

2.5 Harmonisation and Streamlining Initiatives

In recent years, there has been a growing recognition that the national reporting burden has increased. As the reporting burden and the complexity of reports increases, it seems partly that the reporting may rather detract than support explicit agreement implementation. The challenge, but also the prerequisite, for an effective agreement implementation on the international level (such as the MCPFE pan-European C&I for SFM) is (a) to minimise the complexity of various reporting obligations, and (b) to

guarantee that reported data are comparable on all levels. Considering this circumstances, the need to *streamline*[48] or to *harmonise*[49] the national reporting to conventions, resolution and directives – as well as the underlying national information management and data assessments – has been widely acknowledged in several ongoing initiatives.

One example of streamlining reporting obligations is the ongoing initiative concerning national *biodiversity* reporting. The major objective is to streamline the national reporting with respect to the five biodiversity-related conventions - *Convention on Biological Diversity (CBD), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on Migratory Species (CMS), Convention on Wetlands (Ramsar Convention)* and *World Heritage Convention (WHC)*. The initiative is chaired by the UNEP-WCMC and focuses on activities promoting synergies and cooperation between *Multilateral Environmental Agreements*, in particular biodiversity-related conventions, and related mechanisms (UNEP-WCMC, 2004).

There has been a significant amount of work undertaken on exploring synergies and cooperation towards biodiversity-related conventions. The Strategic Plan of the CBD set one major international target to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level. Regionally in Europe a coordinated programme has been initiated to develop a European set of biodiversity indicators to assess and inform about progress towards the European 2010 targets. The programme is called SEBI 2010 (Streamlining European 2010 Biodiversity Indicators) and work is performed in collaboration between EEA, ECNC[50] and UNEP-WCMC. Currently SEBI 2010 elaborates a so called *Forest Status Indicator* (Petriccione and Fischer, 2006). The Forest Status Indicator is a complex indicator based on some surrogate measures for biodiversity. The harmonised Forest Status Indicator is comprised of several sub-indicators identified to be relevant at the pan-European level (MCPFE 2003) and implemented at the pan-European (EU Forest Focus and UNECE

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[48] *Streamlining* in this context describes all activities to streamline various reporting obligations on a common agreed reporting system, e.g. system of common nomenclature, format, time frame etc. (see e.g. CPF Initiative).

[49] Harmonisation in this context describes all activities to harmonise or to convert national or sub-national data, data assessments and evaluations to agreed international standards (see e.g. COST Action E43, ENFIN).

ICP Forests) and National levels (NFIs). The main sub-indicators are: *Tree condition, Forest structure, Deadwood amount and type, Vascular plant species composition, Tree species composition, Conservation status of forests included into Natura2000 sites*, and *Protected forests*. The proposed indicator is directly connected with the CBD focal area of "*Status and trends of the components of biological diversity*" through delivering information about the status and trends of forests. The streamlined joint indicator intends to be policy relevant by showing progress towards the CBD 2010 targets. The major objective is to send one clear message using one indicator at a high level appropriate for policy and management decision making considering forest biodiversity issues.

Another example of streamlining national reporting are the activities of the *CPF Streamlining Task Force* established in July 2002[51]. Members are FAO, ITTO, UNEP-WCMC and the secretariats of CBD, UNCCD, UNFCCC and UNFF. Its objective is to streamline forest-related reporting, explicitly to the forest relevant UN conventions and the work undertaken by UNFF and FAO.[52] Therefore one of the objectives is to propose ways to reduce the forest-related reporting burden, for example, by reducing and streamlining reporting requests, synchronising reporting cycles, harmonising data collection methods and increasing data comparability and compatibility. Also of concern is the facilitation and improvement of the accessibility and flows of existing information (see also Chapter 7). One first result is the identification of linkages between the seven global themes on SFM (see Chapter 2.1.2) as they are used to structure the FAO FRA 2005 and the reporting requirements of major global processes ITTO, CBD, CCD, UNFCCC and UNFF. The synergies are analysed and compiled within the so called *Joint CPF Information Framework* (CPF 2003; CPF, 2004).

In addition to streamlining reporting obligations there is also a great need to harmonise or to standardise national data assessments and collection systems in order to guarantee data comparability at all levels. Decisions about international political measures will not be effective unless they are based on reliable, timely, and readily available information on a comparable basis (Köhl, 2000).

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[50] European Centre for Nature Conservation
[51] The mandate of the CPF Task Force is provided in the resolutions of UNFF-1 and follow-up.
[52] See: www.fao.org/forestry/cpf-mar

Forest resource assessments have been developed by individual countries according to their information needs. Today different inventory systems can be found in Europe. The systems were developed and optimised to meet national objectives, and do not necessarily follow common international guidelines and requirements. Although a considerable amount of valuable information on forests is already available in most countries, there are still significant differences (e.g. differences between national definitions of *forest area*, see Table 5).

Table 5: Different national forest area definitions (EFICS, 1997)

Country	min width [m]	min crown cover [%]	min area [ha]	min production [m3/ha/year]
Denmark	20	30	0.5	
Germany	10	-	0.1	-
Finland	-	-	0.25	1
France	15	10	0.05	-
Greece	30	10	0.5	-
Ireland	40	20	0.5	4
Italy	20	20	0.2	-
Netherlands	30	20	0.5	-
Austria	10	30	0.05	-
Portugal	15	10	0.2	-
Sweden	-	-	0.25	1
Switzerland	25 – 50	20	-	-
Spain	20	5	0.2	-
UK	50	20	2	

The current situation is characterised by essential differences in sampling designs, assessment procedures, data sources and formats, systems of nomenclature (e.g. measurement rules and definitions), models (e.g. timber volume and carbon stocks), analysis techniques, spatial and temporal resolution, and reference points in time (EC, 1997; Köhl et al, 1997; Päivinen, Köhl 2005). In addition to these differences, Requardt (2003) has shown that national data evaluations, like combinations of available National Forest Inventory attributes, do not always fulfil international data requirements such as those for the MCPFE indicators (see Chapter 2.3.3). This is mainly explained by the different information needs national authorities and forest stakeholders have with respect to their forests.

The problems associated with the international aggregation and comparability of National Forest Inventory attributes led to the desire to develop a harmonised set of attributes in the context of forest condition already in the early 1980s. An approach for harmonising data collection activities at the European Union level is, for example, addressed by the EU regulation (EEC) No. 1615/89, 1989, which stated that the European Commission should set up a *European Forest Information and Communication System (EFICS)* in order to address the need for sound forestry information at the European level (see also Chapter 2.6). The so-called EFICS study, conducted 1996-1997, compared the nomenclature of the Member States and the EFTA countries and showed, among other things, the effects of differences in national systems of nomenclature when key attributes such as timber volume and forest area are aggregated at the European level. For example, an application of the Swiss nomenclature for standing volume applied to Finnish forests would result in a 13% loss of volume compared to the Finnish definition (Köhl et al. 2000, Päivinen, Köhl 2005).

The need for harmonised information at the international level leads to a number of initiatives seeking common approaches to facilitate national data sets for international forest and environmental policy making. Examples for initiatives are:

- the *MCPFE* and the development of pan-European C&I for SFM
- the *ICP Forests* under the mandate of the UNECE Convention of Long Range Transboundary Air Pollutants (CLRTAP) setting of attributes describing forest conditions in Europe
- the *IUFRO* work on forest terminology, key terms and terminological awareness
- the *COST Action E43* under the umbrella of the *European National Forestry Inventory Network (ENFIN)* looking for alternatives to facilitate the aggregation of national data sets on the European level
- the *IPCC* Good Practice Guidance for Land Use, Land-use Change and Forestry (LULUCF) and the Guidelines for National Greenhouse Gas Inventories: Agriculture, Forestry and Other Land Use (AFOLU)
- the *UNFCCC/SBSTA process* to develop definitions for afforestation and reforestation under Article 12 of the Kyoto Protocol (KP) referring to the Clean Development Mechanism (CDM)

- the *Kotka process* initiated in 1987 in Kotka, Finland, playing a key role by providing a global framework for the development of definitions for the Global Forest Resources Assessment led by the FAO
- the *Expert Meeting on Harmonising Forest related Definitions for Use by Various Stakeholders,* coordinated by the FAO, IPCC, CIFOR, IUFRO and UNEP, looking to facilitate common global definitions (e.g. of *forest area* – see Table 6)

Table 6: Example of harmonised international forest area definitions[53]

	min width [m]	min crown cover [%]	min area [ha]	min tree height [m]	min production [m3/ha/year]
FAO/UNECE	20	10	0.5	5	-
Worldbank Group	-	10	1	2	-
UNFCCC, Kyoto	-	10-30	0.05-1	2-5	-
EFICS	10 40	10 30	0.05 0.5	- -	- -
UNEP/CBD/ SBSTTA 2001	-	10	0.5	5	-

Considering the diversity in national data assessments, it becomes clear that a successful and effective implementation of pan-European C&I as a common – national and pan-European – policy and monitoring instrument towards a common SFM within Europe, depends tremendously on the availability of national harmonised and comparable data. Therefore it is important to incorporate all relevant harmonisation and streamlining processes within C&I initiatives – especially those of the various monitoring, assessment and reporting processes.

2.6 Towards a European Forest Information System

Despite streamlining of reporting obligations and the harmonisation of national data assessments further key issues that still need to be of concern are: (a) the reduction of the enormous heterogeneity of the various data sources; and (b) the development of a

[53] Based on: FAO, 2002: Second Expert Meeting on Harmonising Forest related Definitions for Use by various Stakeholders.

reliable forest information system to compile, process, analyse and disseminate various available information within one system.

Improving access to environmental information, including forests, was formally recognised as a priority by the UNCED in 1992 when it stated in Agenda 21, Chapter 40.19:

"Existing national and international mechanisms of information processing and exchange, and of related technical assistance, should be strengthened to ensure effective and equitable availability of information generated at the local, provincial, national and international levels…" (UNCED, 1992c).

Already in 1989 the EU regulation (EEC) No. 1615/89 stated that the European Commission set up such a *European Forest Information and Communication System (EFICS)* in order to address the need for sound forestry information on the European level (EEC, 1989). The main objective of the EFICS was to collect, co-ordinate, standardise and process data concerning the forestry sector and its development. Existing data should be utilised in compiling particular statistics by the European Communities statistical office and information from Member States and other available and accessible databases both at the national and international levels. This regulation expired in 2002. It is being followed up by the development of a *European Forestry Information and Communication Platform (EFICP)* prepared by the Directorate General and the Joint Research Centre of the European Commission. EFICP will build upon the experiences obtained in EU financed projects such as the *European Forest Information System (EFIS)* and the 5th Framework Programme Accompanying Measure *Network for a European Forest Information Service (NEFIS)* (implemented in 2003-2005). A European Forest Information System is considered to be the European node of a *Global Forest Information System*, which first approaches have been developed in the GFIS project which is a CPF initiative (see GFIS, 2005).

However, the development of an operational system for information accessibility and exchange supports the pan-European forestry strategies on the EU level to respond to the implementation of international commitments. A fundamental pillar of meeting such commitments is the accessibility to and the exchange of forestry and forestry-related information and datasets. A concerted approach to the sustainable development of

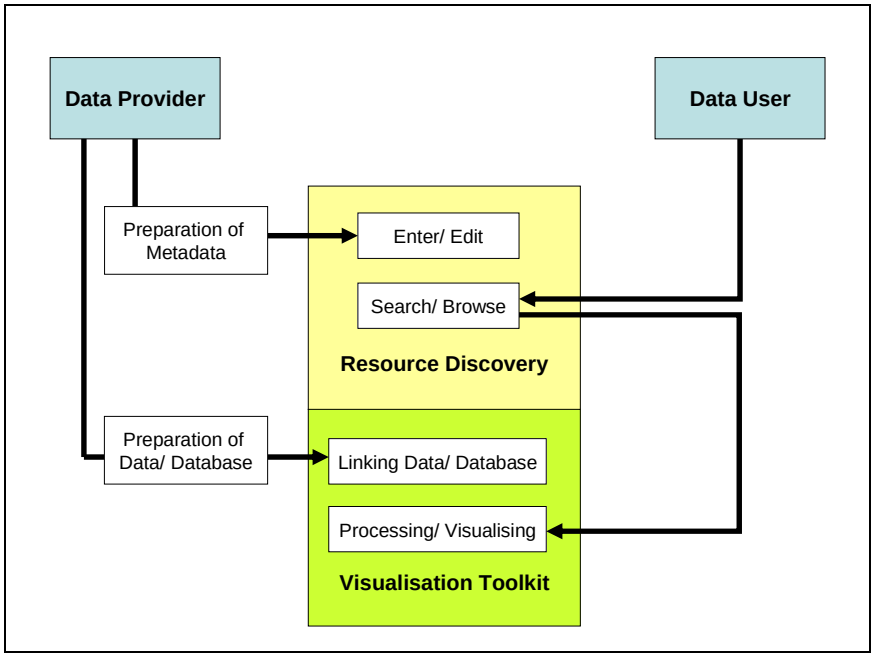
forestry is based on harmonised information flow between data providers and data users (EC JRC, 2002; Schuck et al., 2006).

Presently a large variety of information sources exists on forests at the international, European, national, regional and local levels. Examples are the Forest Resources Assessments carried out by FAO and UNECE/FAO, the FAOSTAT Forestry Data, the UNECE/FAO market services, the Eurostat Forestry Statistics, the EEA's European Environment Information and Observation Network (EIONET), and several national forest inventory reports and forestry statistics (see Chapter 4). However, information on forests is scattered and partly still rather incomplete or difficult to access (see Päivinen et al., 1998; Päivinen et al., 2001). The information does not necessarily cover all potential application fields where data are needed or they are not available at adequate depth in particular for reporting to international commitments like MCPFE C&I (see Chapter 2.3.3 and Chapter 4).

The overall goal of the EFIS and NEFIS project was to develop – or at least to set the basis for – an interactive system which allows analysis and evaluation of actual data using statistical, decision support and other analysis methods. One objective was that the system should be an independent platform allowing easy access to all data providers and potential users. Such a system would enhance the communication between various existing databases as well as between related research fields within the forest sector. It would contribute to the sustainable multifunctional management of forests and the development of improved C&I by providing a service to access relevant data to the research community and policy and decision-makers (Schuck et al, 2006).

In principle such a system would be used by two different types of user: on one hand by the data provider who uses the system as a tool for data dissemination; and on the other hand by the data user who uses the system for data and information search as well as for the visualisation and analysis of certain data and information (see Fig. 7).

Fig. 7: Key Components and Users of a European Forest Information System (EC JRC, 2002)



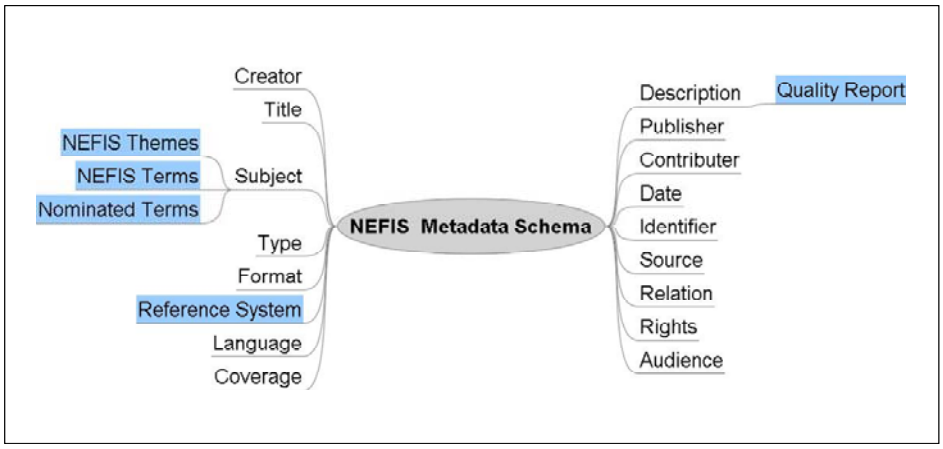
The success of an EFIS is dependent on the degree to which the information needs and expectations of potential data users and data providers will be satisfied. Thus the demand side, as well as the supply side, of information are essential. In particular, the data provider is confronted with numerous constraints with regard to making data available in an efficient, timely and cost efficient way.

The goals of a pan-European forest information system are common to most large-scale systems in that the system must aim to improve efficiency and reduce duplication of effort, that it must reduce the redundancy and duplication of data and that, by facilitating validation and single sourcing of information, it should add value and confidence to that information.

One central task of NEFIS was to elaborate a NEFIS metadata schema being an important component of an operational EFIS. Metadata are data about data – like in a library where books are described and organised according to information like author, date of publishing, content, etc. Datasets and data sources can also be described and organised to get an understanding of the source or dataset. Especially when transforming data into knowledge for decision-making it is crucial to have a clear understanding of the source (data), its organisation, and use of supplementary information. Thus comprehensive metadata description and a well functioning management system will contribute to the transparency and knowledge on the physical

accessibility and potential value of a resource (Päivinen and Schuck, 2003). The development of the NEFIS metadata schema was based on existing or emerging standards, such as the Dublin Core Metadata Initiative (DCMI), the ISO 19115 standard, and the activities within the INPIRE initiative.

Fig. 8: NEFIS Metadata schema based on DCMI metadata element set. (NEFIS modifications marked in blue) (after Schuck et al., 2006).



In addition to the metadata, the Unified Modelling Language (UML) has been adopted by the NEFIS project as a means of structuring discussion and formulating the information systems requirements and software specification for the development of and the extension to the EFIS that might satisfy pan-European needs. Within NEFIS it has been recognised that the real value of the UML was to support the analysis of requirements and the identification and modelling of the information system architectural framework (Fedorec and Richards, 2005).

The approach taken within the NEFIS project has been to develop a core set of characteristic European forest "*Use Cases*". These Use Cases have been developed as a set of "*Storylines*" that each consisted of a brief description of the particular information process, like UNECE/FAO TBFRA or MCPFE C&I.[54] For each of these storylines, a few UML Use Case diagrams were developed to better understand the linkages and relations within these information processes, but also to locate relevant information sources through an appropriate metadata schema. In developing selected UML Use Cases it became clear that some are rather complex and that their full development was beyond the scope of the NEFIS project.

[54] See http://nkb.efi.fi/

Fig. 9: UML Diagram according to MCPFE and the pan European Criteria 1: *Maintenance and Appropriate Enhancement of Forest Resources and their Contribution of Global Carbon Cycles* (after Fedorec and Richards, 2005)

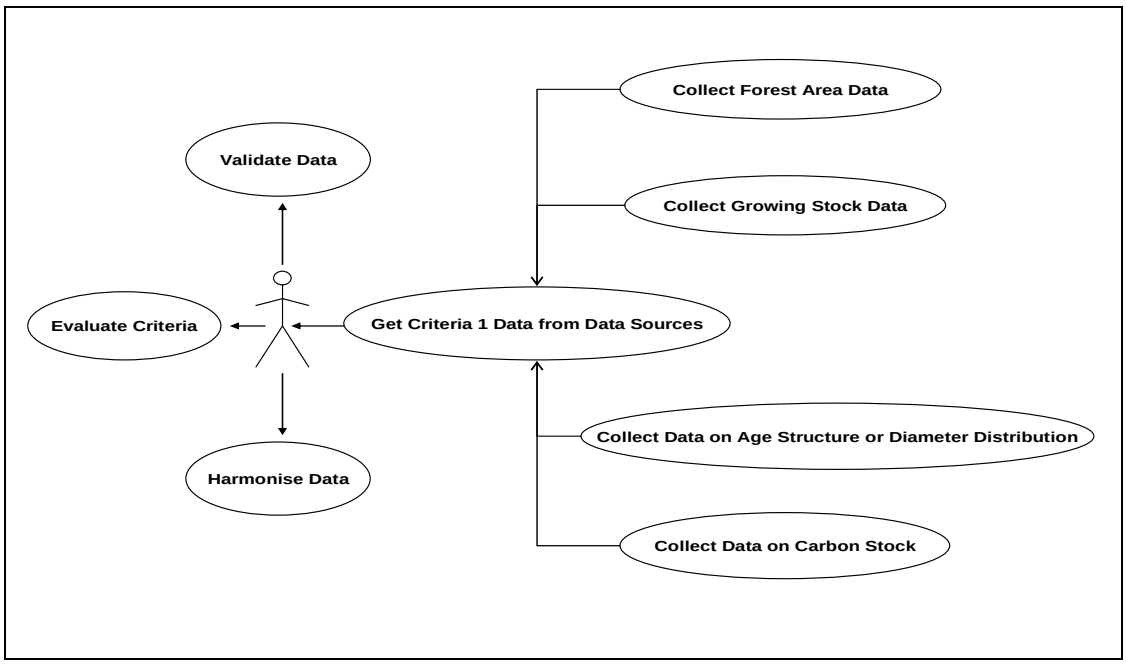


Fig. 9 depicts a simple UML diagram of the first pan-European criteria data requirements in relation to the MCPFE which objectives are to facilitate the harmonisation of national data but also to validate reported data according to the criteria requirements. Missing within this very simplified UML model are the located data sources for each indicator and the process describing the explicit data flow from the national or international data source to the MCPFE. However this diagram gives a first glance on the challenging and complex task to analyse data potentials, data flows and networking structures of national and international data sources regarding the requirements of the pan-European C&I for SFM. This is the one of the fundamental objectives of this study.

3 Concepts, Objectives and Methodological Approaches

3.1 Introduction

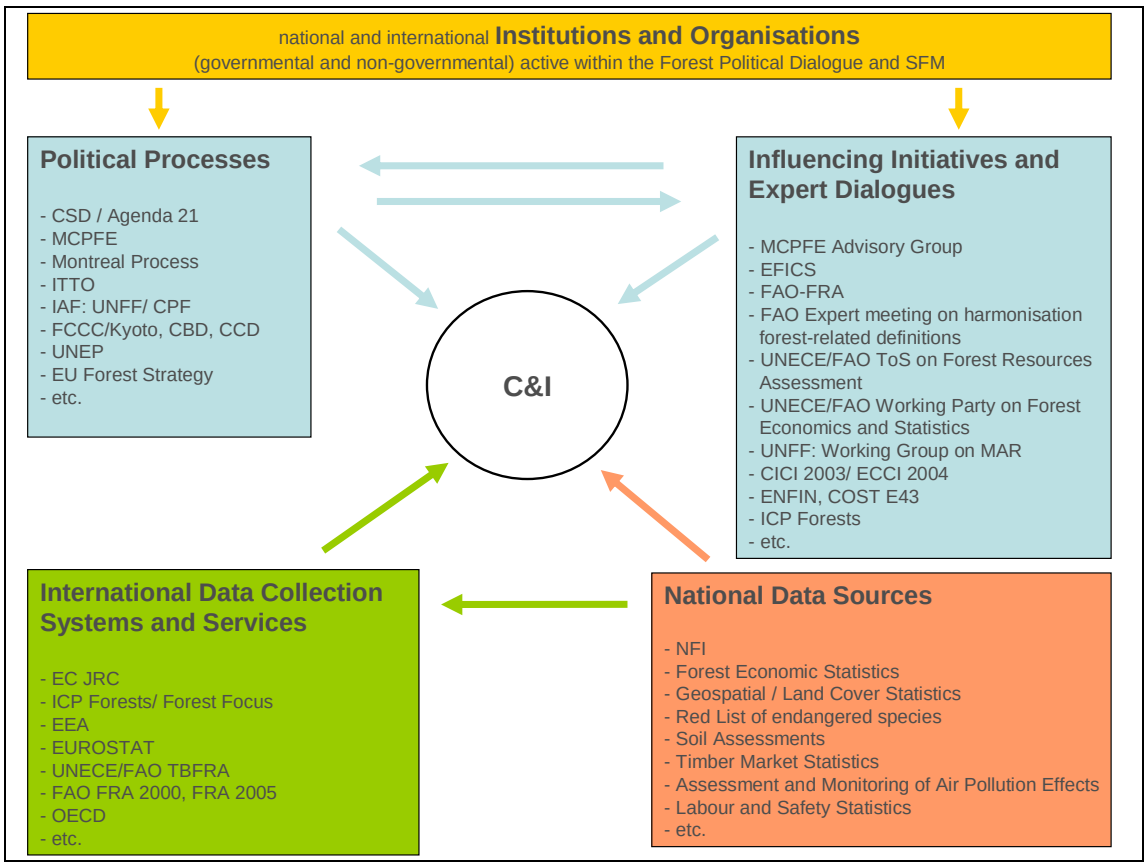
As clearly reflected by the study background (see Chapter 2), it can be seen that the monitoring, assessment and reporting on SFM using pan-European C&I incorporates different actors at different thematic or spatial levels (sub-nationally, nationally and internationally). Due to the large amount of involved actors with different backgrounds and objectives, the implementation of SFM through the use of C&I as a baseline for management or monitoring can be regarded as challenging. To improve and support C&I implementation, the major objective of this study is to analyse the networking structures and data potentials of international data sources according to the pan-European C&I for SFM. Study approaches will provide input to model a C&I Information Network that will help to analyse and evaluate different data potentials, data flows and networking structures of datasets, data sources and relevant institutions according to the pan-European C&I. Besides supporting pan-European monitoring, assessment reporting on SFM, this study also describes the theory and meaning of C&I network correlations, the understanding of which is important for implementing C&I as a baseline for forest management and forest monitoring.

3.2 The Idea of a C&I Network

Trying to depict the entire interlinkages and ongoing processes within the context of pan-European C&I would certainly lead to a very complex and ambiguous system and correlation network. This would be so for most C&I relevant political processes, initiatives, expert consultations (see Chapter 2), but also for relevant institutions and data sources for the reporting on C&I at national and international levels. Fig. 10 illustrates in a simplified scheme **the C&I network** with its major components and actors influencing the implementation of pan-European C&I – specifically from the perspective of data demands and data supply.

The content and structure, but also the different purposes and methods of C&I implementation are influenced by several forest related political processes and expert initiatives (see also Chapter 2.1 and 2.2). Within these processes and initiatives several actors from various international, regional and national institutions and organisations are represented. As the same actors of SFM relevant political processes and also of related expert consultations are influencing the structure and content of the pan-European C&I, it can be assumed that the improved pan-European C&I catalogue (MCPFE, 2002a) is a comprehensive reflection of the various information demands on SFM – at least in the highly aggregated form suitable at the pan-European level.

Fig. 10: Draft sketch of a C&I Network Model



Concerning the network of information demands and influencing processes, there is also a network of information supply. National, but also international, data sources maintained by different institutions and organisations are asked to provide adequate datasets for the reporting – in particular – of the 35 quantitative pan-European indicators. As already described in Chapter 2.3.3 data collection and reporting is carried out at pan-European level, based on national level data collection systems. National

forest inventories in European countries are a primary source of information. However, the gap-analysis (Sollander, 2001) and the Liechtenstein Case Study (Requardt, 2003) have shown that other sources are also essential for reporting, in particular for indicators that cover cultural or socio-economic aspects.

Countries already collect and report data in order to fulfil other international commitments and information requirements in the context of SFM (see Chapter 2.3.2 and 2.3.3). Numerous organisations and networks at the European or international levels collect relevant national datasets such as: (a) the UNECE/FAO with its regional Forest Resources Assessment; (b) Eurostat with its New Cronos Forestry Statistics Database; (c) the UNECE/Eurostat/ITTO/FAO Joint Forest Sector Questionnaire focusing on timber production and market statistics; (d) the UNECE ICP Forests/EC Forest Focus Programme on monitoring forest conditions and health; (e) the EEA with its European Environment Information and Observation Network (EIONET); and (f) the IPGRI[55] EUFORGEN Programme on European Forest Genetic Resources.

There are many actors, stakeholders and users of information throughout the forest sector and other related sectors (see Schuck et al. 2006). The ways in which forest information are collected, utilised and presented at the different European national and international levels are manifold (see EFICS, 1997; Päivinen and Köhl, 2005). The various international legally or non-legally binding agreements that are concerned with forests have their own specific objectives and reporting requirements (see also Chapter 2.4). Although several efforts to harmonise and streamline forest monitoring, assessment and reporting are ongoing (see Chapter 2.5), a common information framework at the pan-European level has not been defined yet.

3.3 General Objectives

To minimise the national reporting burden and to maximise the use of available datasets by using synergies within existing information strands, it is of general interest to analyse data availability and data potentials, data flows and networking structures of national and international data collection systems and data services with respect to the various reporting obligations.

Within the context of MCPFE C&I reporting it is specifically of interest to investigate:

- what parts of the required information of the pan-European C&I, both in quantity and quality, can be supplied by the current data collection systems at the national and/or international levels; and
- how the available information can be compiled by using synergies and links within existing data collection initiatives at the national and/or international levels.

At the International Conference on the Contribution of Criteria and Indicators for SFM (CICI) in Guatemala in 2003, it was concluded that:

"…the capacity for C&I reporting depends on the technical and organisational capacity (national and international) to collect, collate, analyse and validate large sets of data on a broad range of forest attributes."

Furthermore it was concluded that:

"…little new data need to be generated or collected for C&I implementation. It is simply a question of connecting disjointed information strands and collating or processing the information that exists in those strands" (FAO, 2003).

Considering the general objective of minimising national reporting burdens, and also the awareness that several datasets might already be available at the international level, the MCPFE/UNECE specified and contacted, in addition to the national correspondents, several international data providers, such as the EC JRC, ICP Forests, Eurostat, EEA, etc., to provide national data for about 12 of the 35 quantitative indicators for the forthcoming MCPFE report in 2007 (see Chapter 2.3.3, Table 3). Despite the ongoing progress to use international available datasets partly for the MCPFE reporting, there is a need to investigate in more detail whether data sources and datasets for adequate reporting are available and in how far those datasets are consistent. Such an analysis of data availability and data potential is fundamental for getting an overview on reporting ability and quality, but also to structure and understand forest related information and collection initiatives.

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[55] International Plant Genetic Resources Institute

3.4 Study Objectives

Already the EFIS and NEFIS projects (see Chapter 2.6) have raised a number of interesting questions that are relevant in this context (see EC, 1997; JRC, 2002b; Päivinen and Köhl, 2005, Schuck et al. 2006): (1) *What forest information is actually processed?* (2) *Where is it maintained?* (3) *How are the resources shared and distributed?* and (4) *Where and how is this information processed?* Most of these specific questions are – at least to some extent – answered within this study.

To discuss the concept of SFM and methods for its implementation requires an assessment of what datasets are considered to be relevant and what datasets are actually available. As the MCPFE C&I cover a wide range of different forest related information, in this study the pan-European C&I are taken as a basis to reflect SFM relevant data and information process within Europe. This study assess what international data sources and institutions are actually relevant, and what datasets for which criteria and indicators are actually available, and what the data and information preferences are in the complex context of pan-European monitoring, assessment and reporting on SFM. Furthermore, this study describes the different relationships and cause-effect mechanisms (also described as network correlations) between different SFM aspects (C&I). This is relevant for developing and defining different forest management and monitoring concepts in consideration of different objectives at different levels.

With respect to the above objectives and the idea of a **C&I Network** the following four specific tasks are of concern, and the next chapters of this study are structured according to these tasks. The **four tasks** are to:

- provide an overview of "Where to find which forest data" and structure international organisations and their data collection systems and sources according to the pan-European C&I (see Chapter 4),
- show in how far the 35 indicators correlate to each other and depict C&I interlinkages by applying approaches of network analysis (see Chapter 5),
- analyse detailed data potentials for certain indicators and a selected international data source (case study) (see Chapter 6), and

- show different approaches (e.g. data flow charts) to model a pan-European C&I Information Network that enables the complexity of pan-European monitoring, assessment and reporting on SFM to be structured and understood (see Chapter 7).

Analysing national data availability for C&I reporting has already been the focus of case-studies like Sollander (2002) and Requardt (2003), but are currently also under evaluation within the ongoing UNECE/MCPFE reporting process.[56] Because of this, and also because of the different data requirements of the pan-European C&I and the tremendous amount of various data sources and datasets at international, national and sub-national levels, **this study focuses exclusively on the international level**.

The primary objective of this study is to investigate the complexity of pan-European C&I relevant data and data collection process at the international level. It is of interest to demonstrate various approaches to model a *C&I Information Network* by showing interlinkages between and among international data sources and pan-European C&I. By developing and evaluating the pan-European *C&I Information Network* this study strongly supports:

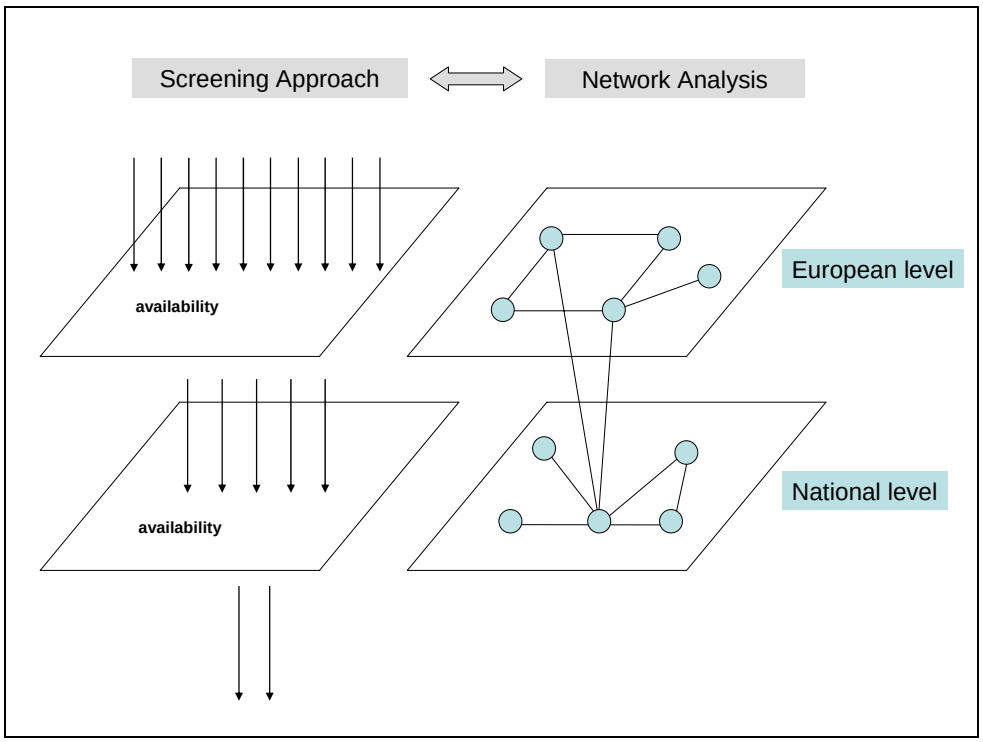
- the capacity building and improvement of pan-European monitoring, assessment and reporting on SFM,
- the C&I implementation, not only for the purpose of monitoring but also for implementing the concept of SFM,
- to streamline and harmonise various reporting obligations and therefore minimise national reporting burden,
- the development and implementation of a *European Forest Information System*, e.g. as it is foreseen by the European Commission.

3.5 The Screening Approach and Network Analysis

To analyse what datasets are already available and what data sources and institutions are relevant for the monitoring, assessment and reporting on SFM at pan-European level

(see Fig. 11), *a screening approach* in combination with *network analysis* is applied. The screening approach facilitates an overview of data potentials of selected international institutions and data sources regarding the data requirements of the pan-European C&I. Furthermore the network analysis facilitates identification of: (a) the correlation between selected institutions/data sources and the pan-European C&I, and (b) pan-European C&I network interlinkages. The combination of both approaches is conducted in order to identify network structures, groups, core-elements, stand-alone areas, redundancies and synergies between and among international data sources and the pan-European C&I.

Fig. 11: Screening Approach in combination with Network Analysis



To analyse the structures and potentials of monitoring, assessment and reporting on SFM at the pan-European level, the screening approach and the network analysis are applied to the following specific objectives with respect to the six pan-European criteria and 35 indicators:

- identifying relevant international institutions and data sources;
- identifying data potentials of selected data sources;

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[56] See study background (Chapter 2.3.3): national reporting respective the MCPFE report "*State of Forests and Sustainable Forest Management in Europe 2007/2008*".

- identifying core indicators and also informational gaps and bottlenecks of selected data sources;
- identifying information redundancies and potentials for using synergies between selected sources and available information;
- identifying the correlations and interlinkages between selected international institutions and data sources.

The screening approach can be described as a top-down approach (see Fig. 11). The screening works like a raster – a raster in which relevant data sources and their data potentials are identified coming from international (European) level and going down to the national or also sub-national levels. As mentioned above this study focuses primarily on the international level.

However, the data potential screening is conducted in two phases. The first screening (see Chapter 4) intends to provide an overview of what data sources and institutions are actually relevant according to the pan-European C&I rather than showing complex details of data potentials and data discrepancies of selected data sources and assessments. Within the first screening various international data sources like databases, information systems, enquiries and data reports are analysed according to their potential to supply relevant quantitative data concerning the 35 pan-European quantitative indicators The first screening facilitates analysis of whether the indicator information *in its basic form* is available (covered) on the international level or not. *In its basic form* means that further indicator classifications like "*forest types*" or "*availability for wood supply*" and also all specific indicator reporting units are not considered. The primary objective of the first screening is to analyse and evaluate the question: *Where to find which forest data at the pan-European level?*

The second phase of the screening considers the entire complexity of classifying data potentials in more detail (see Chapter 6 and Annex 2). Approaches of analysing and classifying data availability and data potentials of national data sources such as those developed by Requardt (2003) but also approaches used in Multi-Criteria-Decision Making are taken into account to develop a *data potential classification scheme* appropriate for international data sources. Due to the limited framework of this study, and also the enormous complexity of relevant international sources and data requirements of the pan-European C&I, a further detailed data potential classification is

conducted and demonstrated only for the example of the *joint monitoring programme of ICP Forests/Forest Focus* (see Chapter 6).

3.5.1 Introduction: Analysis of Data Potentials

The analysis of data potentials reveals the extent to which national or international sources are able to provide required datasets and information in the explicit required form – in this case according to the MCPFE C&I requirements. In required form indicates the specific information demands of each requested pan-European indicator which are described by its nomenclature, definitions, data classifications, reporting units, and data format.

As stated in the study introduction, **data potential**[57] is defined in this study as the following:

Data potential characterise in different categories in how far available data or available data assessments (e.g. methodologies of data assessment, analysis and evaluation) or data storage and maintenance fulfil specific data requirements, defined by applied nomenclature, definitions, data classifications, reporting units and data format as well as by the temporal and spatial resolution of data.

The major objective of analysing data potentials is to describe data availability in more detail. It is of interest to reveal whether: (a) explicit data are available and can be reported, (b) available data (raw data) can be used but new data evaluations are

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[57] The commonly used term *data availability* is a near synonym of the term *data potential*. Unfortunately there is not much scientific background available to clarify or to specify both terms.

Data availability on the one hand is a term frequently used by computer networks and database services to describe in how far data continue to be available at a required level of performance (see Ranganathan et al., 2002). Within the various initiatives to develop and implement *sustainability indicators* it is widely acknowledged that *data availability* might be an important limiting factor – especially when it comes to its major purpose of measuring and reporting *driving forces, pressures, states, impacts* and *responses* towards any specified objectives (see e.g.: Garcia et al., 1999; Stockmann, 2001; Niemeijer, 2002; Brang et al., 2002; ECOSOC Statistical Commission, 2004). On the other hand **data potential** is a term much less used than data availability. Data potential is a term that is partly applied when it comes to specified user perspectives and demands on e.g. the use of available data and information. Data potential describes in how far available data are applicable to fulfil specified demands with respect to available data, data assessments and data sources. A given data potential implies that at least either the data itself or information about the data assessment, data storage and data maintenance exist. Based on the analysis of data potential it is possible to develop and implement various concepts to optimise the potential use and applicability of available data, data assessments, storage and maintenance.

necessary, or (c) completely new methods of data collection and assessment have to be implemented to report required information.

The basic elements of describing data potential for reporting abilities are that a) either data (final explicit figures or also raw data) or b) the methodology of data assessment or data processing are available or not. Sollander (2002) analysed data availability for C&I reporting for selected test areas (see Chapter 2.3.3), and asked national correspondents for some general descriptions on *availability of data, reliability of the method used to collect the data* and *weaknesses and possibilities to improve the applied methodologies in selected test areas*. Similar information on data availability is collected within the UNECE/FAO TBFRA 2000, the FAO FRA 2000/2005 or also within the national reporting for the forthcoming MCPFE in Warsaw 2007 (see study backgrounds, Chapter 2.3.3). In order to differentiate data potentials of national data sources with respect to the abilities of national reporting on pan-European C&I, Requardt (2003) developed the following classifications of data potentials in 2003 (see Chapter 2.3.3 – Liechtenstein case study):

DM (A): datasets and methods of assessment are available and available figures match data requirements – datasets can be reported in required form.

DM (B): datasets and methods of assessment are available, but available figures match only partially data requirements – datasets can only be reported in another form, e.g. according to a different classification/definition from the required classification/definition.

DM (C): although datasets (raw data) and methods of data evaluation and processing (like specific algorithms) are available, explicit figures are missing.

Dm: raw data are available, but there is no methodology on how to process raw data to derive required information (e.g. explicit functions or algorithms are not available).

dM: methods of assessment are known, but for various reasons no datasets have been assessed (e.g. because of limited resources/capacities).

dm: neither raw data nor methods of assessment are known – no data potential.

According to the distinguished classification of data potentials and a brief metadata description of *methodology of data assessment*, *data error* and the *temporal* and *spatial resolution* of provided and reported data, a sound picture of the current national data situation of Liechtenstein for the fulfilment of the pan-European C&I was described.

3.5.2 Introduction: Network Analysis

Network Analysis has its origins in Social Science. Network data are defined by actors and by their relations, also called nodes and ties. Social network analysis is based on an assumption of the importance of relationships among interacting units (see Wassermann and Faust, 1994). The unit of analysis in network analysis is not the individual actor or node and its attributes (Hanneman, 2001), but the entity consisting of a collection of individuals and the linkages among them. Network methods focus on *dyads* (two actors and their ties), *triads* (three actors and their ties), or larger systems (subgroups of actors or entire networks) (Wassermann and Faust, 1994; Jansen, 2003). Social Network Analysis is the mapping and measuring of relationships and flows between people, groups, organisations, computers, modules or other information/knowledge processing entities.[58] Social Network Analysis is based on graph theory where relations between selected actors and groups can be depicted and analysed. Social Network Analysis provides both a visual and a mathematical analysis of complex relation systems.

Although social relations were already studied within the Social Sciences at the beginning of last century (see e.g. Simmel, 1908), Social Network Analysis and especially the applied graph-theory are a rather novel approach. First scientific discussions and methodology developments started at the beginning of the 1970s (see Alba, 1973; Doreian, 1974). Until today Network Analysis is predominately used for measuring or describing social structures such as of connections within family relationships or communication flows between employees (see e.g. White, 1968). When analysing social structures it is of particular interest to analyse the relationship, the interaction or the information flow and exchange between selected actors and within the

[58] See: www.orgnet.com/sna.html

selected social group (see e.g.: Haythornthwaite, 1996; Almendral et al., 2003; Wu et al., 2004). In recent years *network analysis* became a tool within policy and economics. Aspects of the communication or information flows between employees or between companies or organisations are becoming more and more of a concern in complex systems. Centrality, prestige or roles such as isolates, liaisons and bridges are important parameters to understand but also to improve the relations and interactions within a certain unit. Improved knowledge management and inter-organisational or business cooperation rely more and more on results gained from network analysis (see e.g.: Kappelhoff, 1999; Dahlstrom and Ingram 2003).

Network data are organised in a matrix. The most common form of a matrix in social network analysis is a straight forward one, composed of as many rows and columns as there are actors in the unit that is to be investigated. The simplest and most common matrix is where the described relations are binary. If a relation is present a "1" is entered in the cell; if there is no relation a "0" is entered. This kind of a matrix is the starting point for almost all network analysis, and is called an "*adjacency matrix*" because it represents who is next to whom in the unit mapped by the relations that have been measured (Hanneman, 2001).

Relations can be described by directed or undirected ties. In a directed graph, the sender of a tie is the row and the target of the tie is the column. Directed ties are shown by arrows, and undirected ties (also called bonded ties) are shown as lines (Hanneman, 2001). As described above, binary data are usually represented with zeros and ones, indicating the presence or absence of each logically possible relationship between pairs of actors. Signed graphs are represented in matrix form (usually) with -1, 0, and +1 to indicate negative relations, no relations, and positive relations. When ties are measured at the ordinal or interval scale, the value of the measured tie is entered as the cell value of the matrix. Other scales are also possible such as multi-category nominal[59], ordinal

[59] Multi-category nominal scales can be used to score a relationship according different types of relationships, for example whether it is a *friend, lover, business relationship, kin*, or *no relationship* (see Hanneman, 2001).

with more than three ranks or full-rank order nominal[60] (Hanneman, 2001). This allows various options to describe relations in a more descriptive or *valued*[61] context.

Fig. 12: Organisation Network Data (e.g.: P = Person; E = Event)

One-Mode Network

	P1	P2	Pn
P1			
P2			
Pn			

Two-Mode Network

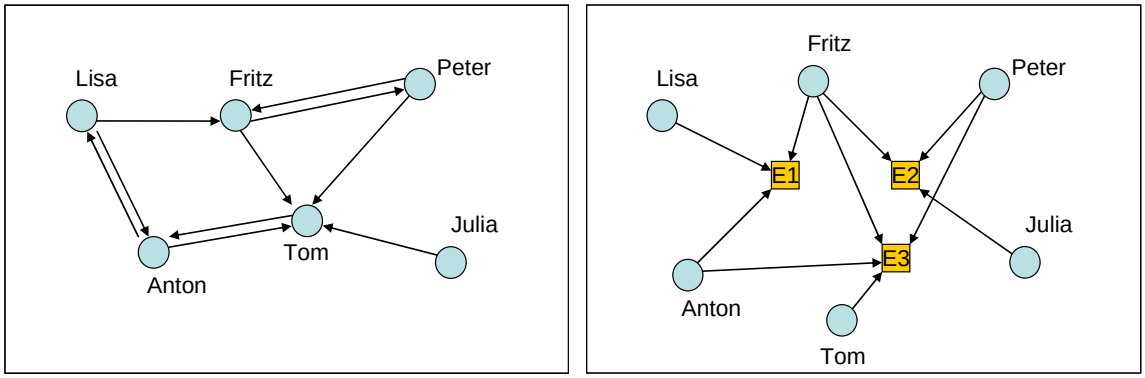
	E1	E2	En
P1			
P2			
Pn			

Ties:

- binary (0/1)
- signed +/-
- ordinal
- directed or bonded

According to Diaz-Bone (2000), three characteristics have to be distinguished to describe networks: (1) properties of the network actors, (2) characteristics of the relations between actors (e.g. symmetric/asymmetric), and (3) characteristics of the entire network structure (e.g. density, connectivity, sub-groups etc. – see also further below).

Fig. 13: Example of a network graphs: (a) one-mode network showing the relation of six selected pupils within a school class, or (b) two-mode network showing the interlinkages between six pupils in correlation to three selected events, e.g. sport events.



In principal network analysis distinguishes **one-mode networks** and **two-mode networks**. One-mode means that the same list of actors (nodes) is put into relation to each other (see Fig. 13a). One-mode networks are the most classical form of social networks and are in this study primarily be applied for depicting and analysing C&I

[60] Full-rank order nominal scales can be used to score the strength of all relations of an actor in a rank order from strongest to the weakest (see Hanneman, 2001).
[61] Valued graphs have numerical values attached to the lines that measure the magnitudes of interaction, i.e. the strength of the relation (see Wasserman and Faust, 1994).

correlations and network interlinkages (see Chapter 5). Two-mode networks (see Fig. 13b) arise when there is some information about e.g. the memberships or attendance of actors in public entities such as events, organisations or political processes. Two-mode data are typically organised as an incidence matrix with actors as the rows and the events or membership units as the columns. Two-mode networks enable analysis of the contacts between actors created by their meetings or at the network of relations between the corporate entities/units generated by those actors who are present in two or more entities/units (Borgatti and Everett, 1997). In this study, the approach of two-mode networks is specifically applied to analyse and describe data potentials (*linkages*) of international data sources according to the pan-European C&I (see Chapter 4).

Due to the data organisation in a matrix, network analysis enables several options of data analysis and graph depiction. Software solutions as provided by *UCINET*[62], *Pajek*[63] or *Visone*[64] provide several features that allow depiction of network graphs, and calculation of various network parameters to describe the network to be analysed with its actors (nodes), relations (ties) and structure. As this study considers methodological approaches of network analysis on a superficial level rather than in its entire complexity, only a few of the most relevant network parameters are listed and briefly introduced (see Jansen, 2003):[65]

Dyad

The dyad is the most possible smallest relation unit within a network. The dyad describes a network consisting only of two actors. Dyads are distinguished into three types: mutual, asymmetric and null[66]. The number of dyads within a network of N actors is:

$$\binom{N}{2} = (N^2 - N)/2 \qquad (1.1)$$

[62] http://www.analytictech.com/ucinet/ucinet.htm
[63] http://vlado.fmf.uni-lj.si/pub/networks/pajek/default.htm
[64] http://visone.info/
[65] All listed parameters are predominately applied for the analysis of one-mode networks.
[66] *Mutual*: described by two-head arrows, meaning that the relation is confirmed or indicated by both actors (nodes); *Asymmetric*: described by one-head arrows, meaning that the relation is confirmed or indicated only by one actor (node); *Null*: describes a dyad with no relation (see Wassermann and Faust, 1994).

Density

The density informs about the overall connectivity within a network. The density is defined by the proportion between the number of existing ties and possible ties. The density $d\square_k$ is 1 if the network is complete.

(1.2) $$d\square_k = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} x_{ijk}}{N(N-1)}$$

where is:

N = Number of Nodes or Actors
j = Number of Columns
i = Number of Rows
x = Boundary Sum
k = Relationfactor

Degree

The degree informs about the connectivity of an actor within a network. It reflects in how far the actor is connected to other actors (undirected) or in how far the actor receives a tie (*indegree*) or sends a tie to another actor (*outdegree*) within a directed network.

Indegree (1.3) $$id_j = \sum_{i=1}^{N} x_{ij} = x_i$$

Outdegree (1.4) $$od_i = \sum_{j=1}^{N} x_{ij} = x_i$$

Centrality

Within an undirected network centrality is the degree of the selected actor. Instead within a directed network the actors' connectivity or its network participation and role are reflected by the outdegree.

(1.5) $$C_D(n_i) = d_i = \sum_j x_{ij} = \sum_j x_{ji}$$

where:

n_i = the node or the actor

Betweenness-Centrality

The betweeness-centrality measures in how far the network actors are affected by or depend on a selected actor within the network. Connectivity between two actors can be also given by a third actor (the *broker*). The more connections the broker has, the higher is its centrality.

(1.6) $$C_B(n_i) = \sum_{j<}^{n} \sum_{k}^{n} b_{jk}(n_i)$$

Indegree, *outdegree*, *centrality* and *betweeness-centrality* are the core parameters to describe the relevance of a selected actor within a network. They reflect the individual role and function of an actor in correlation to the entire network or within a selected group of actors.

Defining the network (the list of actors to be analysed) is the most important task and sensitive challenge within network analysis (see Jansen, 2003). Network analysts most commonly identify a selected number of actors and conduct a census (Hanneman, 2001). Because network methods focus on relations among actors, actors cannot be sampled independently to be included into observations. If one actor has been selected, it is important to include all other actors to whom the selected actor has relations. Most network analysts think of individual actors "*as being embedded in networks that are embedded in networks that are embedded in networks"* (Hanneman, 2001). Such structures are described as "*multimodal*" (see also *two-mode networks*). In the school example, individual pupils form one mode, the classrooms a second, schools a third, and so on. Multimodal networks can be very complex and difficult to be analysed (see Jansen, 2003).

In principal the boundaries of defined networks are of two main types. Most common are boundaries that are created by the actors themselves (e.g. naturally occurring clusters). Alternatively, a network might be defined by listing and analysing all actors that are found in a certain bounded spatial area (e.g. Europe) or that meet some certain selection criterion (e.g. being member of the MCPFE). Full network methods require that information is collected about each actor's ties with all other actors. Full network data allow much differentiated descriptions and analyses of network structures. Unfortunately, collecting full network data is often very expensive, time consuming or difficult (Hanneman, 2001). An alternative is the so called "*Snowball Approach*" (see Hanneman, 2001; Jansen, 2003). The Snowball methods begin with one actor or a set of actors. Each of these actors is asked to list (a) only those actors that are explicitly relevant to the survey objective, or (b) all actors to which any kind of relation exist. Then, all the actors listed are tracked down and asked for some or all of their ties. The process continues until no new actors are identified, or until the analyst decides to stop (usually for limits of time and resources).

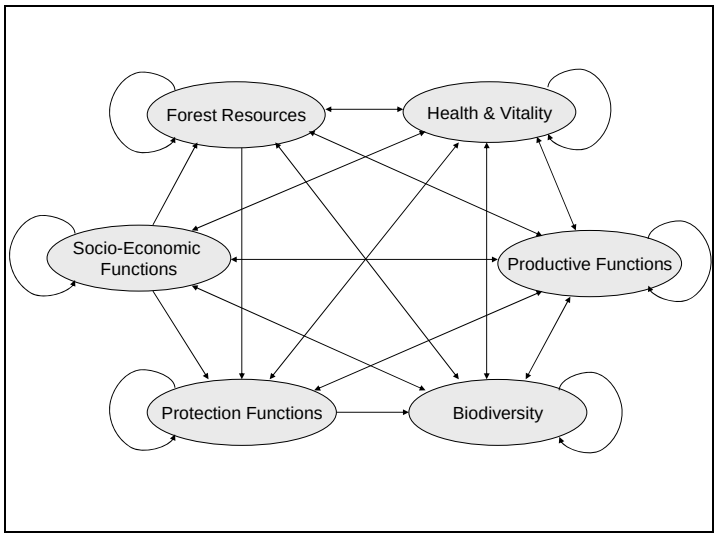
3.5.2.1 Network Analysis in the domain of Forestry or Forest Science

Reviewing literature, the approach of network analysis seems to be a quite new approach within the sector of forestry and forest science. First applications in the field of forest research were done within the sector of forest policy analysis, predominately focusing on the issue of communication. Hasanagas (2004) for example focused on the question how powerful different actors were within environmental policy networks, assuming that power is a function of network and organisational characteristics and thus not every actor can be powerful in every network. Without exactly applying approaches of network analysis, Janse (2005) developed various network charts in which he illustrated and explained the co-operation and organisation structures of various forest policy makers within the domain of European forest communication.

Mendoza and Prabhu (2003) and Wolfslehner et al. (2005) applied approaches of network analysis to draw so called "*causality*- or *correlation maps*" of C&I for SFM on the Forest Management Unit (FMU) level. Both applied approaches of Multi-Criteria Analysis to generate a set of applicable indicators on the FMU level (see also Chapter 2.3.4.2). Specifically Mendoza and Prabhu developed a causality map of the FMU level

indicators describing indicator interlinkages. Wolfslehner described the potential interlinkages of the six pan-European criteria for SFM within a theoretical network model (see Fig. 14).

Fig. 14: Draft criterion network (after Wolfslehner et al., 2005)



In contrast to *network analysis*, the term *network* is used much more frequently in forestry, forest science and forest policy – particularly considering aspects of cooperation and communication. The idea of *networks* therefore is crucial within the issue of harmonising and streamlining forest data and forest reporting obligations. The EFIS[67] and NEFIS[68] projects (see Chapter 2.6) for example focused on the development and implementation of a European Forest Information System (EFIS) embedded within a multilevel network of various data providers and data users. Applying the Unified Modelling Language (UML) (see Fedorec and Richards, 2005; Schuck et al, 2006) first draft networks have been sketched to better understand the correlations and interactions of various actors and processes within the issue of forest monitoring, assessment and reporting (see Chapter 2.6). The CPF Initiative[69] on streamlining forest related reporting also used the idea of generating networks in which different reporting processes such as MCPFE, ITTO, CBD, UNFCCC, CCD, UNFF, CSD, etc., were put into relation to the 15 FRA 2005 reporting tables[70] (see Chapter 2.2.2 and 2.5).

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[67] http://www.efi.int/efidas/efis/
[68] http://www.efi.int/projects/nefis/
[69] http://www.fao.org/forestry/site/cpf/en/
[70] FAO FRA - Relevance of National Reporting Tables for International Processes, see: http://www.fao.org/forestry/site/21107/en/

This study takes the idea and methodology of network analysis described above into account and develops new approaches that analyse international sources and their data potentials for C&I reporting (*two-mode networks*) as well as the interlinkages of pan-European C&I (*one-mode networks*).

4 Approach 1: Where to find which forest data (Overview)

4.1 Introduction

The abundance of available information offers the challenge to select the *vital* information. Decision makers need to find purposeful information distilled to a degree that facilitates effective and objective decisions (see Schuck et al., 2005). Already in 1996, T. J. Peck, former director of the FAO/UNECE Timber Division, suggested structuring the various ongoing international activities of collecting and disseminating forest sector information in Europe (Peck, 1996). Furthermore in his discussion paper he raised the question: "*Is there too little or too much forestry information at the international level?"*

Considering these general objectives and this particular question, this study chapter provides an overview of *where to find which forest data* at the international level. Within this study it is assumed that structuring international institutions and data sources according to the pan-European C&I helps to: (a) find SFM relevant information more easily; and (b) evaluate the international capacities to monitor, assess and report on SFM. Furthermore it is of interest to generate a C&I Information Network that can be used as a basis for developing and implementing a C&I structured *European Forest Information System* (see Chapter 2.6). A structured overview of international (and also of national) forest datasets according to the pan-European C&I will assist in harmonising multiple data collection initiatives, but also improve the communication between different organisations and stakeholders in the field of monitoring, assessment and reporting on SFM.

The primary objective of this approach is to analyse the correlation and interlinkages between data requirements of the pan-European C&I and various international data sources by applying approaches of network analysis and the screening approach (see Chapter 3.5). The screening approach and the network analysis are conducted according to *thematic strands*. These *thematic strands* are the 35 pan-European indicators, or

aggregated the six pan-European criteria: Who collects and provides datasets for example concerning *forest biodiversity* or concerning *forest production*?

4.2 Methodology

The major challenge within this approach is to define the network – in this case: the list of data sources relevant for the reporting on the pan-European C&I. The predominant problem is the information complexity: either considering the specific data requirements of the pan-European indicators (see Chapter 2.3.3), or also considering the enormous amount and diversity of existing forest related data sources maintained by various international institutions and organisations.

To minimise the complexity (but also to retrieve most sound and unambiguous results) within this approach, the C&I information requirements were limited to what was perceived to be a reasonable minimum. That means the data potential of selected data sources has just been investigated for the basic indicator information requirement itself. Specific indicator classifications, reporting units or explicit definitions were not considered. That means, for example, that in the case of indicator *1.1 Forest area* only the data potential for the attribute *forest area* has been investigated. The potential for adequate data supply of specific classifications like *forest area classified by forest types* and *by availability of wood supply* were not considered.

The major objective of this approach is to provide a sound picture of international forest related data sources reflected by the pan-European C&I. Therefore, a comprehensive list (the network) of relevant international data sources and institutions has to be defined.

The following approaches were applied to define the network:

- the MCPFE Paper "*Where to find forest data*" (MCPFE, 2003) is taken as a basis;
- thematically defined network that focuses exclusively on C&I data demands;
- geographically defined network that focuses exclusively on pan-European level;
- snowball approach, to identify further relevant sources.

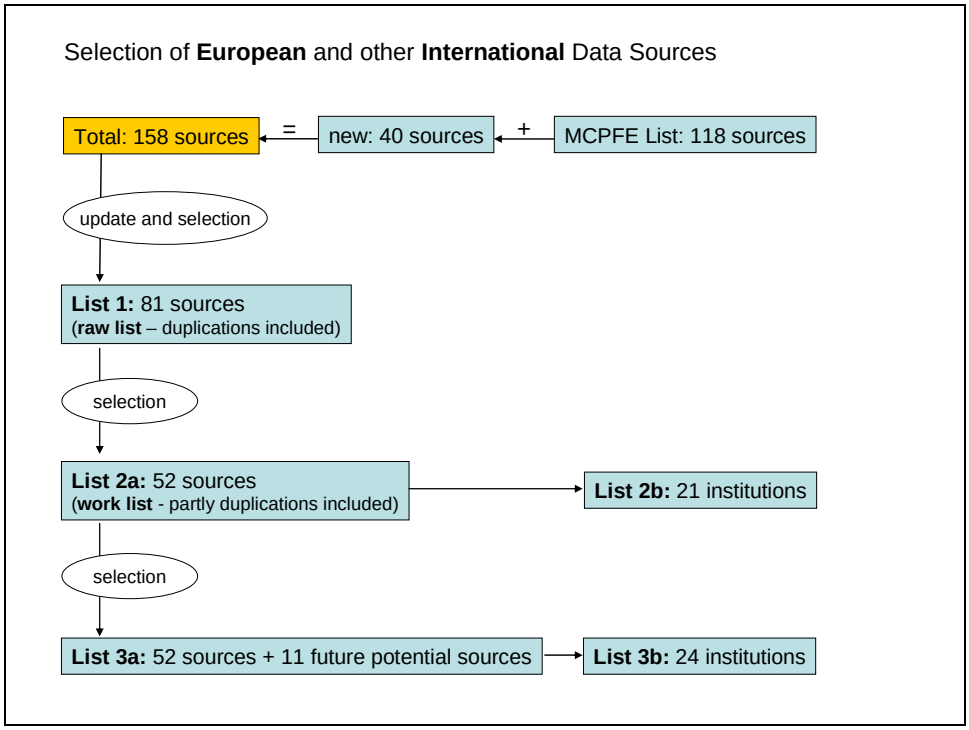
The MCPFE Paper "*Where to find forest data*" (MCPFE, 2003) provides in alphabetic order a sound list of forest data and information sources structured by responsible institutions and organisations. This document presents a pan-European overview of various international forest related information sources like databases, information systems, reports, websites, programmes or temporally conducted projects. The document can be regarded as a snapshot of the year 2002/2003 listing also several non-statistical information sources.

The MCPFE Paper was taken as a basis to select relevant data sources reflected by the pan-European C&I. All listed sources providing rather non-statistical information than quantitative data were not taken into account. Only those sources that provide quantitative datasets like descriptive forest statistics explicitly relevant for at least one of the 35 pan-European indicators were selected. As this study focuses on a pan-European overview, predominately sources relevant within the European context were selected. Global sources instead, as for example databases of the World Bank Group or the World Resources Institute (WRI), were only considered as long as they also provide explicit European quantitative data.

Although the MCPFE document can be regarded as a comprehensive list of relevant sources, more sources had to be added (40 in total). In this study updating the MCPFE source list was indicated because (a) some relevant new or even older sources were not considered within the MCPFE document and (b) some of the MCPFE listed sources were only outputs of temporary pilot studies without any long-term maintenance and implementation. Temporary or not yet implemented data sources were only considered as long as they seem to be potentially relevant for the future (see list below).

Finally a snowball-approach (see Chapter 3.5.2) has been conducted, either focusing on one theme of one criteria e.g. *biodiversity* or focusing on one already listed source. The snowball approach facilitates finding of further relevant sources to enhance the source list and to make sure that almost all relevant sources within the pan-European C&I context are considered.

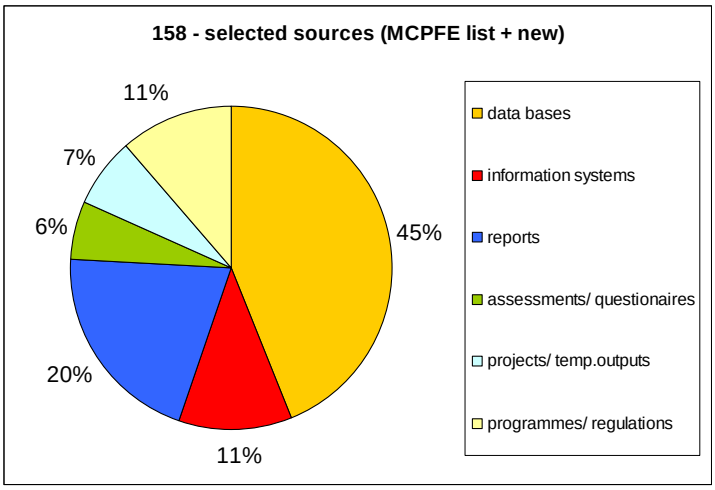
Fig. 15: Defining the network: iterative selection of relevant data source



Relying on about 30 different international institutions and organisations, 158 different information and data sources were investigated according to their relevance for the reporting on the pan-European C&I – 118 sources out of the MCPFE list, plus 40 new added sources (see Fig. 15).

The list included all kind of different types of sources (see Fig. 16). Most of the investigated sources are databases (45%). Only 11% were classified as information systems, systems in which more than one database is linked. Some 20% of the sources are reports, either regular reports such as the UNECE Timber Bulletin Forest Products Annual Market Review or the EEA Environmental Assessment/ Signal Reports, but also irregular published reports as the UNECE EFSOS Report. Different types of data assessments were also included, as for example the UNECE, FAO, Eurostat, ITTO Joint Forest Sector Questionnaire (JFSQ) or the FAO Forest Resources Assessment FRA 2000 and FRA 2005. Temporary projects were checked for their relevance and implementation status and were, if not listed in the MCPFE list, added as new sources to the final list if regarded as a relevant future potential source like the GMES GSE Forest Monitoring Services. Furthermore, also programmes or regulations such as the EC Forest Focus Regulation, the CoE European Diploma on Protected Areas or the CoE European Landscape Convention were investigated.

Fig. 16: Coverage and type of investigated sources



From the 158 investigated sources **81 sources were selected** for the final screening and network analysis. These 81 sources are considered as the relevant sources for the C&I reporting, all other remaining sources of the 158 are not relevant in this context. This list of 81 sources is called the **raw list** (see Table 7) and has been investigated according to their basic data potential to provide quantitative data for the pan-European C&I. Within a matrix (*two-mode network*) all 81 sources were put into relation to the 35 quantitative indicators (see also Annex 3).

The criteria for selecting the 81 sources from the total list of 158 sources were:

- delete from the MCPFE list:
  - sources for which the information and dataset content is not relevant for any of the quantitative C&I requirements;
  - temporary projects without relevance and operational implementation;
  - sources which are too generic in their data supply/ data content (e.g. global reports without any specified quantitative European datasets);
  - political programmes and regulations as they are regarded rather as political measures than explicit sources to provide quantitative data.
- add sources which seem to be relevant for C&I reporting, but not included in MCPFE list. Approaches for updating the MCPFE list were: snowball approach, literature review, expert consultation.

- select and merge double entries – sources which are listed more than once as they are maintained by different institutions (e.g. UNECE ICP Forests/EC Forest Focus, Level 1 and Level 2);
- group sources which are a derivate product of an upper-source/ upper-system (e.g. reports based on already listed databases);
- contact experts in the field of Forest Resources Assessment and Information Management and ask for reviewing the final selected list and further suggestions.[71]

However, the applicability of the raw list to analyse the current data potentials on international level is partly restricted. The list of 81 selected international sources still includes several duplications. In this context, duplications are considered as duplications not of sources but of one and the same dataset, datasets which are assessed by an institution and are stored or published in different formats by the same institution. Most relevant duplications in the raw list are: (a) reports (especially annual reports) which datasets also rely on a listed database or information system, or (b) data assessments like the Joint Questionnaires, the datasets of which are (or will be) stored in any explicit, already listed, database or information system.

In the raw list are also included some selected future potential sources – the sources of which are not fully implemented yet but are regarded as potentially relevant in the future (see below). These sources were included to analyse possible trends and changes within the current data coverage of already implemented monitoring, assessment and reporting activities at pan-European level (see Chapter 4.3.4).

To provide an overview on **which data are currently available** according to only fully implemented international data sources and to show what data coverage actually exists within the current pan-European activities of monitoring, assessment and reporting on SFM, a further list of sources had to be selected from the raw list of 81 sources. This selected list is called the **work list** and contains **52 sources** (see Table 7). All selected future potential sources, all Joint Questionnaires but also several reports – especially all

[71] Close contact was given to the European Forest Institute, Research Area 4: Forest Resources and Information. Involved experts were Mr. Andreas Schuck and Mr. Jo van Brusselen.

annual reports which are rather duplications than any new assessments – are not considered in the final work list of 52 sources.

The 52 selected sources are maintained by 21 different international institutions and organisations (see Table 7). Some of the sources are part of joint programmes or institutional cooperation such as the UNECE ICP Forests/EC Forest Focus joint monitoring programme on Level I and Level II, the UNEP-WCMC World Database on Protected Areas (WDPA) or the EC/EEA Natura 2000 database. The number of sources per listed institution or organisation is different. Some of them, like Eurostat, EC JRC, FAO, UNECE or the OECD have more than one source listed (between 4 and 6). By six in total Eurostat is considered with the highest number of different data sources. Other institutions instead are considered only with one single data source such as the WRI, ILO, IEA, IPCC, IPGRI or ITTO.

Reviewing the work list of 52 selected sources, it becomes obvious that even in that list some (data) duplications are still included. Most relevant duplications are the data duplications of the FRA 2000 and 2005 and the FAO Forestry Information System (FORIS). The FAO FORIS is nevertheless included as an extra source as some of the individual country profiles provide datasets and information which are not explicitly included within the FRA 2000 and 2005. The datasets of the UNECE/FAO TBFRA 2000 also include data which are already listed for example within the UNECE/EC joint monitoring programme ICP Forests/Forest Focus on Level I and Level II.

To minimise the effect of duplications a final aggregation of all 52 sources according to responsible institutions and organisations facilitates an overview of data coverage without almost any duplications included (see below). Within that summary, the data coverage of one indicator counts only once even if more than one of the listed sources of that institution or organisation provides explicit datasets according to the analysed indicator.

The data potentials of all listed data sources were analysed in autumn 2005 relying on a literature review, metadata review or if datasets were "*accessible by public*" also directly according to available datasets (e.g. data bases accessible via the internet). Manuals of data assessment, tables of contents, data bases and available reports as well as all kind of other data descriptions like metadata were thoroughly reviewed according to any indication of data potentials towards to any of the 35 pan-European indicators.

Additionally, in the case of EFI and the UNECE/EC (PCC of the ICP Forests), expert interviews were conducted to verify analysed data potentials of explicit listed data sources. Due to the limited framework of this study most of the organisations could not have been directly contacted and been asked for data potential verification.

The study reflects the status of spring 2006. Future developments and trends were analysed by the effect of some selected future potential sources. To minimise the complexity, this study includes only partly detailed background descriptions of sources and their explicit data potential.

Table 7: List of selected data sources (raw list and work list)

Legend:					
	work list		future potential sources		duplications
CoE	European Landscape Convention				
CoE	EMERALD Pilot-Database				
CSD	Indicators of Sustainable Development				
EC JRC	EUSIS - European Soil Information System				
EC JRC	EFFIS - European Forest Fire Information System				
EC JRC	Global Land Cover 2000 Database				
EC JRC	Global Burnt Area 2000 Database				
EC JRC	Forest Focus - Forest Mapping				
EC/EEA	Natura 2000 Database				
EEA	EIONET - Data Service				
EEA	EIONET - EUNIS European Nature Information System				
EEA	CDDA - European Common Database on Designated Areas				
EFI	Forest Map of Europe				
EFI	WFSE Trade Flow database				
EFI	EFISCEN European Forest Resource Database				
EFI	DFDE - Database on Forest Disturbances in Europe				
ESA	ATSR World Fire Atlas				
ESA	GMES GSE Forest Monitoring - Services and Products				
Eurostat	EUROPROMS - European Production and Market Statistics				
Eurostat	COMEXT Database				
Eurostat	GISCO - Geographical Information System of the European Commission				
Eurostat	New Cronos DB: Forestry Statistics Database				
Eurostat	New Cronos DB: EAF - Economic Accounts for Forestry (wood sector)				
Eurostat	New Cronos DB: EAF - Economic Accounts for Forestry (non-wood sector)				

Eurostat	New Cronos DB: Forestry Statistics 1992-2002 (Pocketbook)
Eurostat	Agriculture – Statistical Yearbook
Eurostat	Environment Statistics - Pocketbook
Eurostat	Renewable Energy Resources Statistics
Eurostat/UNECE/ITTO/FAO	JFSQ - Joint Forest Sector Questionnaire
FAO	FAOSTAT
FAO	FORIS - Forestry Information System - Country Profiles
FAO	FRA 2005
FAO	FRA 2000
FAO	Non-Wood Products Database
FAO	SOFO State of the World Forests (Tables)
FAO	REFORGEN - Worldwide Information System on Forest Genetic Resources
IEA	IEA Energy Statistics
ILO	LABORSTA
IPCC	EFDB - Database on Greenhouse Gas Emission Factors
IPGRI	EUFORGEN - European Forest Genetic Resources Programme
ITTO	Annual Review and Assessment of the World Timber Situation
IUCN	2000 IUCN Red List of Threatened Species
IUCN	ISSG - Invasive Species Database
IUCN	United Nations List of Protected Areas
MCPFE	RFRA 2003 - MCPFE new assessment
OECD	Compendium of Environmental Data
OECD	Key Environmental Indicators
OECD	Energy Statistics
OECD	Labour Market Statistics Database
OECD	Labour Force Statistics Database
OECD/EEA	Environmentally Related Taxes Database
OECD/Eurostat	Joint Questionnaire - Forest
OECD/Eurostat	Joint Questionnaire - Wildlife
OECD/Eurostat	Joint Questionnaire - Land Use
OECD/Eurostat	Joint Questionnaire - Environmental Protection Expenditure and Revenues (EPER)
UNECE	TBFRA 2000
UNECE	Timber Database
UNECE	Forest Fire Statistics Database
UNECE	EMEP
UNECE	EFSOS - European Forest Sector Outlook Studies (new assessment)
UNECE	Timber Bulletin - Forest Products Statistics

UNECE	Timber Bulletin - Forest Products Annual Market Reviews
UNECE	The Condition of Forests in Europe
UNECE/EC	BioSoil (Level I)
UNECE/EC	ForestBiota (Level II)
UNECE/EC	ICP Forests/Forest Focus - Level I
UNECE/EC	ICP Forests/Forest Focus - Level II
UNECE/MCPFE	RFRA 2003
UNEP	GEO-3 Data Compendium
UNEP	GRID - Global Resource Information Database
UNEP	GRID - Arendal´s Online GIS, Map and Graphics Database
UNEP-WCMC	WDPA - World Database on Protected Areas
UNEP-WCMC	Datasets and Maps of Forests and Protection
UNEP-WCMC	Species Database
UNESCO	World Heritage Convention/MaB Programme
UNFCCC	Greenhouse Gas Inventory Database
UNIDO	Industrial Statistics (ISIC 20/21)
WorldBank Group	WDI - World Development Indicators
WorldBank Group	The Little Green Data Book
WorldBank Group	Environmental Performance Indicators
WRI	EarthTrends - Country Profiles

Remarks on some special sources listed in the work list:

The **UNECE ICP Forests** and the **EC Forest Focus** joint monitoring on Level I and Level II plots are listed separately to the UNECE data sources and the sources of the EC JRC. The ICP Forests was already launched in 1985 under the UNECE *Convention on Long-Range Transboundary Air Pollution (CLRTAP)*. Today both the ICP Forests and the EC JRC are closely cooperating in coordinating and financing the monitoring of forest conditions in Europe. In 1986 the EU Member States agreed upon the *European Union Scheme on the Protection of Forests against Atmospheric Pollution* (Council regulation (EEC) 3528/86). This regulation was continued and enhanced in 2003 by the *EC Forest Focus regulation* (Council regulation (EC) 2152/2003). As the Forest Focus regulation specifically aims at the protection and preservation of the forests within the EU, it contributes and builds furthermore the foundations laid by the ICP Forests scheme. Currently more than 40 countries participate in the ICP Forests, including all EU countries that are explicitly co-financed and jointly coordinated by the EC. Datasets

of the EU countries will also be covered by the currently developed EC Forest Focus database in the future. As the Forest Focus Regulation exists of two main components – the *Council regulation for monitoring the impacts of atmospheric pollution on forest ecosystems* (former Council regulation (EEC) 3528/86) and the *Council regulation for monitoring of forest fires* (former Council regulation (EEC) 2158/92) – the Forest Focus database will also include the current EC JRC European Forest Fire Information System (EFFIS). With the termination of the EC Forest Focus regulation in 2006 and the discussions related to a future EC LIFE+ regulation 2007-2013, the future objectives of the joint programme of ICP Forests and Forest Focus are presently under discussion.

The Eurostat New Cronos Database: **Economic Accounts for Forestry (EAF)** is considered and listed as a relevant European data source, although only seven EU countries are covered by datasets. The current EAF, developed in 1999/2000 under the *European Framework for Integrated Environmental and Economic Accounting for Forests (IEEAF)*, is actually rather a pilot-database than an already fully implemented source. However, it is considered to be potentially relevant for covering several economic and socio-economic data. The EAF is part of the Eurostat *Economic Accounts for Agriculture and Forestry* and a satellite account of the *European System of Accounts (ESA95)*. Based on a gentlemens' agreement and on the *Manual on the Economic Accounts for Agriculture and Forestry EAA/EAF 97 (REV. 1.1)* developed in 1997, National Statistical Institutes or Ministries of Agriculture are responsible for annual data collection and calculation of national EAF. Eurostat is responsible for the EU aggregations. The main purpose of the EAF is to analyse the production process of the forestry industry and the primary income generated by it. Datasets are therefore collected predominately according to the sector of forest industry. The forestry industry, as described in the EAF, corresponds to Division 02 in NACE[72] Rev. 1 "*Forestry, logging and related activities*". The current EAF database covers predominately datasets only from the classical "*wood sector*". First pilot investigations have started in 2001/2002 to include also datasets from the "*non-wood sector*", covering data like non-wood goods, services, etc.

The **MCPFE** publishes all kind of SFM relevant data and information, like within the MCPFE Report "*State of Europe's forests 2003*" (MCPFE, 2003). National data for that

[72] Statistical classification of economic activities in the European Community

report are specifically outlined according to the pan-European C&I (see Chapter 2.3.3 and 2.3.4). However, several of the published data are collected and provided by other international institutions like the UNECE, FAO or Eurostat. To minimise the effect of duplications within this analysis, the MCPFE is only considered for those datasets that are explicitly assessed by the MCPFE in addition to other international covered/provided datasets. Under the framework of the MCPFE/UNECE Regional Forest Resources Assessment (RFRA) 2003 the MCPFE collected data at national level for the two indicators of the criterion C5 *Protective forests* and the biodiversity indicator *4.9 Protected forests*. Datasets were collected according to explicit MCPFE definitions and data requirements.

Although the **ITTO** covers predominately SFM relevant data of the tropical countries, the ITTO Annual Review and Assessment of the World Timber Situation is included in the list of relevant sources as this report provides relevant datasets for the situation of European timber trade and timber consumption. Datasets for the ITTO Annual Review are based on the JFSQ, Table ITTO 1-3. The annual report mainly reviews the timber market situation (imports/exports) between developed and non-developed countries.

Some global institutions and their data sources are also considered in the list of sources. Global data sources (like those maintained by the UNEP, the WorldBank Group, the WRI, the ILO, the IEA, etc.) are considered less as explicit reporting references for the MCPFE reporting, rather than to give a sound overview of potentially available datasets at the international level and consider possibilities of using synergies within international data flows and data distribution.

4.3 Results

Based on the approach of network analysis, where the correlations between explicit selected data sources and the 35 pan-European indicators are organised in a matrix (*two-mode network* approach, see also Annex 3), it was possible to analyse data coverage, dataset potentials and network structures from various perspectives.

The results of this approach show different perspectives on:

- available datasets at the pan-European level;

- data preferences within the pan-European activities of monitoring, assessment and reporting on SFM;
- the *core* indicators, and the *deficit* indicators;
- the most relevant sources and institutions within the pan-European monitoring, assessment and reporting on SFM; and
- the effects of some selected future potential sources.

4.3.1 Overview: Data Coverage according to the 35 pan-European Indicators

The three diagrams A, B, C in Fig. 17 show the data coverage (the number of potentially relevant sources/institutions) for each of the 35 pan-European indicators. Diagram A describes the data coverage according to the raw list of 81 sources, diagram B according to the work list of 52 selected data sources, and diagram C summarises the data situation with respect to the 21 institutions and organisations which maintain at least one or more of the 52 selected data sources.

Although the list of sources is extended in diagram A, as it includes also selected future potential sources and duplications as reports or questionnaires, the distribution of indicator coverage according to the 35 pan-European indicators is almost the same as in diagrams B or C. This distribution of indicator coverage shows clearly the data preferences, but also the data deficits, within the complex pan-European activities of monitoring, assessment and reporting on SFM. Diagram B can be regarded as the reference diagram showing the current data coverage for only fully implemented international data sources.

The first and the third quartile[73] above and below the median[74] of each distribution of indicator coverage are taken to define an objective threshold or interval which describes those indicators that are notably covered more or also less than others. Those that are notably covered more are called **core indicators** and those that are covered less are called **deficit indicators** (see Fig 18, Diagram A, B, C).

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[73] A quartile is any of the three values which divide the sorted data set into four equal parts, so that each part represents 1/4th of the sample (distribution) (Meyers Taschenlexikon, 1992).

Core indicators are defined as:

indicators covered by a number of sources higher than the third quartile of the distribution of indicators coverage (Diag. A >13; Diag. B >7; Diag. C >6)

Deficit indicators are defined as:

indicators covered by a number of sources lower than the first quartile of the distribution of indicators coverage (Diag. A <5; Diag. B <3; Diag. C <2)

[74] A median is a number dividing the higher half of a sample (distribution) from the lower half. The median of a finite list of numbers can be found by arranging all the observations from lowest value to highest value and picking the middle one (Meyers Taschenlexikon, 1992).

Fig. 17: Indicator data coverage according to explicit selected list of sources.

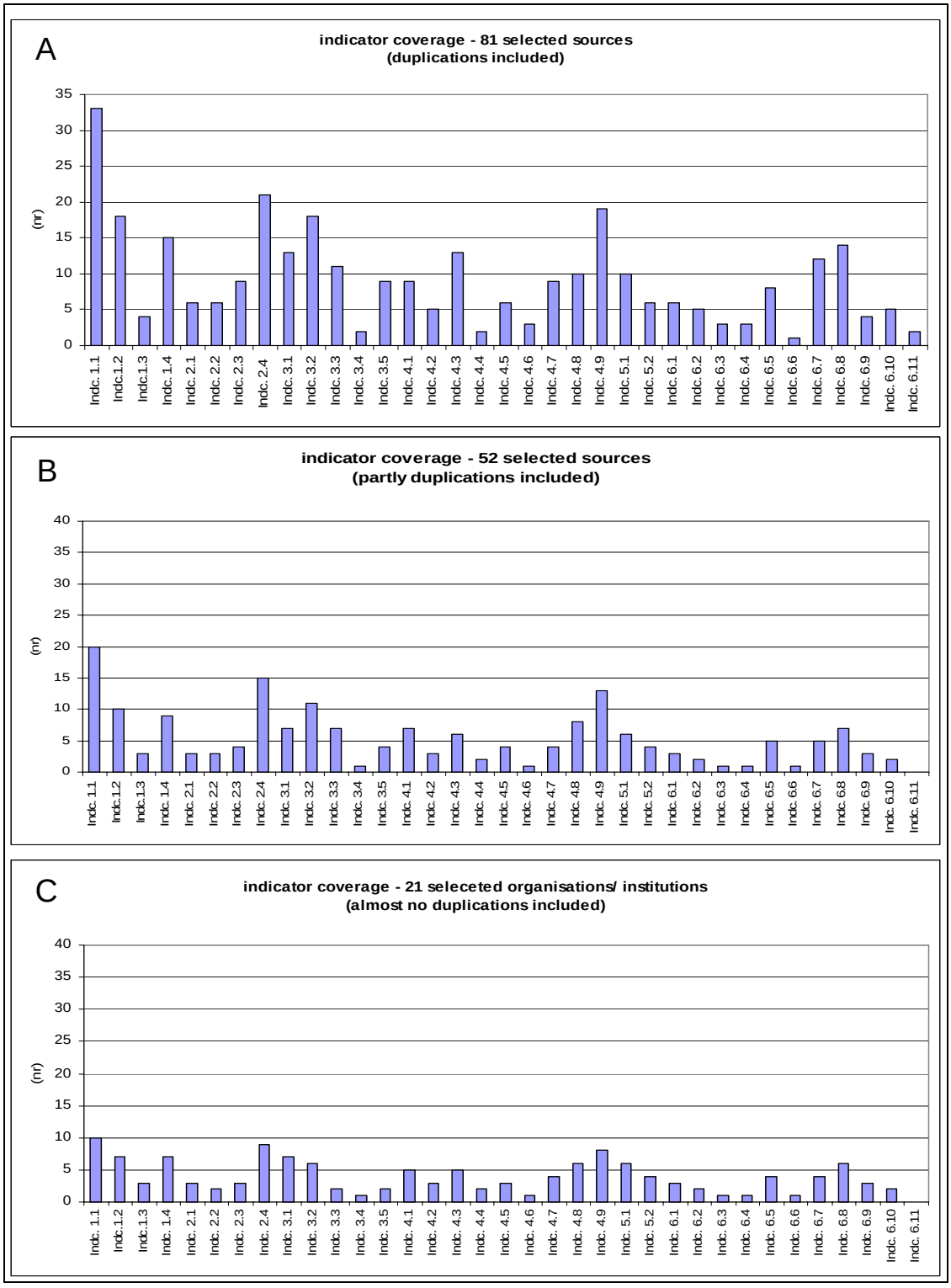
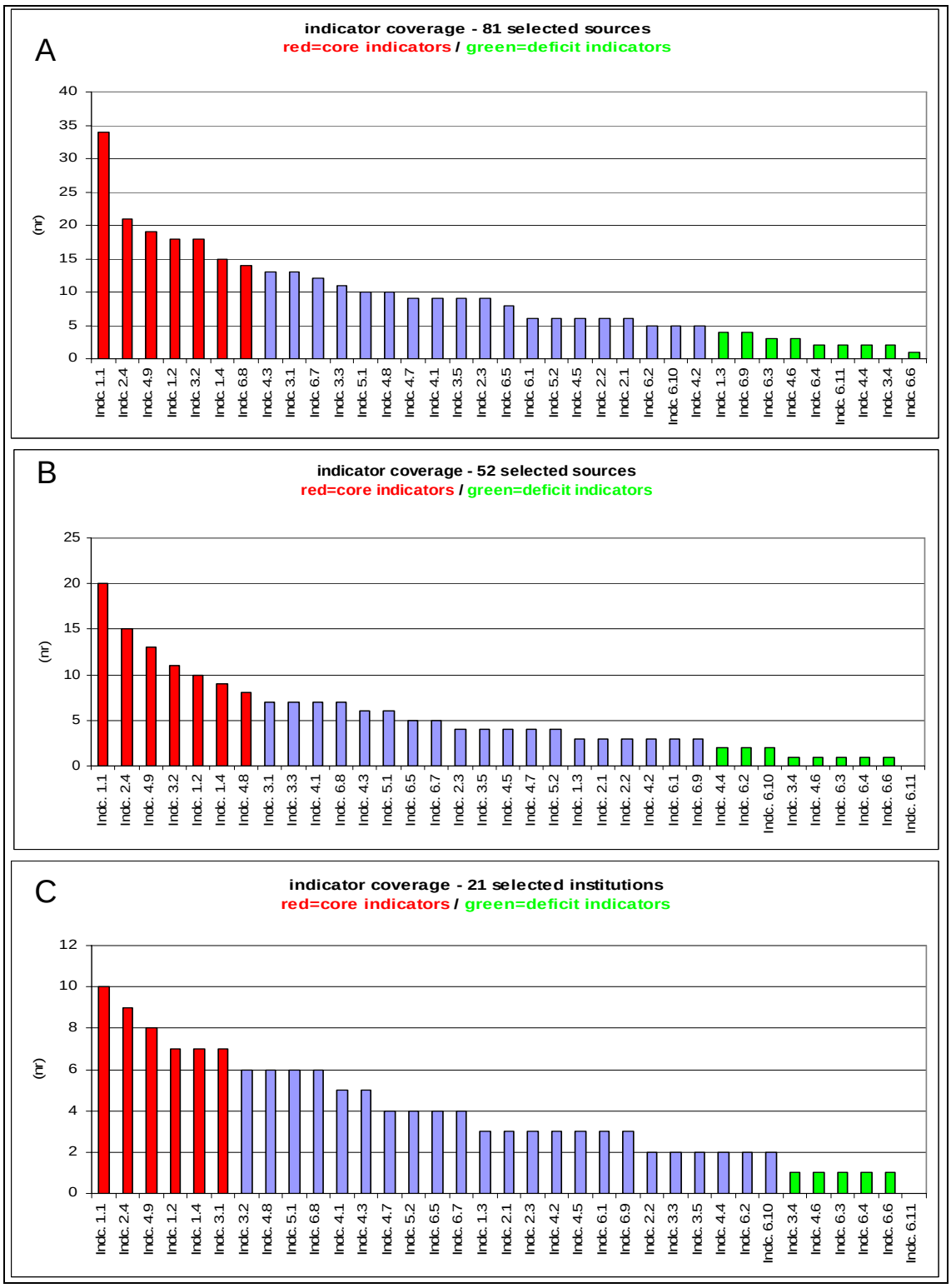


Fig. 18: Core and deficit indicators according to the 1st and the 3rd quartile of indicator data coverage.



4.3.1.1 Core Indicators

Analysing the distribution of indicator coverage of all three diagrams and taking the third quartile as a threshold value, the following **nine core indicators** are identified:[75]

1.1 Forest area
1.2 Growing stock
1.4 Carbon stock
2.4 Forest damage
(3.1 Increment and fellings)
3.2 Roundwood
(4.8 Threatened forest species)
4.9 Protected forest
(6.8 Trade in wood)

The indicator ***1.1 Forest area*** can be regarded as *the* major core indicator – the central information in almost all explicit forest related data sources. Out of the 20 investigated institutions 10 provide certain quantitative data on forest area, and out of the 52 selected data sources 20 provided quantitative data on forest area. Datasets on forest area are not covered by those institutions which collect no particular or direct forest related datasets like the IEA, ILO or UNIDO. But also few other direct *forest related* sources such as the UNFCCC Greenhouse Gas Inventory Database, ICP Forests/Forest Focus Database or the ITTO Annual Review and Assessment of the World Timber Situation do not necessarily provide explicit quantitative data on forest area.

Analysing the datasets in more detail with respect to the indicators classifications *forest area classified by forest type* or *forest area by availability of wood supply* it can be seen that the data availability is different. Only the OECD Compendium of Environmental Data provides datasets for both forest area classifications. Out of the 20 sources that provide any quantitative data on forest area 11 provide data according to the classification by *forest type*. All other relevant sources cover *only forest area* without

[75] Those indicators written in brackets are only considered as core indicators according to one or two of the three distributions of indicator coverage (see Fig 18).

any further indicator classification. The OECD Compendium of Environmental Data and the Eurostat Economic Accounts for Forestry (wood sector) are the two only sources that collect datasets according to the classification *availability for wood supply*.

However, the centrality of forest area as the most relevant parameter within the international monitoring, assessment and reporting on SFM also becomes underlined as several future potential sources like the ESA GMES GSE Forest Monitoring Services and the EC JRC Forest Mapping focus on the development and implementation of new techniques and approaches – like the integration of remote sensing techniques – to assess and monitor status and changes of forest area from an international perspective independent from national data assessments. Especially changes of forest cover, e.g. described by its spatial fragmentation and effected by large-scale disturbances such as forest fires, storms, but also human interventions like illegal logging, are of concern to develop new improved techniques to monitor forest area and are therefore a central element within SFM.

The indicator ***2.4 Forest damage*** can be regarded as the second most relevant indicator within the pan-European monitoring, assessment and reporting on SFM. There are 15 different international sources maintained by nine institutions that provide datasets on forest damage. The relative high data availability on forest damage can be explained by the wide scope of different types of forest damage. Seven out of the 15 relevant sources are data sources explicitly focusing only on forest damage. Four of these sources are specified on forest fires: (1) the EC JRC European Forest Fire Information System (EFFIS), (2) the EC JRC Global Burnt Area 2000 Database, (3) the UNECE Forest Fire Statistics Database, and (4) the ESA ATSR World Fire Atlas. The other three specified sources include datasets on all kind of forest damages such as the joint ICP Forest/Forest Focus Database or the EFI database on Forest Disturbances in Europe (DFDE). All other forest damage relevant sources are of a more general content and scope, like the FAO FRA 2000 and 2005 or the UNECE TBFRA 2000.

The third most internationally covered indicator is the indicator ***4.9 Protected forests***. Its 13 different sources that provide datasets on protected forests within Europe. Four of these sources are specified on protected areas and protected forests: (1) the EEA European Common Database on Designated Forest Areas (CDDA), (2) the MCPFE data assessments under the framework of the RFRA 2003, (3) the UNEP-WCMC World

Database on Protected Areas, and (4) the UNEP-WCMC Datasets and Maps of Forests and Protection. The EEA CDDA is a collaborative venture to streamline all reporting on Designated Areas in Europe. The CDDA includes also all Natura 2000 sites as designated by all EU member countries according to the EC Birds Directive and the EC Habitats Directive. Close collaboration is given to the UNEP-WCMC initiatives and databases at global level but also to the Council of Europe (CoE), which is the responsible body for the European Landscape Convention and the EMERALD Database, covering Natura 2000 sites of all non-EU countries. An explicit Natura 2000 database has been currently released by the EC DG Environment in 2006. The database has been developed in cooperation with the EEA. As the database has been under development during the period of investigation, the Natura 2000 database is listed as a future potential source instead of as a fully implemented source.

Considering biodiversity indicators, the indicator ***4.8 Threatened forest species*** can also be regarded as a core indicator. The UNEP-WCMC Species Database and the IUCN Red List of Threatened Species Database are the international data sources that are specified as covering datasets on threatened species. Both databases cover data for all kinds of taxa and environments. A data evaluation according to particular forest species is possible. In addition to these very specified data sources, also some general forest related data sources like the FAO FRA 2000/2005, the UNECE TBFRA 2000, or the OECD Compendium of Environmental Data cover datasets on threatened forest species. FRA, TBFRA 2000 and OECD datasets on protected forest areas and on threatened forest species refer to the definitions as used by IUCN and WCMC.

Also of high relevance within the pan-European monitoring, assessment and reporting on SFM are the indicators ***1.2 Growing stock***, ***1.4 Carbon stock*** and ***3.1 Increment and fellings***. Although datasets on increment and fellings are much less covered than any datasets on growing stock or carbon stock, these three indicators can be grouped as they are thematically linked to each other (see also Chapter 5). However, only the EFI EFISCEN Database, the UNECE TBFRA 2000 and ICP Forests/Forest Focus Level II provide datasets for all three indicators. The FAO, for example, provides datasets on increments and fellings only for few country profiles in the FAO FORIS. Increment and fellings are not covered by the FRA 2000 and FRA 2005. These two sources only focus on growing stock and carbon stock. Data sources such as the ICP Forests/Forest Focus Level I, the EEA European Soil Information System (EUSIS), the IPCC Greenhouse

Gas Emission Factors Database or the UNFCCC Greenhouse Gas Inventory Database are relevant sources for covering specific datasets on carbon issues.

The indicators ***3.2 Roundwood*** and ***6.8 Trade*** in wood are also thematically interlinked. Both are relevant indicators within the current pan-European monitoring, assessment and reporting on SFM. Especially indicator *3.2 Roundwood* is covered by several international data sources (11 of 52 selected sources, see Fig. 18 Diag. B). The value and quantity of produced roundwood are items of information particularly covered by forest and timber market related reports such as the Eurostat Forestry Statistics Pocketbook 1992-2002, the UNECE Timber Bulletin Forest Products Statistics, or the UNECE Forest Products Annual Market Reviews. Although roundwood is mainly covered by data sources of general content like the Eurostat New Cronos Forestry Statistics or the FAO FRA 2000 and FRA 2005, roundwood and trade in wood can be regarded as the core indicators of explicit timber relevant data sources like the FAO FAOSTAT and the UNECE Timber database. Trade in wood is rather covered by particular trade data sources like the Eurostat COMEXT database, the EFI WFSE Trade Flow database, and the ITTO Annual Review and Assessment of the World Timber Situation focusing on the tropical timber market.

Comparing all three diagrams A, B and C in Fig. 17 and 18, it can be seen that especially the core indicators get reduced in the number of potential coverage. This can be explained by the effect of future potential sources included in Diagram A, but also by the effect of data duplications included in Diagram A and partly Diagram B. Especially data reports cover predominately several core indicators. This underlines once more the centrality of explicit core indicators – not only within pan-European monitoring, assessment and reporting, but also within forest data publishing and communication.

Looking from the perspective of relevant institutions and organisations, the UNECE and the FAO are the two most relevant institutions covering datasets according to all nine core indicators. Quite relevant (covering 5 or more of the nine core indicators) are also the EFI (7), Eurostat (6), the OECD (6), UNEP (5) and the EEA (5). The WRI for example, with its Country Profiles and Earth Trends database, provides datasets for only 4 indicators in total, but all of them are core indicators (see Table 8).

Table 8: Core indicators coverage according to 21 selected institutions.

	Indc. 1.1	Indc.1.2	Indc. 1.4	Indc. 2.4	Indc. 3.1	Indc. 3.2	Indc. 4.8	Indc. 4.9	Indc. 6.8	Total
EEA	X			X	X		X	X		5
EFI	X	X	X	X	X	X			X	7
ESA				X						1
Eurostat	X	X			X	X		X	X	6
FAO	X	X	X	X	X	X	X	X	X	9
IEA										0
ILO										0
IPCC		X	X							2
IPGRI										0
ITTO									X	1
IUCN							X			1
EC JRC	X		X	X						3
OECD	X	X		X	X		X	X		6
UNECE	X	X	X	X	X	X	X	X	X	9
UNECE/EC		X	X	X	X					4
MCPFE (n.a.)								X		1
UNEP	X			X		X	X	X		5
UNFCCC			X							1
UNIDO										0
WorldBank	X									1
WRI	X					X		X	X	4
Total	10	7	7	9	7	6	6	8	6	

4.3.1.2 Deficit Indicators

According to the indicator data coverage as described in Fig. 17 and 18, and taking the first quartile within each distribution as a threshold value, the following **eleven deficit indicators** are identified:

(1.3 Age structure and/or Diameter distribution)
3.4 Services
4.4 Introduced tree species
4.6 Genetic resources
(6.2 Contribution of forest sector to GDP)
6.3 Net revenue
6.4 Expenditures for services
6.6 Occupational safety and health
(6.9 Energy from wood resources)
(6.10 Accessibility for recreation)
6.11 Cultural and spiritual values

Most of the deficit indicators belong to the criterion C6, the *Maintenance of Other Socio-Economic Functions and Conditions*. Out of the 11 pan-European socio-economic indicators, seven are classified as deficit indicators.

Considering the indicator coverage of only currently relevant and fully implemented data sources (excluding future potential sources), only indicator ***6.11 Cultural and spiritual values*** currently is not covered by any quantitative data. Relevant future potential sources for this specific indicator could be the UNESCO World Heritage Convention, or the MaB Programme, or the CoE European Landscape Convention (see also further below).

Almost not covered by any international data source are also the indicators ***6.3 Net revenue*** and ***6.4 Expenditures for services***. Only the OECD Compendium of Environmental Data provides some data on expenditures for services. Some limited datasets regarding the indicator *6.3 Net revenue* can be provided by the Eurostat

Economic Accounts for Forestry (EAF). EAF datasets are currently limited in their availability as they cover data for only seven EU member states.

Similar to the data situation of the indicators *6.3* and *6.4*, is the situation for the thematically correlated indicator ***3.4 Services*** – the value of marketed services on forests. Only the FAO FORIS and its country profiles have a rather limited data potential for at least some information on marketed services within the forest sector. Market services might be covered in the future by the enhanced Eurostat EAF non-wood sector database (see the effect of selected future potential sources, Chapter 4.3.4).

There is also a scarcity of explicit quantitative international datasets for the indicator ***6.6 Occupational safety and health***. The International Labour Organisation (ILO) collects some relevant but highly aggregated datasets for the sector agriculture, forestry and fisheries. ILO collects national employment and workforce datasets by joint questionnaires together with Eurostat. Datasets are available according to the ISIC categories and cover information on *employment*, *wages*, *work hours* but also on *occupational injuries*. These datasets are annually published in the ILO Yearbook of Labour Statistics.

Datasets according to the indicator ***6.9 Energy from wood resources*** are only available in a highly aggregated form. The International Energy Agency (IEA) collects national datasets for the following energy sources: *coal, oil, gas, electricity* and *renewables*. Wood consumption for energy purposes is mainly covered within the IEA questionnaire on renewables. This joint questionnaire is produced together with Eurostat. A copy of the provided datasets is sent directly to Eurostat from the National Correspondent. Some slightly relevant information on wood energy is also included in the IEA coal questionnaire, which is a joint questionnaire together with the UNECE.

However, it is not only the socio-economic indicators that are significantly less covered than others. Two indicators of the criterion C4 (*Biodiversity*), the indicator ***4.4 Introduced tree species*** and the indicator ***4.6 Genetic resources*** are also regarded as deficit indicators. The IUCN Invasive Species database and the UNECE TBFRA 2000 are the only two sources that provide data on the indicator *4.4 Introduced tree species*. The indicator *4.6 Genetic resources* is currently covered only by the IPGRI European

Forest Genetic Resources Programme EUFORGEN.[76] The current EUFORGEN database provides some general information on genetic resources within Europe rather than explicit quantitative data as requested by the MCPFE indicator.

The indicator ***1.3 Age structure and/or Diameter distribution*** can also be regarded as a deficit indicator – at least according to the list of 81 selected international sources. Only the EFI EFISCEN database and the UNECE TBFRA 2000 are potentially relevant to provide adequate datasets according to age structure and/or diameter distribution. The current EFI EFISCEN database can therefore be regarded as being rather relevant for statistical simulation and scenario modelling than representative for any international reporting. The TBFRA 2000 database provides datasets only on age-class distribution of even-aged high forest available for wood supply classified according to species groups and forest types. Both sources, the TBFRA and the EFISCEN database, rely on National Forest Inventory data. Independent from any NFI assessments are datasets of the ICP Forests/Forest Focus joint monitoring on Level II. On Level II, diameter at breast height on all trees with a diameter of at least 5 cm over bark are assessed at least every five years. Available raw data could be re-evaluated according to required diameter classes. Datasets on age structure are not available (see also Chapter 6 and Annex 2).

4.3.2 Overview: Data Coverage according to relevant Institutions and Sources

The chapter of indicator data coverage already gives some first indications on which of the various international institutions and organisation are relevant for and involved within the pan-European processes and activities of monitoring, assessment and reporting on SFM. This chapter specifically shows which of the institutions or organisations are responsible for and able to provide which kind of data. Relying on the screening approach and the applied two-mode network approach, Fig. 20 shows the number of potentially available indicators for each selected source reflected by the six pan-European criteria. The diagram lists the 52 selected data sources structured according to each of the responsible institutions or organisations. In addition, selected future potential sources are also included (see also Chapter 4.3.4).

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[76] The FAO REFORGEN is currently under development and not fully implemented yet (Status, 2005). Furthermore the FAO REFORGEN database, covering forest genetic information from a global perspective is not considered, as it includes the EUFORGEN database that covers explicit European data and information on forest genetics.

Ignoring the effect of future potential sources, Fig. 19 summarises the data potential for each of the relevant institutions and organisations considering only fully implemented data sources. It shows which of the relevant institutions and organisations are potentially able to provide which kind of data according to the six pan-European criteria. To minimise the effect of duplications, but especially to minimise the effect of double counted indicators, indicators which are already covered by one source of an explicit listed institution or organisation, are counted only once within that summary.

Fig. 19: Data potential summarised according to the 21 most relevant international institutions and organisations according to the six pan-European criteria.

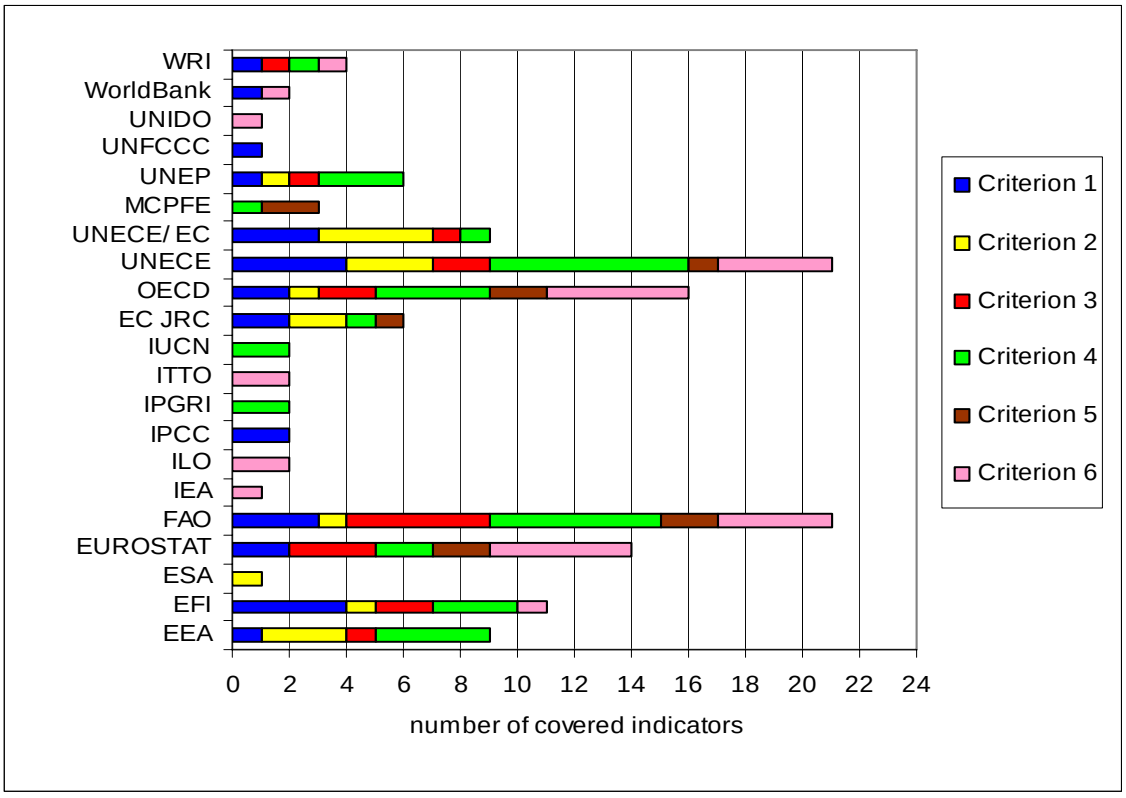
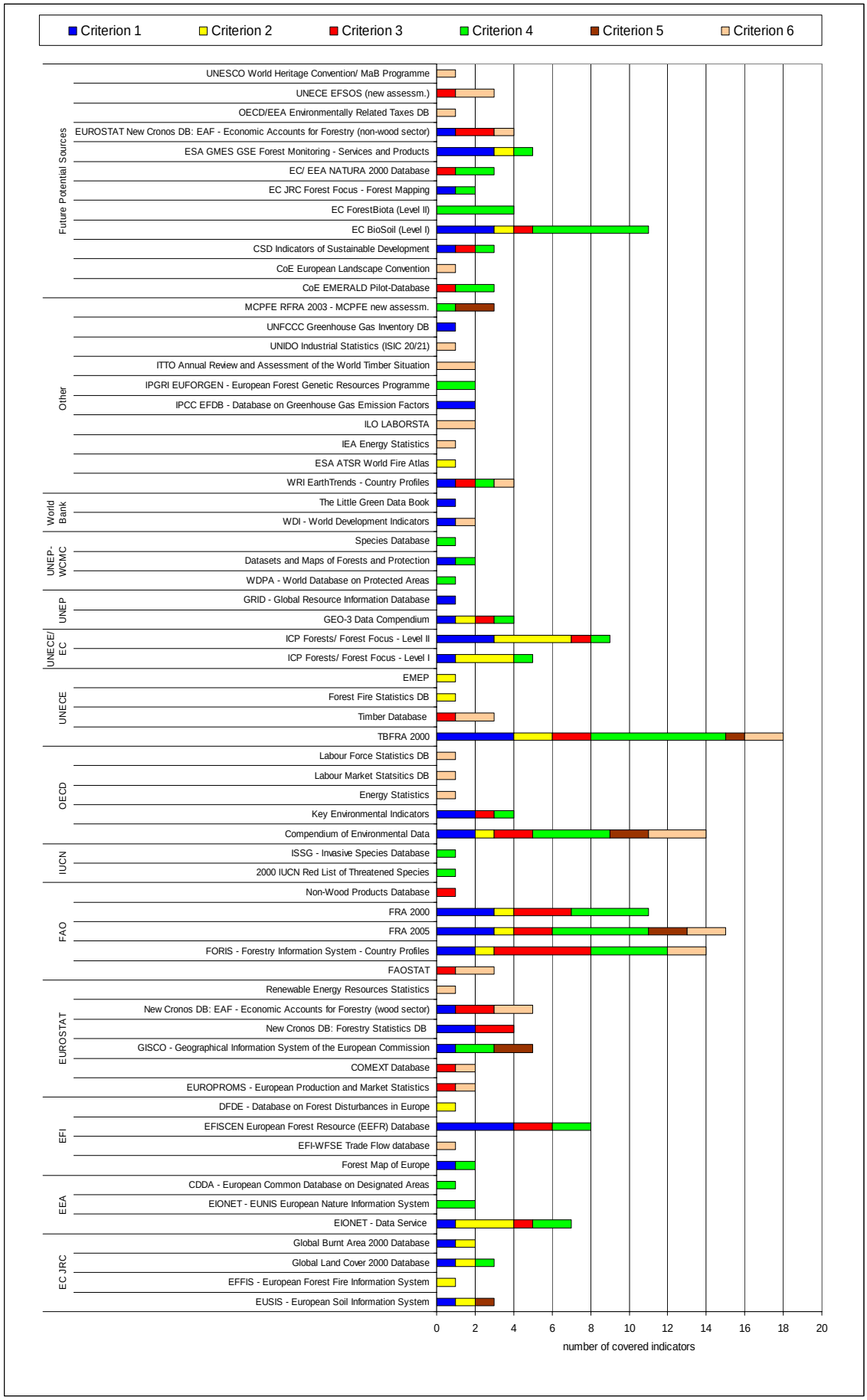
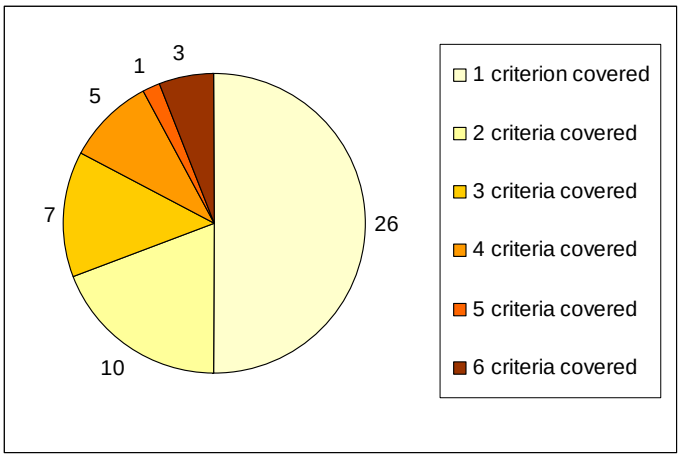


Fig. 20: Data potential of selected international sources according to the pan-European criteria.



The two Figures 19 and 20 show that none of the explicit listed data sources, or even the institutions or organisations, covers all 35 pan-European indicators. Most of the selected sources (37 of 52) cover less than four indicators. The differences in data coverage are also clearly expressed by the differences towards covering the six pan-European criteria. Almost 70% (36 of the 52) selected international data sources cover only one or two criteria. Just three sources thematically cover all six criteria (see below). This shows that most international data sources are specified and focused on particular themes. Only a few sources can be regarded as multi-resources – sources that cover various forest datasets with respect to all kinds of SFM relevant themes/criteria (see Fig. 20 and 21).

Fig. 21: Number of sources according to the number of thematically covered criteria (relying on 52 selected international data sources).



The UNECE, the FAO, the OECD and Eurostat can be regarded as the most relevant institutions within the pan-European process of monitoring, assessment and reporting on SFM. The EFI and the EEA are also relevant as well as the joint monitoring programme of ICP Forests/Forest Focus, jointly financed and coordinated by the UNECE and EC (see Fig. 20).

Referring to the Fig. 19 and 20, the UNECE and the FAO are the two most relevant institutions. Both institutions have a data potential for 21 out of the 35 pan-European indicators. The UNECE TBFRA 2000 is the data source that covers most of the quantitative indicators. It has a data potential for 18 indicators. Although the TBFRA 2000 covers datasets for all six pan-European criteria, it predominately covers data for the indicators of criterion C1 and of criterion C4. Relatively less covered are the indicators of criterion C6 – only 2 of 11 indicators.

The second most relevant data source according to the number of indicators covered is the FRA 2005. The FRA 2005, which is much more enhanced than the FRA 2000, has a potential to supply relevant datasets for 15 indicators covering all six criteria. Not covered by the FRA 2000 are data on criteria C5 and C6. The FAO FORIS with its country profiles is also a relevant source as it contains several datasets and additional descriptive information that is not explicitly covered by the FRA 2000 or FRA 2005. The FAO FORIS has a potential to supply, at least for some countries (not only European countries), datasets for the indicators *3.1 Increment and fellings*, *3.4 Services*, 3.*5 Forest under management plans*, *6.7 Wood Consumption* and *6.8 Trade in wood*.

Also relevant is the OECD in particular with its Compendium of Environmental Data. The OECD can be regarded as the third most relevant institution, covering 16 of the 35 pan-European indicators. In addition to the OECD Compendium of Environmental Data, two other OECD sources are considered to be relevant, in particular covering additional datasets on some socio-economic indicators, such as the OECD Labour Market Statistics Database and the OECD Joint Database of Energy Statistics. Joint data cooperation for these databases is partly given to Eurostat, the ILO or also the IEA. The OECD Compendium of Environmental Data can be regarded as the third most relevant data source, having a data potential for 14 different indicators covering all six pan-European criteria. Its national datasets are compiled by eight different questionnaires, collecting national datasets on different environmental aspects such as on *air, inland waters, marine, land use,* etc. Most of these questionnaires are Joint Questionnaires produced in cooperation with Eurostat. At the moment most of the explicit forest related datasets of the Compendium of Environmental Data are jointly provided by the UNECE TBFRA 2000 or the Joint Forest Sector Questionnaire (JFSQ) maintained by Eurostat, UNECE, FAO and ITTO (see also Chapter 7.3).

Each of the six listed data sources of Eurostat covers less than five indicators, like the two New Cronos Databases (the Economic Accounts for Forestry (EAF) and the Forestry Statistics Database) as well as the EC Geographical Information System (GISCO). Nevertheless Eurostat can be regarded as the fourth most relevant institution. Eurostat covers 14 indicators potentially relevant for five pan-European criteria. Special emphasis is put on the economic and socio-economic data.

Some EFI databases are also relevant within the pan-European monitoring, assessment and reporting on SFM. EFI in total has a data potential for about 11 different indicators covering all criteria except criterion C5. The EFISCEN database has the highest potential for explicit data requirements, containing mainly classical NFI data such as *forest area*, *forest growth*, *increment*, *tree species composition* or *deadwood*. EFISCEN data are mainly used for national and European carbon scenario modelling.

The EEA covers datasets relevant for four pan-European criteria. Most of the datasets (4 of 9 in total) are datasets on forest biodiversity, especially on protected areas within Europe. The EEA EIONET Data Service is an information system containing environmental statistics (including georeferenced data or maps). Although the EIONET Data Service covers predominantly all kinds of other environmental datasets, except for some specific forest data, at least some of the datasets are relevant for about seven of the 35 pan-European indicators. Most of the biodiversity datasets are maintained by the EEA European Nature Information System (EUNIS). The other forest related datasets rely on other already listed international data sources like the FAO FRA or the UNECE TBFRA 2000.

As already mentioned above, the joint monitoring programme of ICP Forests/Forest Focus on Level I and Level II, also has highly relevant data potentials covering nine indicators in total (Level I = 5 indicators; Level II = 9 indicators). The current data potential of the already existing joint monitoring on Level I and Level II, but also its future potentials for capacity building are analysed more detailed in Chapter 6.

From the global perspective, the UNEP and also the World Resources Institute (WRI) can be considered as relevant institutions for providing some adequate datasets according to the pan-European indicators. Especially the joint data assessments of the UNEP-WCMC on biodiversity issues provide several relevant datasets such as on the indicators *4.8 Threatened forest species* and *4.9 Protected forests*.[77] The WRI Earth Trends database with its different country profiles also covers relevant pan-European forest data. However most of the WRI datasets rely on – already covered – FAO or WorldBank data.

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[77] The UNEP-WCMC Species database is divided into three sub-databases, which are the Animals Database, the Threatened Plants Database and the Tree Conservation Database. UNEP-WCMC data on threatened species are partly streamlined already with IUCN data (see IUCN Red Lists).

Although most of the global sources receive datasets from European level sources, some global organisation such as the WorldBank, UNIDO, UNFCCC, IPCC, ILO, IEA also collect datasets directly from national level sources. Most of these sources have been listed and considered as they are potentially relevant for the monitoring, assessment and reporting at pan-European level. Most of the global sources are specific – covering data on a certain issue, e.g. IEA Energy Statistics or ILO LABORSTA. Global sources have been considered in this analysis especially in the case where they cover indicators that are (a) either not covered at European level or (b) covered according to different definitions or indicator classifications.

4.3.3 Overview: Data coverage according to the six pan-European Criteria

Further relevant questions within the evaluation of quantitative C&I data coverage are:

- Which criteria, which themes of SFM, are predominately covered by potentially available datasets?
- How many of the specific information requirements of each of the pan-European criteria are covered by which institution or organisation?

To answer these questions it is important to minimise the effect of dataset duplications, but also the effect of the different numbers of indicators per criterion – e.g. criterion C6 has 11 indicators and criterion C5 just two. To minimise the effect of duplications, indicators have been counted at the institutional level. That means just once per institution, regardless of whether one or more sources of the institution provide explicit datasets for that indicator. To minimise the effect of different numbers of indicators per criterion, the quantitative amount of requirements of one criterion – expressed by the number of indicators per criterion – is counted as 100%. By this it is possible to describe the **relative quantitative data potential** of each of the relevant institutions according to each of the six criteria (see Table 9 and Fig. 22).

Table 9: Relative quantitative data potential in percent - counting the amount of information requirements (i.e. the number of indicators of each criterion) as 100%

Legend:							
100%		= or > 50%		< 50%			
	C1	C2	C3	C4	C5	C6	Nr. covered criteria
EEA	30	80	20	40	0	0	4
EFI	100	30	40	30	0	10	5
ESA	0	30	0	0	0	0	1
Eurostat	50	0	60	20	100	50	5
FAO	80	30	100	70	100	40	6
IEA	0	0	0	0	0	10	1
ILO	0	0	0	0	0	20	1
IPCC	50	0	0	0	0	0	1
IPGRI	0	0	0	20	0	0	1
ITTO	0	0	0	0	0	20	1
IUCN	0	0	0	20	0	0	1
EC JRC	50	50	0	10	50	0	4
OECD	50	30	40	40	100	50	6
UNECE	100	80	40	80	50	40	6
UNECE/EC	80	100	20	10	0	0	4
MCPFE (new ass.)	0	0	0	10	100	0	2
UNEP	30	30	20	30	0	0	4
UNFCCC	30	0	0	0	0	0	1
UNIDO	0	0	0	0	0	10	1
WorldBank	30	0	0	0	0	10	2
WRI	30	0	20	10	0	10	4
Nr. of Inst./Org.	13	9	9	13	6	11	
QDC Index	6,8	4,3	3,6	4,1	5,0	2,5	

Fig. 22 Quantitative C&I Information Network (valued network: the thickness of lines indicates the relative data potential as a percentage)

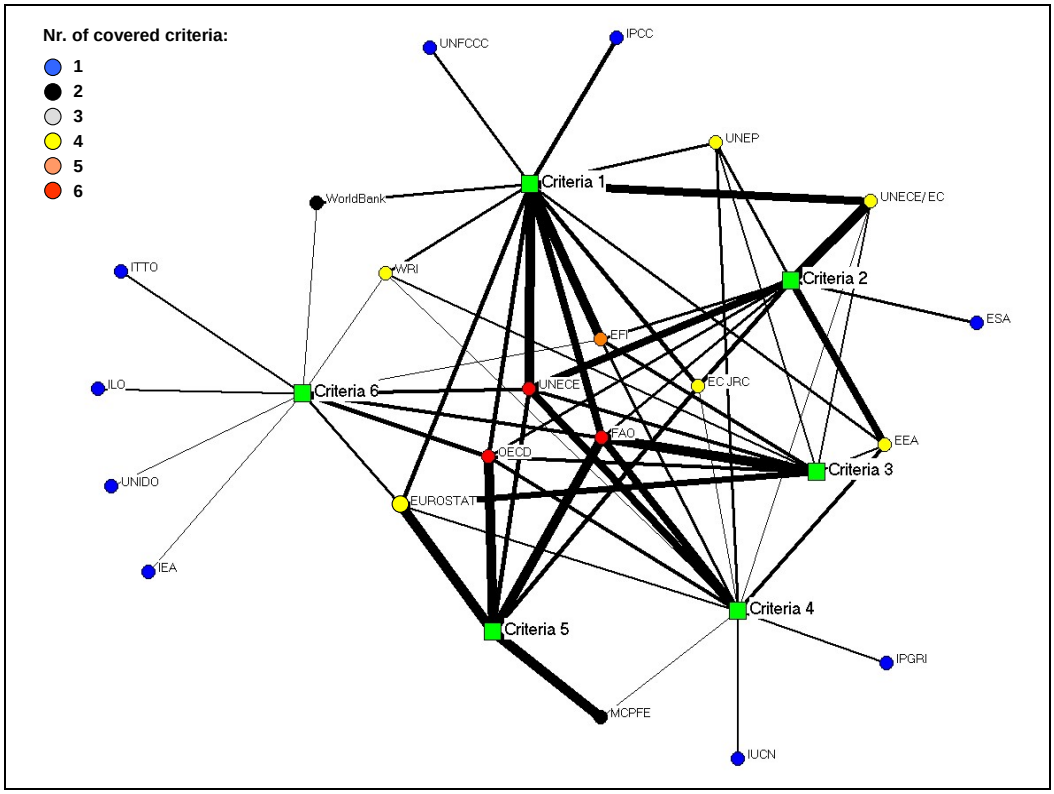


Table 9 and the Network Diagram in Fig. 22 show clearly how many of the information requirements, are potentially covered by datasets by each of the listed institutions or organisations. However, the data coverage is only expressed from the quantitative point of view – which means the relative data potential as a percentage. It can be seen that some institutions provide datasets for all indicators of one criterion – in this case expressed by the relative data potential of 100%. Other criteria instead are not covered or only covered to a certain extent.

With respect to the requirements of criterion C1 (*Forest Resources and Carbon*) 13 of 21 listed institutions or organisation provide some datasets according to any of the four indicators of criterion C1. The UNECE and the EFI cover all indicators. According to the criterion C2 (*Health and Vitality*) it is only the joint monitoring programme ICP Forests/Forest Focus that covers all four indicators. Criterion C3 (*Productive functions*) is also only covered once to a 100% – namely by the FAO. Although criterion C4 (*Biodiversity*) is covered by 13 of the 21 listed institutions, none of the institutions or organisations provides datasets for all of the nine indicators. Only the FAO (with 70%) and the UNECE (with 80%) cover more than 50% of the indicators. Criterion C5 (*Protective functions*) is covered only by six of the 21 listed institutions and organisations, but as there are only two indicators, four of them (the MCPFE, the OECD, the FAO, and Eurostat) have a data potential for all indicators. The situation of criterion C6 (*Socio-Economic functions*) is similar to the situation of criteria C1 and C4. Several institutions or organisations (11 in total) provide some datasets for some of the 11 socio-economic indicators, but only two of them (the OECD and Eurostat) cover at least 50% (5 of 11 indicators).

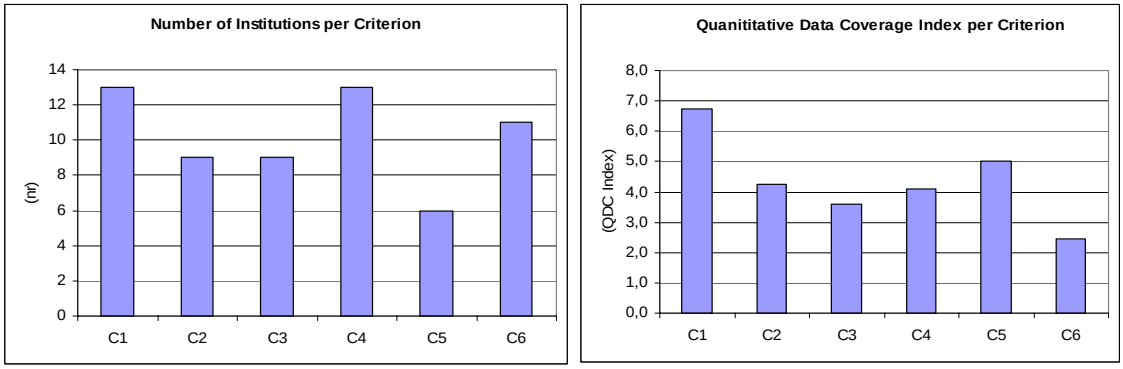
The network diagram in Fig. 22 underlines again the centrality of the UNECE, FAO and OECD to the requirements of the pan-European C&I. All three institutions cover at least some indicators of all six criteria. Other institutions are relevant only for one or two criteria. These institutions, like IPGRI, IUCN, IPCC, UNFCCC maintain data sources that are specified on one particular aspect of SFM, relevant for only one or a few indicators. The different thickness of the network lines (ranking from 1-10) in Fig. 22, indicates the amount of potentially available datasets. As also shown in Table 9, it can be seen that institutions such as the MCPFE assess data for both indicators of the criterion C5 (expressed by a 10 point thick line), but only one indicator – the indicator *4.9 protected forests* – of the criterion C4 (expressed by a 1 point thick line). Taking

criterion C5 and C6 as an example, it can be seen that the number of institutions (expressed by the number of lines to one criterion), but also the data coverage (expressed by the thickness of lines) is different. It can be seen that criterion C5 only has a few, but therefore thick lines, expressing high data coverage by sources. Criterion C6 instead is linked to a lot more institutions but the thickness of lines is relatively low, expressing a relatively low data coverage.

Considering the above aspects it becomes clear, that the **quantitative rating of the total data coverage** of each of the six pan-European criteria has to be analysed from different perspectives. The central remaining question is still: Which criteria, which themes of SFM, are covered more than others?

Fig. 23: Criteria Data Coverage

a) **b)**



One option is to count the different numbers of institutions covering each of the six criteria, regardless only 10 or 100 percent of each criteria indicators are covered (see diagram a) in Fig. 23). Due to the effect of the different numbers of indicators that each criterion has listed this perspective leads to a partly fuzzy result. It is obvious that only a few sources are needed e.g. to cover datasets according to the just two indicators of criterion C5, but that many more sources are needed to cover any of the eleven different indicators of C6. To minimise the effect of different numbers of indicators per criterion to some extent, a **Quantitative Data Coverage Index (QDCI)** has been developed.

The **QDCI** per criterion is calculated as:

(1.6) $$QDCI_C = \sum^{N} \frac{\text{criterion in \%}}{100}$$ (see Table 9)[78]

or

(1.7) $$QDCI_C = \sum^{N} \frac{\sum_{i=1}^{I} \text{covered indicators per institution}}{\text{number of indicators per criterion}}$$

where is:

C = Criterion 1,…,c,…,C

I = Indicator 1,…,i,…,I

N = Institutions 1,…,n,…,N

If all 21 listed institutions and organisations covered one explicit criterion to a 100% – which means that each institution covers all indicators of that explicit criterion – the highest possible QDCI for that criterion in total would be 21. According to diagram b) in Fig. 23 it can be seen that criterion C1 (Forest Resources) has the highest QDCI, calculated with 6,8 and criterion C6 (*Socio-Economic functions*) the lowest with 2,5.

Looking at diagram a) in Fig. 23, it can be seen that in the case of criterion C6 (*Socio-Economic functions*) eleven institutions (i.e. ~50%) provide some datasets. However, looking at diagram b) in Fig. 23 it becomes clear, that the data coverage regarding each institution is quite low as the QDCI counts for just 2,5 out of the possible 21. The situation of criterion C6 is similar to the situation of C4 (*Biodiversity*). Many institutions provide some datasets on forest biodiversity but none of them covers all indicators of the criterion. In contrast – and that was of course to be expected – is the situation for the criterion C5 (*Protective functions*). Even though only six out of the 21 institutions provide some datasets for at least one of the two indicators of criterion C5, quite many of them (4 of 6) cover all two indicators and therefore the criterion to a 100%.

These examples show evidently that the different amount of requirements of each criterion – expressed by the different number of indicators – complicates a simple comparison of data availability between the six criteria. Nevertheless, diagram b) in Fig. 23, and also Table 9, illustrate clearly that the current knowledge and other capacities at the international level to monitor, assess and report on the multiple socio-economic aspects of SFM are currently rather limited compared to those capacities respective to the requirements of e.g. criterion C1 (*Forest Resources*).

4.3.4 The effects of Future Potential Sources

Some future potential sources have been selected and analysed according to their potential to provide datasets for the 35 indicators (see below). Their potential is added to the 52 sources be selected above, to demonstrate possible future developments and trends within the data coverage or data preferences of the pan-European processes of monitoring, assessment and reporting on SFM.

The following eleven sources were selected as potentially relevant data sources in the future:[79]

Table 10: Selected future potential sources

Institution	Source
CoE	European Landscape Convention
CoE	EMERALD Pilot-Database
CSD	Indicators of Sustainable Development
EC JRC	Forest Focus - Forest Mapping
EC/EEA	NATURA 2000 Database
ESA	GMES GSE Forest Monitoring - Services and Products
Eurostat	EAF - Economic Accounts for Forestry (non-wood sector)
OECD/EEA	Environmentally Related Taxes DB
UNECE/FAO	EFSOS (new assessment)
UNECE/EC	BioSoil (Level I)/ ForestBiota (Level II)
UNESCO	World Heritage Convention/ MaB Programme

[78] Percentages of data coverage within the Table 9 are rounded off. The calculated QDCI instead relies on the not rounded off percentages of data coverage.
[79] The sources were selected in 2005. Some of the sources might be fully implemented by now.

All selected future potential sources are sources that are currently under development or for various reasons not fully implemented yet (status 2005).

The effect of future potential sources has to be seen from a relative point of view, as only a certain list of future potential relevant sources have been selected. Although suggestions of a few other experts in the domain of monitoring, assessment and reporting on SFM are considered (e.g. Mr Andreas Schuck or Mr. Jo van Brusselen from the EFI), the selection of future potential sources is a non-representative expert opinion.

However, the major objective of the following section is to illustrate for at least some future potential sources: (a) in how far the data coverage of which indicators is affected by selected future potential sources, and (b) which of the institutions enhance their data potential relevant for which pan-European indicators.

Backgrounds and potentials

The CoE European Landscape Convention and the UNESCO World Heritage Convention/ MaB Programme are less considered as explicit data sources rather than potentially relevant programmes which might implement relevant databases in future. Both programmes are seen as potentially relevant for the data assessment and reporting on the indicator *6.11 Cultural and Spiritual Values* – an indicator that is currently not covered by any international source (see Chapter 4.3.1.2).

The CoE EMERALD database and the EC/EEA NATURA 2000 database are databases that are almost completed within their development but not fully implemented yet (status autumn 2005). Both databases cover datasets relevant to the Bern Convention (1979). The NATURA 2000 database covers national datasets according to the EC Flora Fauna Habitat (FFH) Directive (92/43/EEC) and the EC Bird Directive (79/409/EEC). National reporting to the NATURA 2000 Network is mandatory for all EU members. In contrast, the reporting to the EMERALD Network is voluntary, as it is based on a soft law regulation. The EMERALD database covers similar datasets as the NATURA 2000 database, but concentrates on non-EU countries only. Both databases provide datasets according to the national reporting on designation areas like on habitats of the wild flora and fauna species, endangered natural habitats and areas of importance for migratory species. Close linkages are given to the EEA European Common Database on

Designated Areas (CDDA). The NATURA 2000 database is developed by the EEA and was officially released by the EC in 2006. Both databases, the NATURA 2000 and the EMERALD database, are regarded as especially relevant for the indicator *4.9 Protected forests*, but also potentially relevant for the indicators *3.5 Forest under management plans* and *4.3 Naturalness*.

The CSD Indicators for Sustainable Development are currently only reported by some countries. The current database covers seven countries rather for test purposes than a fully reporting on all CSD Indicators. Only three of the CSD Indicators are linked to the pan-European indicators, which are the indicator *1.1 Forest area*, *3.1 Increment and fellings* and *4.3 Naturalness*. The CSD Indicators for Sustainable Development are not so much considered as a potential data source for the explicit reporting on the pan-European indicators, but are listed as an example of using potential synergies between regional (pan-European) and global reporting. CSD forest datasets rely partly on FAO datasets.

The Eurostat Economic Accounts for Forestry (EAF) are considered and listed as a relevant European data source, although it is rather a pilot-database than an already fully implemented source covering all EU member countries. However, the relevance of the EAF to provide explicit datasets on certain economic or socio-economic indicators is important. Already in 2004, the MCPFE considered the EAF as a possible international data source for the forthcoming reporting to the MCPFE 2007 in Warsaw (see Table 3, Chapter 2.3.3). As mentioned above, the current EAF database focuses mainly on data from the forestry industry sector. At present, the integration of forest-related datasets is limited to the concepts of the European System of Accounts. Nevertheless, there is strong interest to focus also on other issues of SFM in future – for example on the "*non-market, non-wood values*" of forests. As a starting point, a list of ecological and social functions of forests has been compiled. The non-wood part of the EAF will focus on the environmental and recreational functions of forests, such as carbon storage, recreation, biodiversity and protection of soil, water, etc. Initial pilot studies have recently been completed in several EU countries. The EAF non-wood sector database is considered as being potentially relevant for the indicators *3.3 Non-wood goods, 3.4 Services, 6.3 Net revenue,* and *6.4 Expenditures for services*.

Some further socio-economic datasets might be potentially available by the joint OECD/EEA Database of Environmentally Related Taxes. This database provides information about environmentally related taxes, fees and charges levied in OECD countries. National datasets are provided in most cases by the Ministries of Finance. The primary focus of the database is on pollution-oriented levies and tax-bases. Nevertheless, levies related to certain categories of resource management, such as forestry, have also been included. Data like the total revenues from environmentally related taxes as a percentage of GDP, total tax revenues and revenues per capita in OECD member countries are calculated. This source could be relevant to provide additional input data according to the indicator *6.3 Net revenue*.

The UNECE/FAO European Forest Sector Outlook Study (EFSOS) is relevant for several socio-economic data as well. The latest EFSOS, published in 2005, presents long-term trends for supply and demand of forest products (*roundwood, sawnwood, panels, pulp, paper, non-wood products*) and services, and an outlook to 2020, in Western and Eastern Europe and four major CIS countries including Russia. It reviews trends for the forest resource, trade, markets and recycling as well as stressing the importance of cross-sectoral issues, notably consequences for the forest sector of energy, environment and trade policies. Similar to the MCPFE Report "*State of the forests in Europe*" (MCPFE, 2003), the EFSOS report relies on several datasets provided by other international data sources such as the UNECE, FAO and Eurostat. In this study the UNECE/FAO EFSOS report is considered as a future potential source only for those datasets that are explicitly assessed for and described within the EFSOS report independently from other already covered international data sources. The EFSOS report 2005 provides some pan-European relevant information concerning the indicators *3.3 Non-wood goods, 6.2 Contribution of forest sector to the GDP*, and *6.5 Forest sector workforce*. This kind of new data assessment, as initiated and conducted for this specific report, could be theoretically enhanced and developed further to supply adequate datasets for explicit indicators in the future.

To also consider new approaches like the integration of remote sensing sources and techniques for forest monitoring, the EC JRC Forest Mapping Project and the GMES GSE Forest Monitoring services are considered as being potentially relevant for several forest data – especially to provide forest related spatial georeferenced information.

The Global Monitoring for Environment and Security (GMES) is a joint initiative of the European Commission and ESA. Within the GMES, the GSE[80] is the first dedicated ESA programme within this joint initiative. The project is financed by the ESA but coordinated by the GAF AG. The current Forest Monitoring Services are comprised of the following services and product packages:

- GMES GSE - Clear Cut Mapping and Monitoring Service
- GMES GSE - Forest Monitoring Inputs for CDM[81] Projects
- GMES GSE - Land Cover and Forest Indicator Service
- GMES GSE - Sub-National Forest Information Update

To minimise complexity within this study, all four services are summarised as one future potential source.

The GSE Forest Monitoring addresses policy related demands for securing the ecological functions in the forestry and land use sector. The first stage (2003-2004) consolidated services related to information needs of environmental policies, focusing predominately on UNFCCC and the Kyoto Protocol. Additionally, existing infrastructural systems and data sources were reviewed and utilised in order to develop forest monitoring services such as yearly carbon balance information, forest disturbance data, as well as products for practical forest and land use management. As the second consolidation stage was successfully completed the GSE FM is currently implementing a fully operational system from 2005-2008. The GMES GSE Forest Monitoring Services and Products are considered as potentially relevant sources for the indicators *1.1 Forest area, 1.2 Growing stock, 1.4 Carbon stock, 2.4 Forest damage*, and *4.7 Landscape pattern* – especially providing spatial georeferenced data, e.g. in the form of forest maps.

To consider new approaches of harmonised ground level data assessment as well, the approaches of the EC funded projects ForestBiota and BioSoil are considered as potentially relevant approaches to enhance the joint monitoring programme of ICP Forests and Forest Focus on Level I and Level II – and specifically with regard to

[80] Global Monitoring for Environment and Security Services Element (GSE)
[81] Clean Development Mechanisms

biodiversity indicators. A detailed data potential analysis is represented in Chapter 6 and Annex 2.

The effects of selected future potential sources

The diagram in Fig. 24 shows the extent to which the current data coverage according to the 35 pan-European indicators would change if data potentials of the eleven selected future potential sources would be added to the data potential of the 52 already selected data sources. The diagram in Fig. 25 only shows the net effect of selected future potential sources, illustrated according to the data coverage of relevant institutions and organisations. In this diagram a future source was only considered as an additional source, if the explicit indicator was not already covered by the explicit institution.

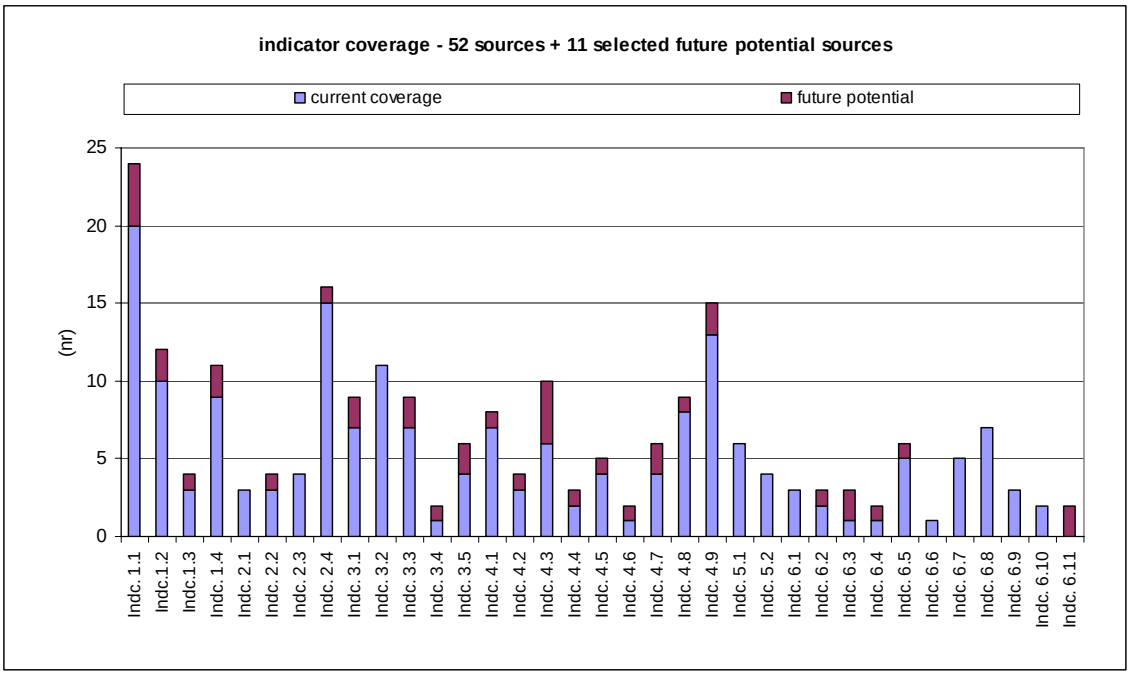
According to Fig. 24 it can be seen that, especially the indicators *1.1 Forest area* and *4.3 Naturalness* will be notably covered more than before. Moreover it can be recognised that seven out of all nine *core indicators* are covered by selected future potential sources – except *3.2 Roundwood* and *6.8 Trade in wood*. This underlines again the importance and high validity of the defined core indicators within the current, but also future, activities of monitoring, assessment and reporting on SFM. Furthermore it indicates that, although several datasets are already available according to explicit core indicators, there is a further need to improve information and datasets according these indicators. Improvements in data quality, but also the enhancements of data complexity, are of great interest.

From the perspective of *deficit indicators* the situation looks slightly different. Four out of the eleven deficit indicators are not covered by any of the selected future potential sources. All other deficit indicators are covered at least by one or two future potential sources. The indicators *4.6 Genetic resources*, *6.6 Occupational safety and health*, *6.9 Energy from wood resources* and *6.10 Accessibility for recreation* are not covered at all.

The indicator *6.11 Cultural and spiritual values* is the only indicator that is not covered by any quantitative data according to the 52 selected international data sources (see Chapter 4.3.1). As mentioned above, the CoE European Landscape Convention and the UNESCO World Heritage Convention/ MaB Programme are considered as relevant programmes (frameworks) which might provide at least some relevant information on indicator *6.11* in the future. More promising seems to be the situation for the deficit

indicators *6.2 Contribution of the forest sector to the GDP*, *6.3 Net revenue*, *6.4 Expenditures for services* and the correlated indicator *3.4 Services*. Especially the Eurostat Economic Accounts for Forestry (EAF) – either for the already covered "*wood sector*" but also for the not yet covered "*non-wood sector*" – seems to be a relevant future data source. The new data assessments for the accomplishment of the UNECE EFSOS report are also relevant. New assessed information like datasets on non-wood goods, or datasets on the contribution of the forest sector on the GDP or information about the forest sector workforce could be used in the future for the reporting on explicit socio-economic indicators. In addition to some slightly improved deficit indicators, the data situation for the indicator *3.3 Non-wood goods* would also be improved at the international level. Even though several sources list this indicator within their database or data report, available datasets are rather inconsistent and incomplete according to the MCPFE requirements.

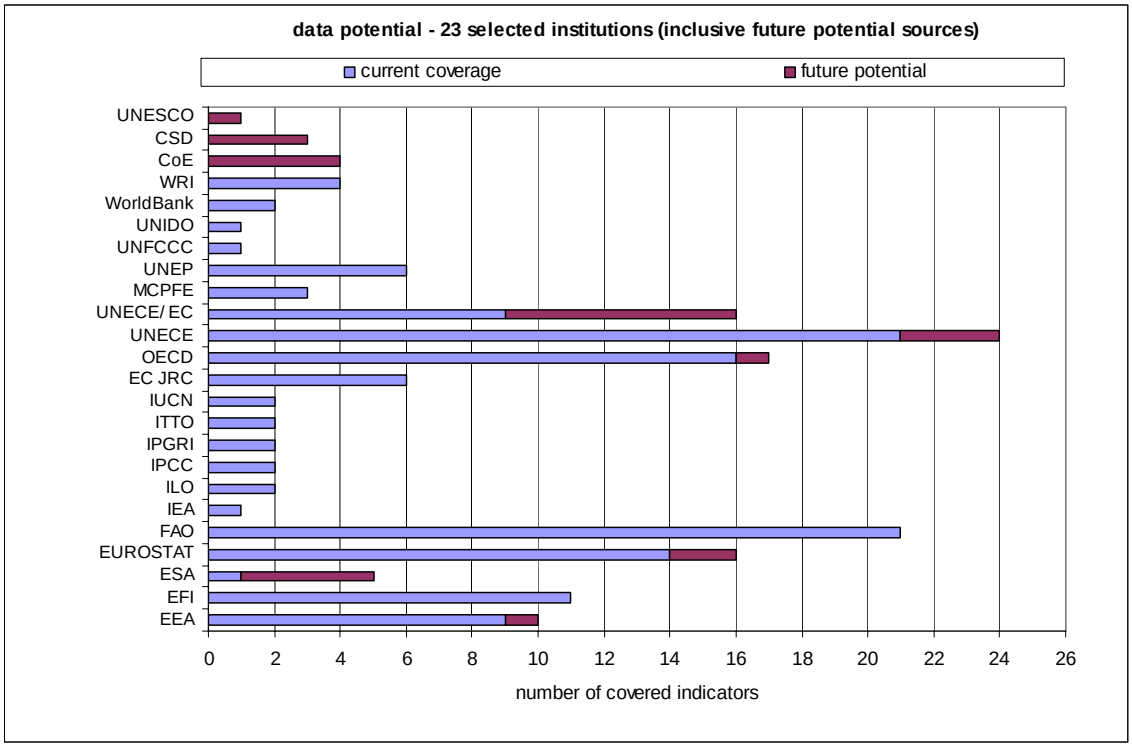
Fig. 24: Effect of selected future potential sources according to the 35 pan-European indicators.



From the perspective of institutions or organisations it can be summarised that, especially the UNECE/EC with its joint monitoring programme on Level I and Level II has high potentials to provide several more datasets in future. Approaches as tested in the project ForestBiota or currently developed under the BioSoil project are of high relevance to provide several datasets – specifically on forest biodiversity. In addition, already available raw data on Level I and Level II could be re-evaluated and optimised

to provide more data on a harmonised comparable basis for the MCPFE reporting (see detailed analysis in Chapter 6). For a harmonised data assessment of forest resources at the European level, the ESA funded GMES GSE Forest Monitoring could also play an important role.[82] Focusing more on the economic and socio-economic data, the UNECE and Eurostat have promising potentials to improve and enlarge their data capacities in the future.

Fig. 25: Net effect of selected future potential sources according to responsible institutions and organisations.



Recapturing the effects of selected future potential sources – either from the point of view of indicators or from relevant institutions – the focus in monitoring, assessment and reporting clearly moves towards more enhanced and improved data assessments according to criteria C1 (*Forest Resources*) and C4 (*Forest Biodiversity*). Especially criterion C4 will be covered by many more datasets in the future. Improved data assessments on forest resources focusing specifically on issues like forest biomass and carbon stocks are also of interest. Also relevant are more integrative landscape perspectives on the spatial distribution and patterns of forests. There is increasing

[82] Although the ESA is financing the project, there is currently no clear indication which of the GMES GSE Forest Monitoring Services and Products will be finally maintained and implemented by which national or international institution or organisation.

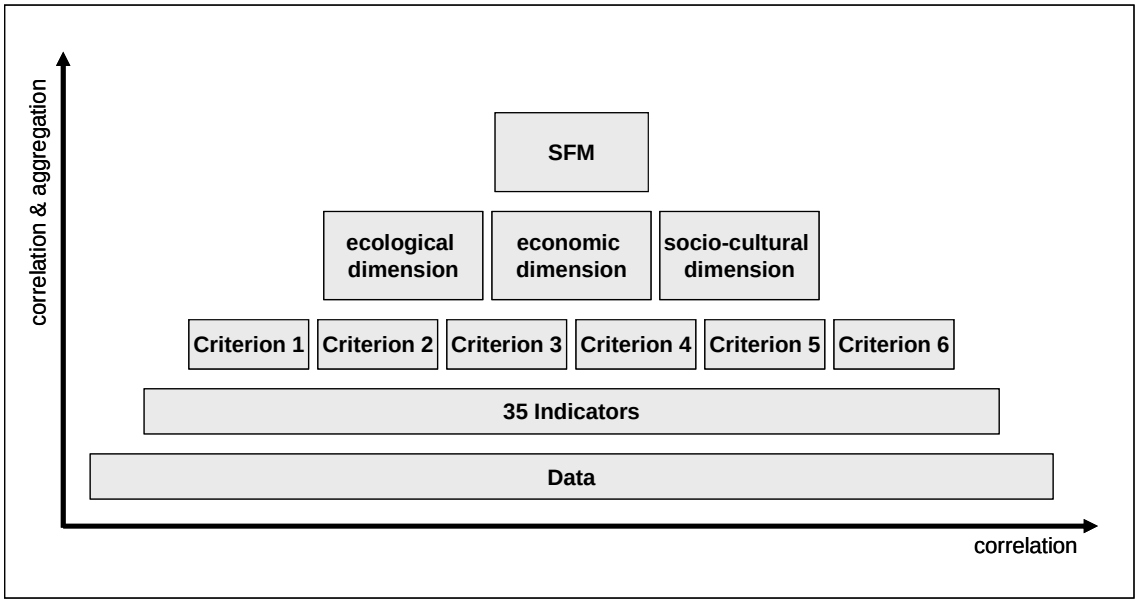
awareness of socio-economic indicators (see criteria C6 and partly C3) to monitor SFM, but there are only a few (or in some cases none) applicable solutions and approaches for explicit data assessment are available at present. However, the effects of future potential sources on the trends and developments within the pan-European monitoring, assessment and reporting on SFM as described in this Chapter have to be seen from a relative point of view as only a few sources have been selected and analysed.

5 Approach 2: Correlation Network of the 35 pan-European Indicators

5.1 Introduction

In consideration of the multiple definitions of sustainability, the viewpoints about the importance of alternative sustainability objectives are always relative. The ecologic, economic and social-cultural dimensions of sustainability display various attributes of high complexity and connectivity. Nothing can be managed in a convenient isolation. Issues are mutually implicated and problems extent across many scale levels of space and time as well as uncertainties and value-loadings of all sorts and all degrees of severity affect data and theories alike (Shields et al., 2002). The inter-connectedness of the social, economic and ecological dimensions within the concept of sustainability or also within SFM is widely acknowledged and recognised. Shields (2002) argued that there is an ordered relationship between sustainability objectives and its measures – either in hierarchical order or in a means-end correlation network. According to that theory and adapted to the objectives of this chapter, the diagram in Fig. 26 describes the correlation of the concept of SFM and its tools to measure its objectives. Correlation is given a) either in form of hierarchical aggregation interlinking the SFM measurement elements between the different levels of aggregation or b) in horizontal correlation interlinking individual measurement elements within one level.

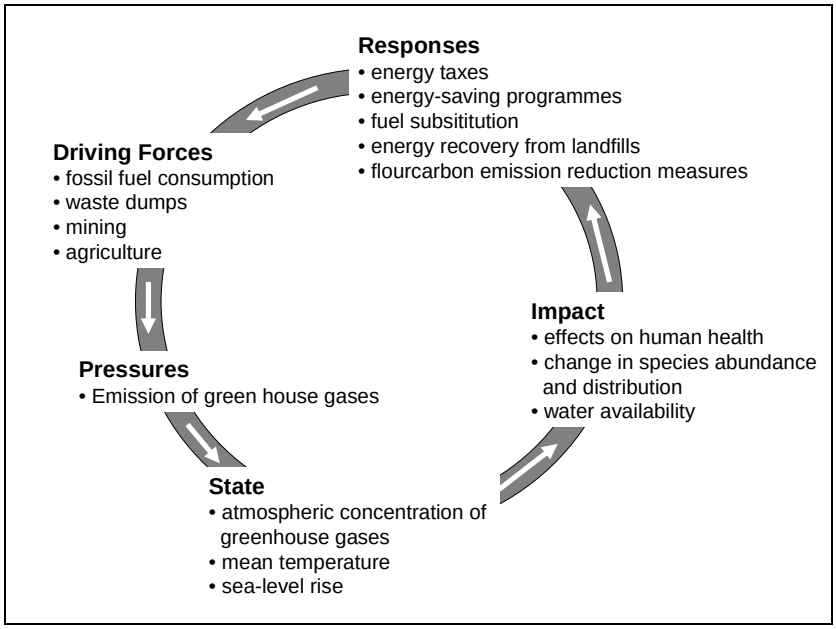
Fig. 26: Correlation Model SFM and its measurement elements.



Mendoza and Prabhu (2003) applied a "*cognitive mapping*" to show cross-indicator linkages of sustainability indicators at the FMU level for a case study in Zimbabwe. The theory behind this is that criteria or indicators seldom impact sustainability by themselves. Because they are intricately linked and connected to other indicators, their impacts are tied through a web of complex relationships that are difficult to extract on an individual indicator basis (Mendoza and Prabhu, 2003).

The EEA for example develops and monitors several environmental indicators in order to report on the progress of the environmental state of the EU in a number of relevant policy areas, e.g. on Climate Change or Biodiversity. The EEA structures and develops their indicators according to the DPSIR concept – the *Driving Forces*, *Pressure*, *State*, *Impact* and *Response*. The DPSIR concept is useful in describing relationships (cause-effect mechanisms) between the origins and consequences of environmental problems, but also to understand and describe the dynamics and interlinkages between different indicators, like the relationship between *Driving Forces* and corresponding *Pressures* (see e.g. EEA climate change indicators depicted in Fig. 27).

Fig. 27: Example of DPSIR diagram for climate change (EEA, 1998; Smeets et al., 1999)



From the point of view of information relevance and information communication, it can also be presumed that indicators, either from the perspective of demands or supply, are not standing somehow alone disconnected in a certain context or framework. With respect to the pan-European C&I it can be presumed that the 6 criteria and 35 quantitative indicators are strongly interlinked, forming an intricately connected correlation network under the concept – the three dimensions – of SFM.

The major objective of this chapter is to show the correlation and cross-indicator interlinkages of the 35 pan-European indicators describing different cause-effect mechanisms between different SFM aspects. By applying approaches of one-mode network analysis, the indicators individual relationship, function, interaction or its *validity* within the entire set of pan-European indicators are analysed. Core (central) indicators, standalone indicators, groups or sub-groups of indicators are identified to describe the correlation structures and validity of individual indicators but also of indicator groups within the entire indicator set. Relying on the correlation of the 35 indicators, the correlation of the six pan-European criteria is also discussed and depicted in network correlation models. Furthermore, it is of interest to analyse whether there is any correlation or similarity between the indicators' validity within the indicator network (e.g. expressed by its centrality) and the current indicator data coverage according to selected international data sources (see Chapter 4).

5.2 Methodology

The basic approach is to apply one-mode network analysis. A network (or matrix) is generated in order to describe the interlinkages and relationships of the 35 pan-European indicators to each other. Where there is a relation a "1" is entered into the matrix cell. In the case where there is no relation a "0" is entered. The basic information of explicit indicator relation – which indicator is linked to which indicator – relies on the indicator description as stated in the MCPFE document: *Background Information on Improved Pan-European Indicators for Sustainable Forest Management* (MCPFE, 2002a). According to this document, the 35 indicators form a directed network in which a link from one indicator to another does not necessarily imply that there is a link (connection) also in the other direction. By depicting indicator relations within *network correlation maps*, relations within directed networks are described by an arrow, connecting and describing the direction of a given relation between two indicators.

Network correlation maps yield descriptive rather than prescriptive results. In other words, results are more broadly stated than those generated from prescriptive or diagnostic approaches. Nevertheless network correlation maps facilitate representation of highly complex elements in an organised and structured diagram or model. In addition to the model several analytical network parameters can also be calculated in order to verify results and evaluation gained from generated correlation maps. The most relevant network parameters are: *density* and *centrality*.

The *density* reflects the relation between most possible or potentially possible relations within a network of a certain number of nodes (in this case: 35 indicators), regardless of the direction of relation. It informs about the overall connectivity within a network (see also Chapter 3.5.2). The *centrality* or connectivity of an indicator is described by the number of relations within a network. The most applied parameter within undirected networks to describe centrality is the *Indegree* or the *Outdegree*. The *Indegree* reflects in how far the indicator receives a link and the *Outdegree* informs in how far the explicit indicator sends a link to another indicator (see also Chapter 3.5.2).

As already mentioned, the information on which indicator is linked to which indicator relies basically on the indicator description provided by the MCPFE background document (MCPFE, 2002a). This document was elaborated by the MCPFE Advisory

Group including several expert workshops and was officially adopted at the MCPFE Expert Level Meeting in October 2002 (see also Chapter 2.2). Although sound knowledge and objective expertise from various fields of forestry and forest science have been the basis for the indicator background document and individual indicators descriptions, the indication of indicator linkages partly remains incomplete and inconsistent. Therefore the indicator correlation network model based on the MCPFE background document is partly enhanced, at least for those indicator correlations which seem to be obvious, but that are missing within the MCPFE background document. Due to the limited framework of this survey no additional expertise – such as a Delphi survey[83] – has been considered to approve and underpin further suggested indicator correlations. The intention of the indicator network analysis is to provide some first input to start some scientific and political discussions with respect to the specific issue of pan-European indicator correlations and their validity within the pan-European monitoring, assessment and reporting on SFM and also within the implementation of forest management concepts.

5.3 Results

5.3.1 Correlation Network of pan-European Indicators – Basic

According to the theory that indicators, parameters or any other information assessed under the scope of SFM, are disconnected without any correlation to each other, the objective of this chapter is to analyse and to depict the linkages and correlations of the 35 pan-European indicators. Following the network approaches and taking into account the indicator descriptions of the MCPFE background document, a first basic indicator correlation map has been generated (see Fig. 28). Within that basic indicator network only those linkages are taken into account that are explicitly mentioned in the MCPFE

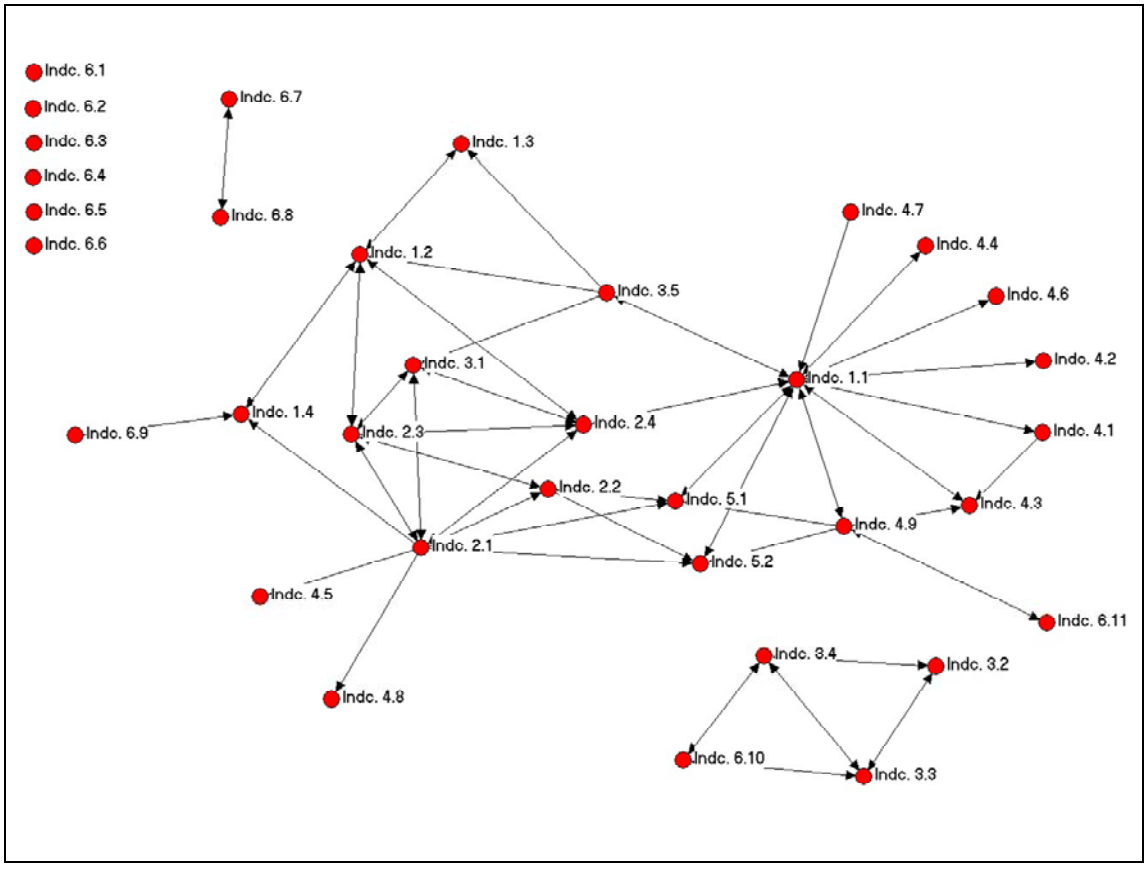
[83] In this study the MCPFE background document is regarded as a kind of Delphi survey. **Delphi surveys** are an effective approach to gather various expertise and find the most common denominator on common issues. A Delphi survey is a structured group interaction process that is directed in rounds of opinion collection and feedback. Opinion collection is achieved by conducting a series of surveys using questionnaires. The result of each survey will be presented to the group and the questionnaire used in the next round is built upon the result of the previous round (Delbecq et al., 1975). Wolfslehner (2004) applied a Delphi survey to indicate correlations of regional SFM indicators relying on the expertise of various stakeholders and actors. Generally it has to be considered that even within a Delphi survey the results are only as valid as the opinions of the experts involved.

indicator descriptions. Undistinguished indications of any linkages are not considered within this network.

Looking at the depicted indicator network in Fig. 28 it can be seen that not all indicators are linked to each other. Especially indicators of criterion C6 are disconnected. Some other indicators rather build sub-groups separately to the major domain indicator network. In total, four different groups of indicator correlations can be distinguished:

- Group 1: the primary network interlinking 23 of the 35 indicators.
- Group 2: correlation sub-group 1 formed by the indicators *3.2 Roundwood*, *3.3 Non-wood goods, 3.4 Services* and *6.10 Accessibility for recreation*.
- Group 3: correlation sub-group 2 formed only by the two timber market relevant indicators *6.7 Wood consumption* and *6.8 Trade in wood*.
- Group 4: the group of non-linked indicators *6.1 Forest holdings, 6.2 Contribution of the forest sector to GDP*, *6.3 Net revenue*, *6.4 Expenditures for services*, *6.5 Forest sector workforce* and *6.6 Occupational safety and health*.

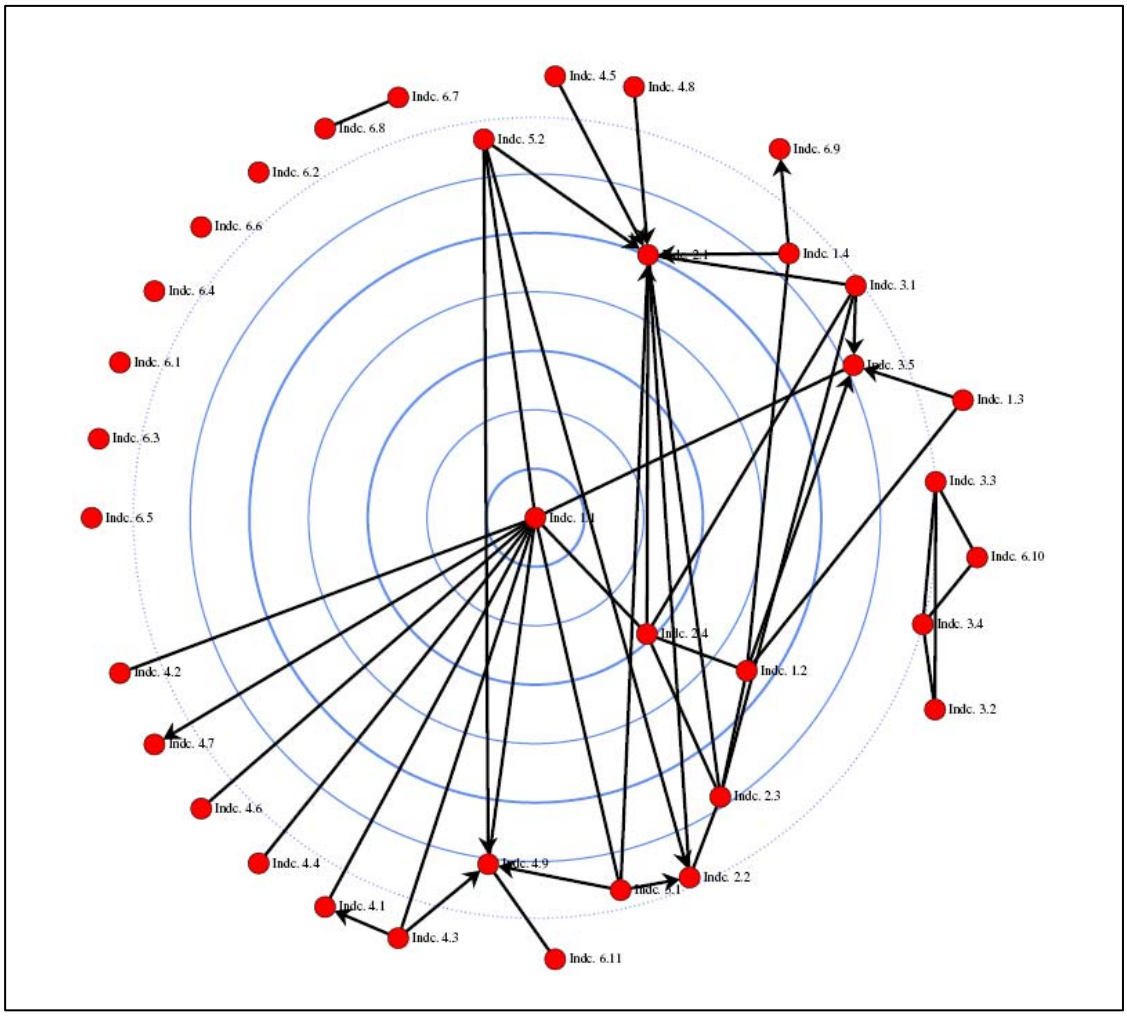
Fig. 28: Correlation Network of the 35 pan-European Indicators, based on the MCPFE background document 2002 – Approach Network Analysis (Software: UCINET6).



Reviewing the primary network, it can be seen that some indicators play a more central role than others (e.g.: 1.1, 2.1, 2.3, 2.4, 3.1, 4.9, 5.1, 5.2). Indegree, outdegree and betweeness-centrality are the core parameters to describe the importance and relevance of selected indicators (actors) within a network. They reflect the individual role and function of an indicator in correlation to the entire indicator network.

The most central indicator is indicator *1.1 Forest area*. This dominant centrality is clearly expressed by its high indegree and outdegree (see Fig. 32, further below). The indicator is linked to 10 indicators (outdegree) and receives a direct link from 11 indicators (indegree). Although both degrees can be considered as the most relevant parameters to describe centrality, the betweeness-centrality additionally underlines the absolute high centrality of indicator 1.1 (see Fig. 29). Contrary to the degrees, the betweeness-centrality (see also Chapter 3.5.2) measures in how far the network actors are *indirectly* affected by or affect a selected actor within the network. That kind of connectivity can be for example supported by a third actor – called a broker. The more connections the broker has, the higher is its centrality.

Fig. 29: Betweeness-centrality of the 35 pan-European indicators (Software: VISONE 1.1.1).



As mentioned above, the pan-European indicators are correlated in a directed network. This is expressed by the arrows of ties in Fig. 28 and Fig 29, but also by the differences between indegree and outdegree. An indicator linkage is not necessarily replied. An indicator might be linked to another indicator but does not necessarily receive a link back from that indicator. The different indicator linkages can be taken as an indication that SFM relevant aspects, such as expressed by the indicators, might affect other SFM aspects, but not necessarily vice versa.

Diagrams A1 and A2 in Fig. 32 (see page 130) reflect the different degrees and therefore the different *centrality* or levels of *validity* of each of the 35 indicators. It can be seen that, although both diagrams are similar in their distribution, some indicators have a higher indegree than outdegree and vice versa. This illustrates that some indicators such as *2.1 Deposition of air pollutants* or *4.9 Protected forests* affect more indicators than they are affected by (i.e. they have a higher *outdegree*). On the other

hand indicators such as *1.4 Carbon stock* or *4.3 Naturalness* are affected by a higher number of indicators than they affect (i.e. they have a higher *indegree*).

According to general network theory a network is called "*complete*" when each indicator is linked to each of the other indicators within the network. A complete network has a network density $d = 1$. This is only a theoretical indication that is almost never the case in larger complex networks. However, the indicator network as depicted in Fig. 28 or Fig. 29 seems to be more incomplete than complete. Reviewing the indicator network above, the following questions arise: Why are not all indicators linked? Why are some indicators much more linked than others? Why are there sub-groups although the entire indicator set should rather be an "*interweaved network*" – a network in which all 35 indicators are somehow interlinked and correlated – describing mutually the most relevant pan-European measurement parameters of SFM?

5.3.2 Correlation Network of pan-European Indicators – Enhanced

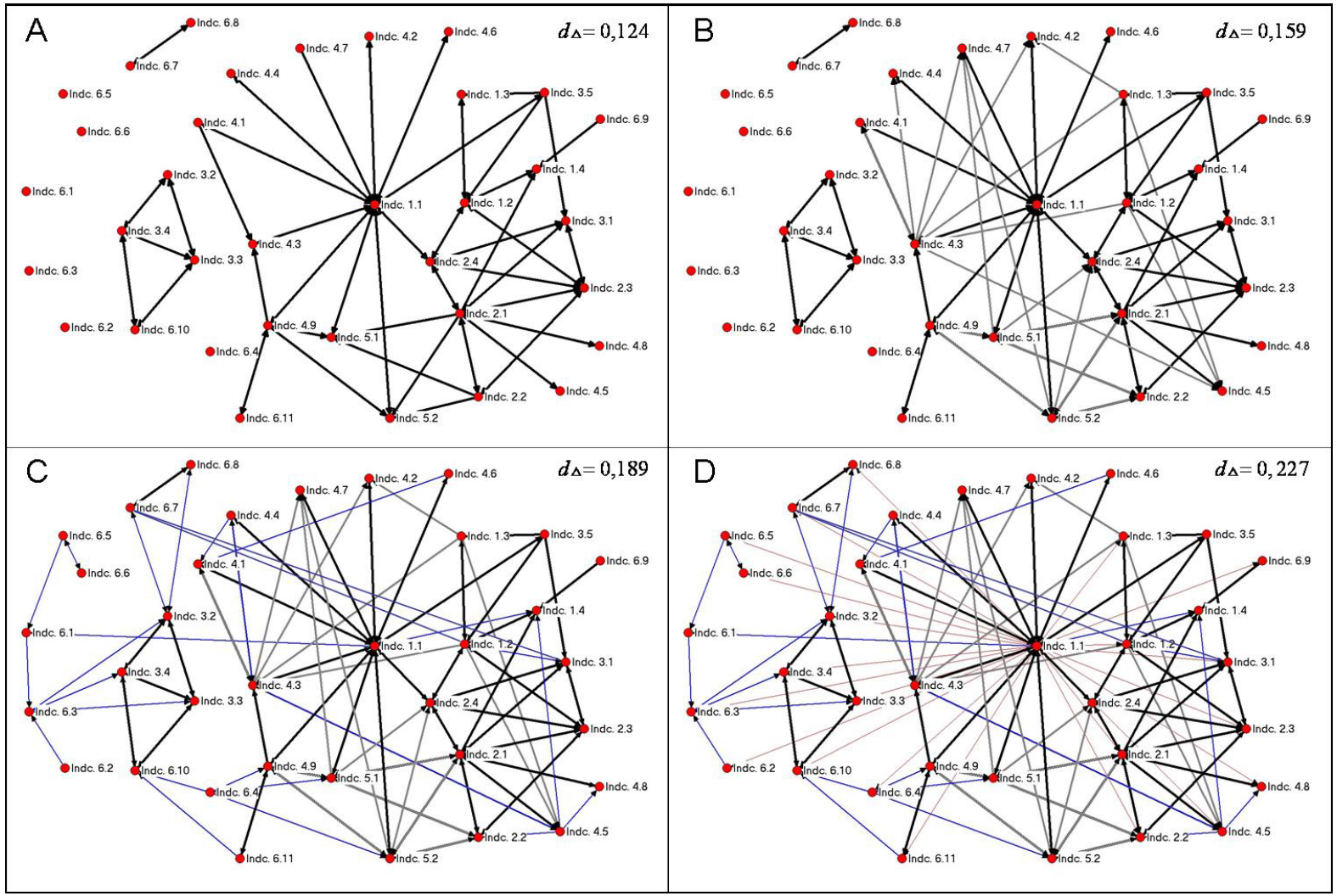
Within the basic indicator network (Fig. 28 and Fig. 30A) not all potential linkages are depicted. Only those that are explicitly mentioned in the MCPFE background document are shown. It seems that the indication of indicator linkages partly remains incomplete and inconsistent within the MCPFE indicator descriptions. Furthermore it seems that some indicators and their relations to other indicators are more promoted by the MCPFE background document than others. Reviewing the network and also the indegree and outdegree of indicators (see page 130, Fig. 32, Diagram A1/A2) it can be seen that indicators like *2.1 Deposition of air pollutants* are of much higher centrality within the depicted network than for example several other indicators such as those of criterion C6 (*Socio-economic functions*). This kind of – maybe at the first sight unfounded – different indicator centrality leads to two different assumptions. The first assumption is that the described numbers of links per indicator, and therefore the indicated validity of each indicator, are influenced by the different subjectivity and understanding of C&I as well as by the influence of individual experts that were involved within the MCPFE C&I development process. The second assumption is that it is simply a matter of fact that certain indicators (SFM aspects) are much more central than others to implement and to monitor SFM at the pan-European level.

However, to provide some first input for further discussions on the issue of pan-European indicator correlations, the basic indicator correlation network model based on the MCPFE background document has to be enhanced, at least for those indicator correlations which seem to be obvious, but are missing within the MCPFE background document. The network diagrams B, C and D in Fig 30 show some suggestions to enhance the indicator correlation network and therefore strengthen C&I connectivity.

Network A describes the same basic indicator network as depicted in Fig. 28, only in a different presentation. Within **Network B** the basic indicator correlation network is enhanced for those indicator correlations where at least an indistinct link is given by the MCPFE background document. For example for the indicator *4.3 Naturalness* the MCPFE background document states: "*This indicator is linked to the indicator 1.1 and to indicators under Criterion 4.*" Unfortunately the MCPFE background document provides no further details as to which of the nine indicators of criterion C4 the indicator *4.3 Naturalness* might be linked. Due to this undistinguished description but also to consider all potential indicator correlations, the indicator *4.3 Naturalness* is linked to all indicators of the criterion C4. The same rule is applied for the indicators 5.1 and 5.2 (*Protective forests*), which have a similar undistinguished description.

Slightly different are the indicated correlations of the indicator *1.3 Age structure or/and Diameter distribution*. The MCPFE description of this indicator refers only to a "*cross-reference to criterion C4*". It already indicates that only some indicators of criterion C4 are linked. Therefore, these indicator correlations were enhanced only with respect to indicator linkages that seem to be reasonable and obvious. In Network B the indicator *1.3 Age structure or/and Diameter distribution* is therefore linked to the indicator *4.2 Regeneration*, *4.3 Naturalness* and *4.5 Deadwood*. Similar enhanced cross-references are given in the case of the indicator *1.2 Growth rate*.

Fig. 30: Correlation Network of the 35 pan-European indicators – enhanced for discussion (Software: UCINET 6).



Network C describes sets of indicator correlations that are reasonable but where no indication within the MCPFE background document is given at all. These additional correlations provide the basis for further discussions. Network C intends to describe further potential linkages that bring all 35 indicators into correlation to some extent. Of particular interest is the interlinking of the socio-economic indicators of criterion C6 that are not linked to any other indicator according to the MCPFE background document.

Examples of new added indicator correlations (Network C) are linkages between the Indicator *3.2 Roundwood* and *6.7 Wood Consumption* and *6.8 Trade in wood*. Correlations between the indicators 6.*7 Wood Consumption*, *1.2 Growing stock* and *3.2 Increment and fellings* are also possible. The indicators *6.2 Contribution of forest sector to GDP, 6.3 Net revenue, 3.2 Roundwood, 3.3 Non-wood goods* and *3.4 Services* could form a network of merely economic indicators. Moreover there are also indicated correlations between the indicator *6.4 Expenditures for Services* and *4.9 Protected forests* or between *6.4 Expenditures for Services* and the indicators *5.1* and *5.2 Protective forests.* Correlations between *6.4* and *6.10 Accessibility for recreation* or *6.11 Cultural and spiritual values* may also be possible. Furthermore any correlations between the two socio-economic indicators *6.5 Forest sector workforce* and *6.6 Occupational safety and health* are missing within the MCPFE background document.

Reviewing the suggestions above, it becomes obvious that there are many possibilities for additional interlinks between various indicators. Finally it can be also suggested that all pan-European indicators are theoretically somehow interlinked and correlated to the most central indicator *1.1 Forest area* (see **Network D**). It is always the point of view – the *subjectivity* – that interlinks indicators or not. An expert from a local management unit level will certainly have a different view on indicator correlations than an expert from the international level. A forest ecologist might also have other indicator correlation priorities than a forest economist. However, the suggestions of enhanced indicator correlations, above depicted, demonstrate (a) the various possibilities of indicator correlations but also (b) that the 35 pan-European indicators should be seen as an intricately linked network rather than standalone indicators measuring and describing different themes and interests of SFM on their own.

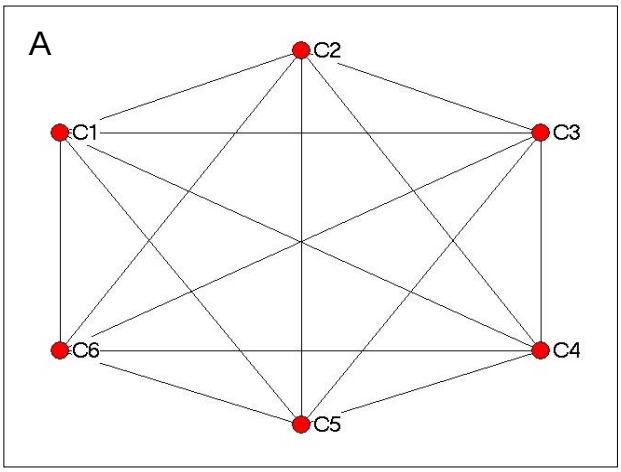
5.3.3 Correlation Network of the six pan-European Criteria

It is widely acknowledged that the six pan-European criteria together describe the most relevant themes of the economic, ecological and socio-cultural dimensions of SFM (see Fig. 26 and Chapter 2.1 Fig.1). Relying on that theory, it can be assumed that all six criteria are mutually interlinked and correlated to each other (see also Chapter 3.5.2.1, Fig. 14). This section intends to demonstrate the various dimensions of criteria correlations and the underlying theory by taking into account only the precisely described indicator linkages according to the MCPFE background document.

Fig. 31 (see below) shows three different views on criteria correlations. **Network A** describes a criteria network where all six criteria are mutually interconnected. Taking into account the 35 indicators and assuming that each of the indicators might be theoretically linked to each of the other remaining 34 indicators (network density: $d = 1$), the table to the right shows the number of all potentially possible indicator linkages (dyads) between two criteria and within one criterion (intra links). In total (N*(N-1)) 1190 linkages are theoretically possible, forming a tight network of indicators and criteria.

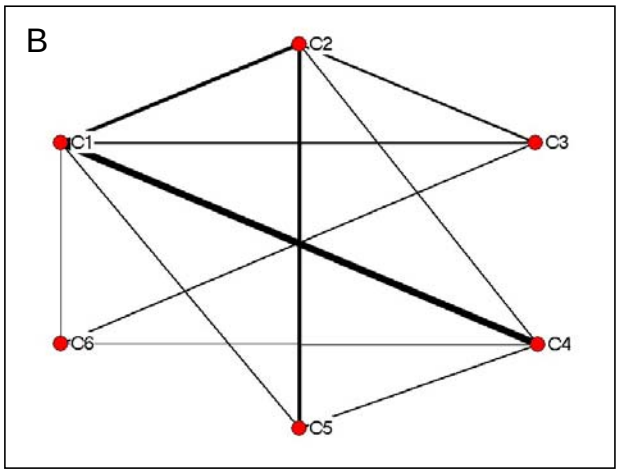
The number of linked indicators can be taken as an index of the correlation strength between two criteria. Only taking into account the linkages according to the MCPFE background document (see Fig. 28, or Fig. 30A), the absolute number of realised links between two pan-European criteria is depicted in **Network B**. In addition, the table to the right indicates also the absolute number of *intra* links within one criterion (see marked cells). As the absolute number of realised indicator links is strongly affected by the number of indicators within one criterion, the *relation* between potentially possible links (Network A) and the absolute number of links (Network B) has been calculated to give a more precise indication of correlation strength (see **Network C**).

Fig. 31: Correlation network of the six pan-European criteria.



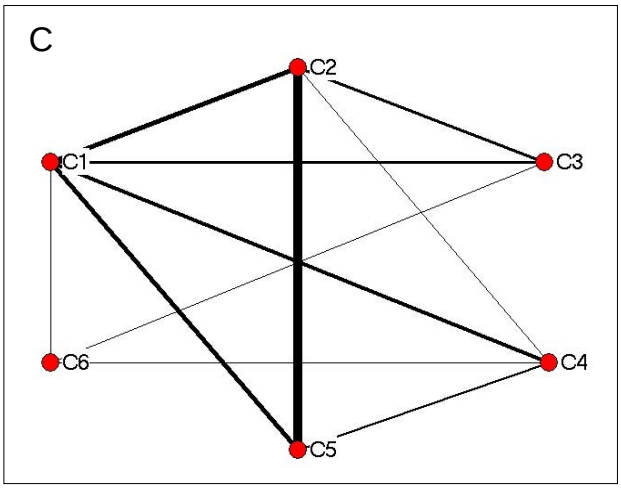
potential linkages

	C1	C2	C3	C4	C5	C6
C1	12	16	20	36	8	44
C2	16	12	20	36	8	44
C3	20	20	20	45	10	55
C4	36	36	45	72	18	99
C5	8	8	10	18	2	22
C6	44	44	55	99	22	110



linkages (absolute)

	C1	C2	C3	C4	C5	C6
C1	4	3	1	6	2	0
C2	4	10	3	2	4	0
C3	3	3	7	0	0	2
C4	7	0	0	2	2	1
C5	2	0	0	0	0	0
C6	1	0	2	1	0	2



linkages (relative)

	C1	C2	C3	C4	C5	C6
C1	33	19	5	17	25	0
C2	25	83	15	6	50	0
C3	15	15	35	0	0	4
C4	19	0	0	3	11	1
C5	25	0	0	0	0	0
C6	2	0	4	1	0	2

By taking into account only the indicator linkages as described by the MCPFE background document, Network B and Network C clearly show what criteria are linked to each other and to what intensity or correlation strength. From the perspective of *absolute* links most correlation is given between the criteria C1 and C4. From a *relative* point of view, there is most correlation between criteria C2 and C5. There are also

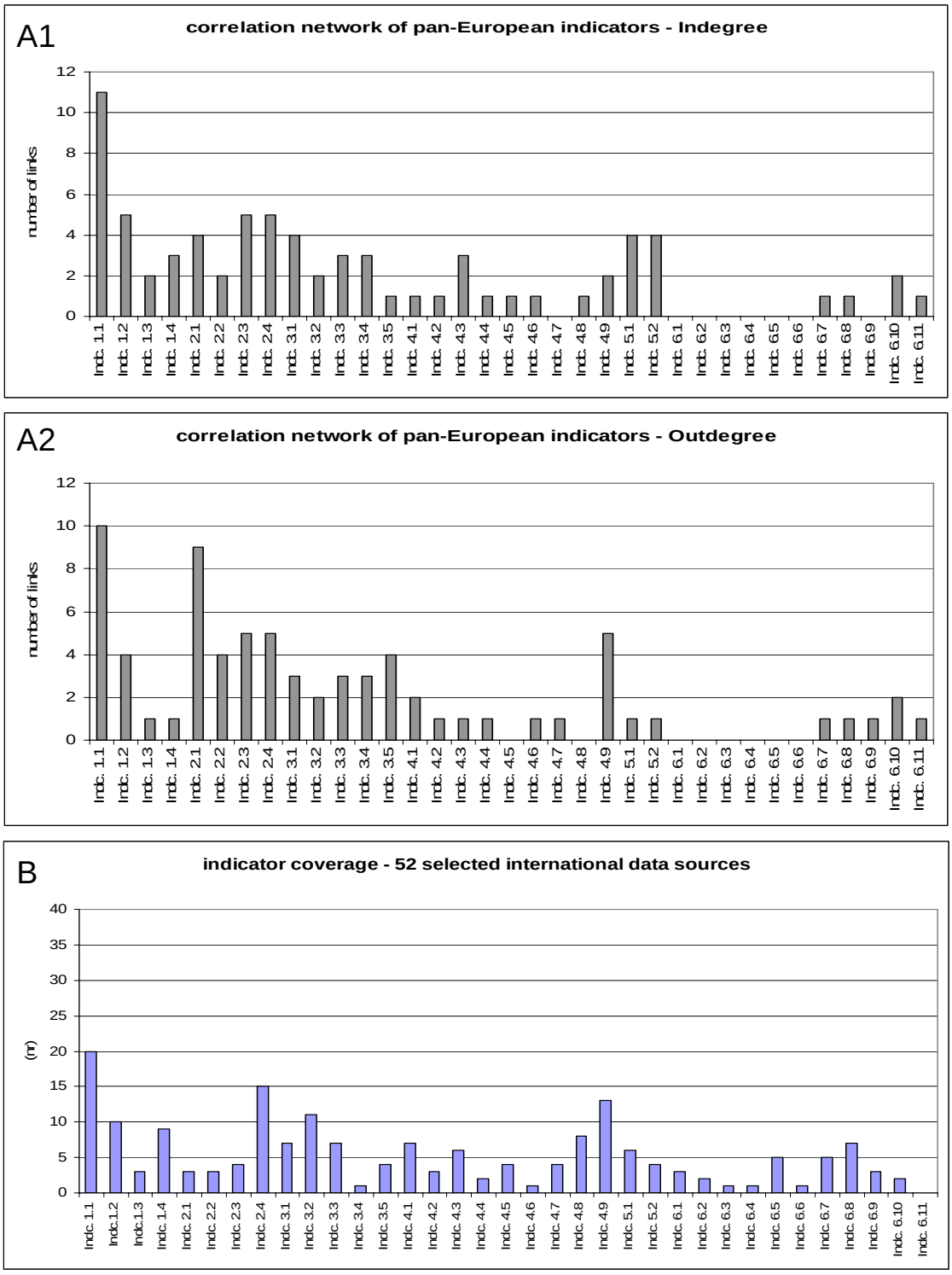
strong interlinks between criteria C1 and C2, and between criteria C1 and C5. No correlation, according to the MCPFE background document, is indicated between the criteria C6 and C5 and between the criteria C3 and C4. To link these criteria, potential indicator correlations could be for example: linkages between the indicator *6.4 Expenditures for services* and *5.1/5.2 Protective forests*, or also between *3.5 Forests under management plan* and *4.9 Protected forests*.

Network B and C underlines again the current marginal validity of criterion C6 and its socio-economic indicators. Only 2 of 110 potentially possible *intra* linkages of criterion C6 (see eleven socio-economic indicators) are currently described by the MCPFE background document, namely between the indicators *6.7 Wood consumption* and *6.8 Trade in wood*. Instead of this, a relative high intra connectivity is described for the indicators of criterion C2 (*Health and Vitality*), realising about 80% of the potentially possible intra linkages.

5.3.4 Correlation between Indicator Network Centrality and international Indicator Data Coverage

Reflected by the international data coverage (see Chapter 4), core indicators or deficit indicators also describe different levels of indicator validity. Within the context of indicator network analysis the following questions arise: Is there any correlation between the international indicator data coverage, described in Chapter 4, and the indicator network centrality as described in this Chapter? To what extent do the most relevant indicators, reflected by the international data coverage, correspond with the most central indicators according to the indicator correlation network? Are the same indicators that are less covered by international datasets are also less interlinked with other indicators? Or the other way around: Are indicators that are often covered are also interlinked to a high degree?

Fig. 32: Indicator network centrality expressed by the indegree or outdegree (diagram A1 and A2) and the current international data coverage according to the 52 selected international data sources (diagram B).



Diagrams A1 and A2 in Fig. 32 show the indegree and outdegree of each of the 35 indicators. Diagram B describes the indicator data coverage according to the 52 selected international data sources (see also Chapter 4.3.1). Both distributions, either the one of the degrees (A1/A2) or the one of data coverage (B), can be taken as an indication of

indicator validity. Although the diagrams A1/A2 and B are not directly comparable as they describe totally different perspectives and results, some similarities are visible between the distributions. Table 11 compares the data coverage in relation to the network indegree and outdegree. All three distributions are listed in a ranked order. Core or central indicators are marked above the third quartile, and deficit indicators are marked below the first quartile of each distribution.

Table 11: Similarity between international indicator data coverage and indicator network centrality expressed by the indegree or outdegree (*red = core indicators; green = deficit indicators*).

Data Coverage		Indegree		Outdegree	
Indc. 1.1	20	Indc. 1.1	11	Indc. 1.1	10
Indc. 2.4	15	Indc. 1.2	5	Indc. 2.1	9
Indc. 4.9	13	Indc. 2.3	5	Indc. 2.3	5
Indc. 3.2	11	Indc. 2.4	5	Indc. 2.4	5
Indc. 1.2	10	Indc. 2.1	4	Indc. 4.9	5
Indc. 1.4	9	Indc. 3.1	4	Indc. 1.2	4
Indc. 4.8	8	Indc. 5.1	4	Indc. 2.2	4
Indc. 3.1	7	Indc. 5.2	4	Indc. 3.5	4
Indc. 3.3	7	Indc. 1.4	3	Indc. 3.1	3
Indc. 4.1	7	Indc. 3.3	3	Indc. 3.3	3
Indc. 6.8	7	Indc. 3.4	3	Indc. 3.4	3
Indc. 4.3	6	Indc. 4.3	3	Indc. 3.2	2
Indc. 5.1	6	Indc. 1.3	2	Indc. 4.1	2
Indc. 6.5	5	Indc. 2.2	2	Indc. 6.10	2
Indc. 6.7	5	Indc. 3.2	2	Indc. 1.3	1
Indc. 2.3	4	Indc. 4.9	2	Indc. 1.4	1
Indc. 3.5	4	Indc. 6.10	2	Indc. 4.2	1
Indc. 4.5	4	Indc. 3.5	1	Indc. 4.3	1
Indc. 4.7	4	Indc. 4.1	1	Indc. 4.4	1
Indc. 5.2	4	Indc. 4.2	1	Indc. 4.6	1
Indc. 1.3	3	Indc. 4.4	1	Indc. 4.7	1
Indc. 2.1	3	Indc. 4.5	1	Indc. 5.1	1
Indc. 2.2	3	Indc. 4.6	1	Indc. 5.2	1
Indc. 4.2	3	Indc. 4.8	1	Indc. 6.7	1
Indc. 6.1	3	Indc. 6.7	1	Indc. 6.8	1
Indc. 6.9	3	Indc. 6.8	1	Indc. 6.9	1
Indc. 4.4	2	Indc. 6.11	1	Indc. 6.11	1
Indc. 6.2	2	Indc. 4.7	0	Indc. 4.5	0
Indc. 6.10	2	Indc. 6.1	0	Indc. 4.8	0
Indc. 3.4	1	Indc. 6.2	0	Indc. 6.1	0
Indc. 4.6	1	Indc. 6.3	0	Indc. 6.2	0
Indc. 6.3	1	Indc. 6.4	0	Indc. 6.3	0
Indc. 6.4	1	Indc. 6.5	0	Indc. 6.4	0
Indc. 6.6	1	Indc. 6.6	0	Indc. 6.5	0
Indc. 6.11	0	Indc. 6.9	0	Indc. 6.6	0

A similar indication of validity – either by the degree (centrality) or the international data coverage – is given for 26 of the 35 pan-European indicators. For 9 indicators no direct correlation can be found. These are the indicators: *1.4 Carbon stock, 2.1 Deposition of air pollutants, 2.3 Defoliation, 3.2 Roundwood, 3.4 Services, 4.8 Threatened forest species, 6.1 Forest holdings, 6.5 Forest sector workforce* and *6.10 Accessibility for recreation*. For some of these indicators, like *3.2 Roundwood* or *4.8 Threatened forest species* the validity expressed by the international data coverage is recognisably higher than the indicated validity according to the network centrality. Other indicators, such as *2.1 Deposition of air pollutants* or *2.3 Defoliation*, have a much higher indicated validity according to the network centrality.

Indicators like *1.1 Forest area, 2.4 Forest damage* or *4.9 Protected forests* are absolutely common and central in both – central either in terms of the indicator correlation network, but also central in relation to the pan-European activities of monitoring, assessment and reporting on SFM. In contrast most of the socio-economic indicators of criterion C6 are of low centrality and also relatively less covered by any international datasets.

It can be concluded that the information basis for regenerating the indicator correlation network models remains partly incomplete and not approved. However, the results described above partly indicate that the current data preferences within the monitoring, assessment and reporting of SFM correspond with the current indicator implementation status described by the indicator networks. Relatively central and well covered are traditional forest aspects such as classic Forest Inventory data, but also datasets concerning forest health and vitality. Relatively new and not well linked instead are most of the socio-economic indicators, but also some biodiversity indicators such as *4.6 Genetic resources* or *4.7 Landscape pattern*. These are also indicators for which almost no adequate datasets are currently available – at least at the international level.

6 Approach 3: Data Potential Case Study – ICP Forests/ Forest Focus

6.1 Introduction

The overview "*Where to find which forest data*" as described in Chapter 4 only shows the very basic data potential of selected international data sources and institutions with respect to the pan-European C&I. As already mentioned in Chapter 3.5.1, data potentials are diverse and can be described by multiple levels of detail. The overview described in Chapter 4 does not differentiate any further what the exact data potentials are. The *methodology of data assessment* (including the *spatial* and *temporal resolution* of available datasets but also the applied *terms* and *definitions*), available *raw data*, and available *evaluated data* are means to describe intricately in how far institutions and their sources have a potential to provide adequate datasets as required by the MCPFE or any other international reporting obligation.

The ICP Forests and the EC Forest Focus joint monitoring programme on Level I and Level II provide harmonised forest related datasets, specifically on forest health and vitality. Therefore, its current data coverage and also its future data potentials are taken as an example to demonstrate the complexity of various data potentials and possible methods for its analysis.

With the termination of the EC Forest Focus regulation in 2006 (Council Regulation (EC) No 2152/2003) and the discussions related to a future EC LIFE+ regulation 2007-2013 the future objectives of the joint programme of ICP Forests and Forest Focus are presently under discussion. Whereas the obligations towards the CLRTAP[90] of the

[90] The *Convention on Long-range Transboundary Air Pollution* has been officially adopted by the UNECE and the EC in Geneva 1979. The Convention officially started to act in 1983.

UNECE will remain rather unchanged[91], there is a strong interest in enhancing the list of attributes assessed by the programme, e.g. related to the MCPFE C&I.

This chapter elucidates the present and future potentials of the joint monitoring network with respect to the information requirements of the MCPFE. According to the data potential screening in Chapter 4 the UNECE/EC joint database (covering Level I and Level II) has a present data potential for about nine indicators in total – covering mainly indicators of criteria C1 and C2. A more detailed analysis of Level I and Level II data potential aims to show in how far:

- datasets are actually available and fulfil the specific MCPFE requirements,
- available datasets – either raw data or already evaluated data – have to be re-evaluated or modified according to the MCPFE requirements,
- data potentials of more detailed datasets could fulfil specific MCPFE requirements in the future, e.g. by implementing approved methodologies of ForestBiota on Level II and BioSoil on Level I in the long term,
- other international institutions and data sources also cover equivalent datasets, and in how far ICP Forests/Forest Focus has a *higher*, *equal* or *lower* data potential to fulfil specific MCPFE requirements.

6.2 The Case Study Sources

The UNECE/EC joint monitoring programme consists of an extensive (Level I) and an intensive (Level II) monitoring network covering predominantly datasets concerning forest health and vitality since the late 1980s and early 1990s. The data assessment of Level I and Level II is internationally harmonised under the scope of ICP Forests and Forest Focus (see ICP Forests Manual (Version 2006)). Currently 40 countries participate in the joint monitoring, including 25 EU countries that are explicitly co-financed and jointly coordinated by the EC.

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[91] ICP Forests was set up to monitor the effects of air pollution on Europe's forests. The mandate of ICP Forests is:

- to monitor effects of anthropogenic (in particular air pollution) and natural stress factors on the condition and development of forest ecosystems in Europe, and
- to contribute to a better understanding of cause-effect relationships in forest ecosystem functioning in various parts of Europe.

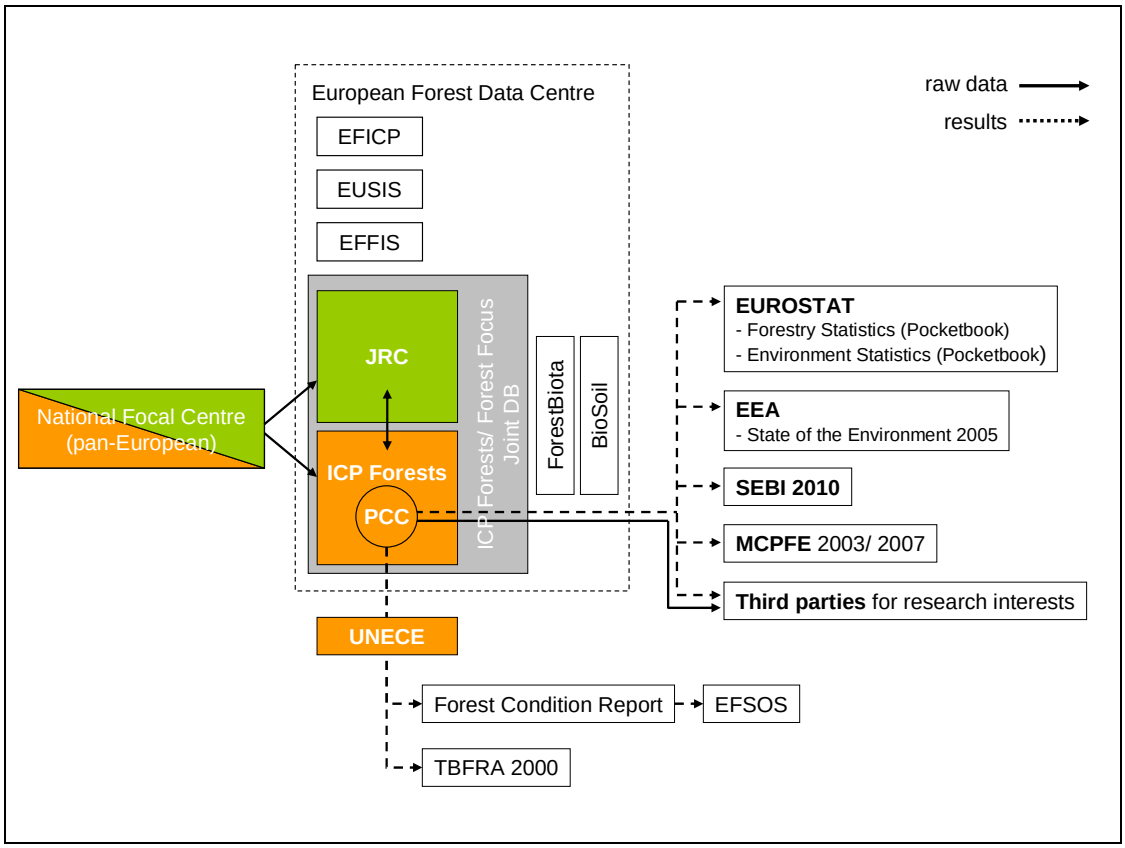
The extensive monitoring of forests is based on a systematic, trans-national 16 x 16 km grid throughout Europe (Level I). Since 1986 the Level I monitoring provides annual estimates on forest health-related parameters like defoliation, discoloration and mortality. In addition a soil survey was conducted between 1992 and 1996. A new soil survey as well as an additional assessment of biodiversity parameters is currently under preparation within the EC financed demonstration project BioSoil. The intensive monitoring of forests on Level II, is based on a European-wide set of long-term observation plots (860 in total) covering the most relevant forest types within Europe. As the selection of Level II plots is based on a case study approach rather than on any probability theory, available datasets are not representative for any international and national reporting. However, some data are collected to assess specific cause-effect mechanisms, like between the deposition of air pollutants and the effects on forest growth and increment (see UNECE Forest Condition reports). Since 1994, soil and soil solution chemistry, foliar nutrient status, increment, meteorological condition, ground vegetation, and deposition of air pollutants are measured in addition to the annual crown condition assessments on these plots. The German Federal Research Centre for Forestry and Forest Products (BFH) conducted a short-term project in 2005-2006, called ForestBiota (also financed by the EC), aiming at a further development of harmonised monitoring and evaluation methods for selected aspects of forest biodiversity. By now datasets concerning stand structure, deadwood, ground floor vegetation and epiphytic lichens have been assessed. Furthermore, a forest type classification based on the outcomes of the BEAR project[92] and the EEA EUNIS forest type classification (EEA, 2006) has been applied.

Currently the EC JRC and the PCC[93] of the UNECE ICP Forests maintain the so called *Joint ICP Forests/Forest Focus Database* (see Fig. 33). This joint database covers Level I and Level II datasets for all EU and all other pan-European ICP Member States. It is planned that this database will be linked and embedded into the so called European Forest Data Centre in the near future. The concept for the *European Forest Data Centre* was established in 2005 under the agreement between the EC (DG ENV, DG JRC, Eurostat) and the EEA. To improve the efficiency of data collection and the quality and range of the information provided to policy makers, the European Forest Data Centre

[92] BEAR - European Research Project: Indicators for Monitoring and Evaluating Forest Biodiversity in Europe (http://www.algonet.se/~bear/)

intends to be a joint integrated system in which various monitoring platforms and databases are integrated.[94] In relation to data access, storage and dissemination, the European Forest Data Centre will build on existing systems and those under current development. It will be a larger complex information system in which various EC data sources like the Joint ICP Forest/Forest Focus database, the European Forest Fire Information System (EFFIS), the European Soil Information System (EUSIS) and the European Forest Information and Communication Platform (EFICP)[95] will be integrated.

Fig. 33: Data Flow Chart – ICP Forests data (2006).



[93] Programme Coordinating Centre

[94] The data that will be stored and made available through the *European Forest Data Centre* will be collected within the *European Forest Monitoring Programme*. The European Forest Monitoring Programme will continue and enhance the Forest Focus Community scheme for a harmonised, broad-based, comprehensive and long-term monitoring of European forest ecosystems expiring in 2006. The European Forest Data Centre, together with the European Forest Monitoring Centre will be the key components of the European Forest Monitoring Programme. The concept for the European Forest Monitoring Programme is currently under preparation and will be jointly coordinated by the EC JRC, the UNECE, the PCC ICP Forests, and the Member States. The programme will be financed and finally elaborated under LIFE+ (2007-2013).

[95] The EFICP builds on the developments of EFIS and NEFIS projects. The EFICP will be a data platform in which various forest data, predominantly harmonised National Forest Inventory data but also economic data, will be jointly stored and maintained.

The EC financed projects ForestBiota and BioSoil are rather demonstration projects than final databases which can be used for any reporting. However, the two projects ForestBiota and BioSoil are considered as potentially relevant approaches which will enhance the current data collection on Level I and Level II if implemented in the future. The major objective of both projects is to develop and validate harmonised data assessments on forest biodiversity and forest soils, and therefore to enhance the already established monitoring on Level I and Level II.

The assessments of the ForestBiota project have been performed on about 100 selected Level II plots located in 10 countries in Europe. The project and its data evaluation was finalised at the end of 2006. The evaluated dataset can be regarded as "*data with restricted pretension in terms of representativeness for area or any type of forest*" (see ForestBiota). The Level II plots of the ForestBiota project were selected by each country according to its own requirements and ideas. Therefore no general sampling strategy across Europe with regard to main tree species, management type or intensity, etc. was applied. All models and data evaluation only apply for the selected plots. Any spatial interpolation is not intended, and would be inappropriate due to the low spatial density of plots. However the results, but especially the applied and developed methodologies of harmonised data assessments, are important contributions to supplement the current monitoring of forest biodiversity on the pan-European level.

The BioSoil project with its two sub-projects on *Soil* and *Biodiversity* is a major initiative under the Forest Focus scheme. As the Forest Focus scheme concentrates in particular on protecting forests against air pollution and fire, the project BioSoil intends to supplement the Level I monitoring by new instruments and measures related to the *monitoring of soils, carbon sequestration, biodiversity, climate change* and *protective functions of forests* (see Council Regulation (EC) No 2152/2003, Forest Focus Article 1 (b)). As the assessments are conducted on Level I plots, available datasets are representative for any international and national reporting. BioSoil field assessments started in most countries in 2006.

As mentioned above, ICP Forests data can be regarded as datasets of high importance within the pan-European monitoring, assessment and reporting specifically on forest health and vitality. PCC delivers regularly either *evaluated data* (*results*) or *raw data* to various international and national bodies. The PCC is the central body for maintaining

and coordinating the ICP Forests data. On behalf of the UNECE, the PCC elaborates the annual UNECE Forest Condition Report. Within the UNECE, ICP Forests data are also reported to TBFRA 2000 or the EFSOS report. Upon request the PCC delivers datasets also to other international bodies, such as Eurostat and the EEA, or to initiatives and processes like SEBI 2010 or MCPFE. Already in 2003, the MCPFE contacted the ICP Forests for direct data contributions to the MCPFE Report "*State of Europe's Forests 2003*". For the MCPFE 2007 report, ICP Forests data have also been requested to describe forest health and vitality on the pan-European level. The MCPFE asked for a data contribution to the indicators *2.1 Deposition of air pollutants*, *2.2 Soil condition* and *2.3 Defoliation*.

6.3 Methodology

In 2003, Requardt already developed a data potential classification scheme that was applied to evaluate the national data availability for the reporting of the Principality of Liechtenstein according to the improved pan-European C&I (see Chapter 2.3.3 and 3.5.1). The applied scheme was successfully tested to answer the questions of whether: (a) explicit datasets are available and can be reported; (b) available datasets (raw data) can be used but new data evaluations are necessary; or (c) completely new methods of data collection and assessment have to be implemented. Therefore that scheme is taken as a basis to develop a similar but enhanced scheme for this study to classify and evaluate data potentials of international institutions and sources.

Basically the enhanced **data potential classification scheme** distinguishes three different levels of data potential – *no data potential*, *raw potential* and *indicator available* – that are divided into six categories (0-5) (see Fig. 34).

No data potential **(0)** describes the situation where absolutely no data – neither raw data nor evaluated data – but also no methodology is available to provide any quantitative data according to the required indicator.

The next level of data potential is the one of raw potential. The raw potential is differentiated into the categories *methodological data potential* **(1)** and *raw data potential* **(2)**. The *methodological data potential* **(1)** indicates that a method (e.g. a sampling manual or an algorithm) is available to assess and calculate the required data.

The available methodology might be either not implemented for various reasons or will be implemented in the near future. Reasons for no implementation could be limitations in financial, personnel or technical capacities. In the case that the available methodology will be implemented in the future; it indicates that first developments and actions of planning for an implementation exist. The methodological data potential describes the lowest potential to supply required data. It rather indicates a future potential than an already applicable data potential. The *raw data potential* **(2)** indicates that some useable data already exist, but that either some additional information is missing or that available raw data have to be re-evaluated e.g. according to required indicator classifications, reporting units, temporal or spatial resolution or applied terms and definitions.

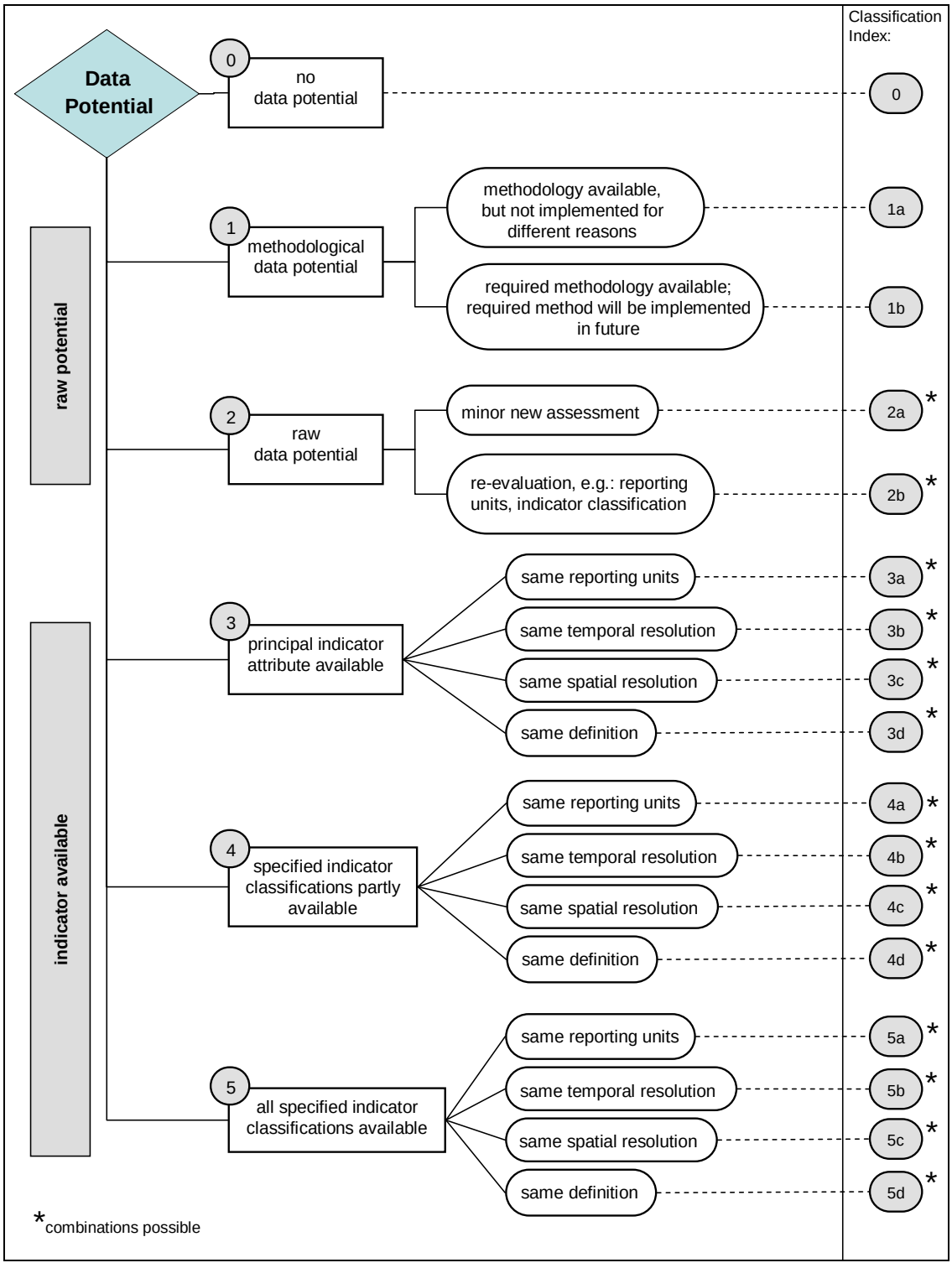
The third level of data potential classification describes the situation when the information with respect to the indicator itself (e.g. of *Forest area* or *Tree species composition*) is available and covered by some quantitative data. As all of the 35 pan-European indicators are specified by further indicator classifications (e.g. *Forest area* according to *availability for wood supply* or *forest types*) this level has to be distinguished into three different categories. The basic indicator data potential category **(3)** describes the situation when the indicator information is available without covering any data of the further specified indicator classifications. The next category **(4)** describes the situation when the required indicator classifications are at least partly covered (e.g. *Forest area* data according to *forest types* are available but not according to *availability for wood supply*). The final category **(5)** describes the situation when quantitative data can be supplied for all indicator classifications.

Beside the availability of an indicator, an assessment needs to be made of whether the available data correspond to the required *reporting units, temporal resolution, spatial resolution* and applied *terms and definitions*.

Not listed within the *data potential classification scheme* (see Fig. 34) is a category that describes a kind of *programme potential*. A programme potential describes a potential which is similar to the category of *methodological potential* (see category 1). It indicates that the concept of data assessment (e.g. a monitoring concept based on a terrestrial sampling grid) provides a solid basis for ideal method development to collect explicit indicators in the future. However, this category is explicitly not listed as it

would always be contestable. Monitoring activities based on questionnaires, for example, could theoretically collect all kinds of datasets. Institutional competition and benchmarking interests as well as institutional subjectivity hold the risk for misuse of such a category. However, the category *programme potential* might still be applicable in cases of an objective and independent data potential evaluation conducted by third parties.

Fig. 34: Data Potential Classification Scheme



Considering the general objectives of this Approach (see above) and by taking the above described data potential classification scheme as a basis, the following specific tasks were of concern:

- review of the data potentials of the ICP Forests/Forest Focus as described in the overview "*where to find which forest data*" (see Approach 1, Chapter 4),
- describe the current data situation as well as the necessary adjustments and modifications to fulfil specified MCPFE demands for each of the potentially covered indicators and each of the sources (Level I, Level II, ForestBiota and BioSoil),
- apply the data potential classification scheme to describe the current data potential situation for each source and relevant indicator with a data potential index.

Important reference documents to approve the current joint ICP Forests/Forest Focus data potentials on Level I and Level II are:

- the UNECE ICP Forests Manual (Version 2006) Manual on methods and criteria for harmonised sampling, assessment, monitoring and analysis of effects of air pollution on forests,
- the UNECE ICP Forests Manual (Version 2006), Part IIIa: Sampling and Analysis of Soil,
- the draft BioSoil Forest Biodiversity Field Manual (Version 1.0, 2006)[96],
- the methodology manuals of the ForestBiota assessments.[97]

In addition to the primary objective of data potential analysis, the ICP Forests data flow chart depicted above has been elaborated to describe the most important data flows and

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[96] P.Neville, A.Bastrup-Birk, et al., 2006: BioSoil Forest Biodiversity Field Manual (Version 1.0), Working Group on Forest Biodiversity, Forest Focus Demonstration Project BioSoil.

[97] ForestBiota methodology manuals (http://www.forestbiota.org/):

- methodology for extended stand structure and deadwood assessments (June 2005)
- methodology for extended stand structure and deadwood field forms (June 2005)
- methodology for epiphytic lichen monitoring (June 2005)
- methodology for extended ground vegetation assessments (2004)
- methodology for habitat classification - Natura 2000 (June 2005)
- methodology for harmonised forest type classification (April 2005)

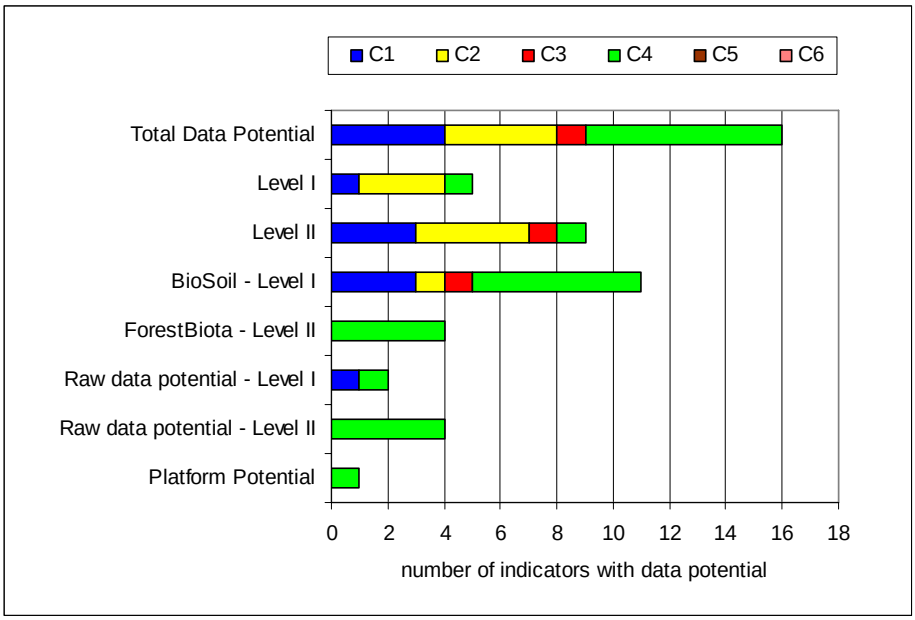
data network relations of the ICP Forests (compare also to other data flow charts in Chapter 7.3).

6.4 Results

The potential of each of the 35 indicators has been quantified according to the data potential classification scheme above. Detailed results of the classification are listed in Annex 2. For each of the relevant indicators, the table in Annex 2 lists the relevant data source (Level I, Level II, ForestBiota or BioSoil) and describes briefly the current data situation as well as the necessary adjustments to provide datasets in required form. When reviewing the detailed classifications it becomes obvious that the data potentials described in this Chapter are much more differentiated than described in the data potential overview in Chapter 4. The much more precise classifications allow differentiating in more detail whether a data potential is actually given or not (see Table 12 and Annex 2). Especially the demonstration projects ForestBiota and BioSoil are considered as potentially relevant to improve and enhance Level I and Level II data assessments. The project approaches encompass a raw data potential for several indicators that are not explicitly considered in the first data potential screening.

Annex 2 and the results below (Fig. 35 and Table 12) show the current data potentials of the joint monitoring of ICP Forests/Forest Focus in detail. Furthermore they describe the future potentials to extend the current data assessment into a harmonised pan-European multi-resource, covering not only datasets on forest health and vitality, but also on forest biodiversity, forest production and carbon issues.

Fig. 35: Overview Data Potential: ICP Forests/EC Forest Focus.



Level I, Level II and the two demonstration projects ForestBiota and BioSoil have some data potential (irrespective of the category of data potential) for 16 of the 35 pan-European indicators in total, covering data according to the requirements of criteria C1, C2, C3 and C4. Ten out of these 16 indicators are covered by datasets according to the data potential categories 3, 4 and 5 – indicating that these indicators are already available. Five other indicators instead are currently only covered by raw data (data potential category 2). To fully describe the entire future capacities and data potentials of the joint monitoring programme with respect to MCPFE requirements, the indicator *4.6 Forest Genetics* has been also considered as potentially relevant in future assessments (see below: programme potential, e.g. supplementing Level I by laboratory analysis).

Table 12: Data potential classification of the ICP Forests/EC Forest Focus joint monitoring (dark shading = high data potential).

	Level I	Level II	BioSoil	ForestBiota	highest potential
Indc. 1.1 Forest area (forest types)	2	0	0	0	2
Indc. 1.2 Growing stock	0	3	2	0	3
Indc. 1.3 Diameter distribution	0	3	2	0	3
Indc. 1.4 Carbon stock	3	3	2	0	3
Indc. 2.1 Deposition of air pollutants	0	5	0	0	5
Indc. 2.2 Soil condition	5	5	2	0	5
Indc. 2.3 Defoliation	5	5	0	0	5
Indc. 2.4 Forest damage	4	4	0	0	4
Indc. 3.1 Increment	0	3	2	0	3
Indc. 4.1 Tree species composition	3	3	2	0	3
Indc. 4.2 Regeneration	2	0	2	0	2
Indc. 4.3 Naturalness	0	2	2	2	2
Indc. 4.4 Introduced tree species	2	2	2	2	2
Indc. 4.5 Deadwood*	0	0	2	4*	4
Indc. 4.6 Genetic resources**	X	X	0	0	X
Indc. 4.8 Threatened forest species	0	2	2	2	2

*) indicator available, but only on a limited number of plots

**) programme potential

As can be seen in Table 12, Level I holds datasets for five indicators, classified with the data potential category 3, 4 or 5. Level II, which datasets are not representative for any international reporting, instead covers nine indicators with data potential categories 3, 4 or 5. Partly the same indicators are covered on Level I and Level II. However, the entire joint monitoring of the ICP Forests/Forest Focus including Level I and Level II assessments currently covers nine different indicators. The data potential for these nine indicators is classified either with the category 3, 4 or 5 – indicating that the indicator itself is already available (see Table 12). However, only three of these nine indicators – the indicators *2.1 Deposition of air pollutants, 2.2 Soil condition* and *2.3 Defoliation* – are covered according to the data potential category 5. As already mentioned in the introduction, these are also indicators for which the MCPFE contacted the PCC of the ICP Forests to provide national datasets for 2003 and 2007. Nevertheless, available datasets according to the indicators *2.1 Deposition of air pollutants* and *2.2 Soil condition* are limited respective to the required spatial resolution. Data on *2.1*

Deposition of air pollutants are collected on Level II plots and are therefore not representative. Data on *2.2 Soil condition* are only available as trans-national plot wise data but not as aggregated country data, as it is foreseen by the MCPFE reporting. The indicator *2.4 Defoliation* is the only indicator for which country aggregated datasets are available (see detailed data potential classification, Annex 2). Trans-national Level I and Level II datasets on defoliation are supplemented by national crown condition reports presenting defoliation classes for major tree species aggregated on the country level. With respect to the MCPFE requirements, the meaning and consequences but also the possibilities to (a) re-evaluate plot wise data into country level data, and (b) enhance Level I assessments by implementing Level II assessments needs to be reconsidered and discussed in the future (see also Chapter 8, Discussion).

The indicator *2.4 Forest damage* is almost completely covered by Level I and Level II assessments (see data potential category 4) as well. Available datasets are only limited with respect to some further detailed indicators classifications such as some abiotic forest damage causes.

The indicators *2.1 Deposition of air pollutants, 2.2 Soil condition, 2.3 Defoliation* and *2.4 Forest damage* are the most central indicators of the joint monitoring of ICP Forests/Forest Focus. In addition Level I and Level II cover a few other indicators. According to the category 3, Level I covers data for the indicator *1.4 Carbon stock* and *4.1 Tree species composition,* and Level II provides data for the indicators *1.2 Growing stock, 1.3 Age structure and/or diameter distribution* and *3.1 Increment and Fellings*. The data potential category 3 indicates that these indicators itself are covered, but that specific indicator classifications, reporting units, temporal and spatial resolution or explicit definitions are partly missing or are not comparable.

As mentioned in the introduction, the two demonstration projects BioSoil and ForestBiota are considered as potentially relevant to improve and enhance the current assessments on Level I and Level II. Both projects are of high relevance for improving the data potential of already available datasets but also for enhancing data coverage such as for several biodiversity indicators. According to the draft manuals of the two BioSoil sub-projects *Soil* and *Biodiversity*, raw data potentials are available for about eleven indicators. Four of these indicators are already partly covered on Level I but its data quality and complexity would be improved through the enhanced assessments

within BioSoil. Not yet assessed on Level I, but covered within BioSoil approaches, are data assessments related to the indicators *1.2 Growing stock, 1.3 Age structure and/or Diameter distribution, 4.2 Regeneration, 4.3 Naturalness, 4.4 Introduced tree species, 4.5 Deadwood* and *4.8 Threatened forest species*. The indicator *1.3 Age structure and/or Diameter distribution* is and will be only covered with respect to diameter distributions. Data collection on age structure is not foreseen on Level I (or Level II).

Although data collection and evaluation of the demonstration project ForestBiota has been completed in 2006, available datasets are considered as not applicable for any reporting as data were collected only on about 100 selected Level II plots. As mentioned above the monitoring on Level II plots is not representative for any reporting. Level II plots are rather selected case studies for an intensive monitoring to analyse and describe certain cause-effect mechanisms. However, the ForestBiota project and its methodologies of biodiversity assessments on Level II can be regarded as important contributions to enhance current harmonised assessments by several forest biodiversity indicators. ForestBiota encompasses a data potential for four additional MCPFE indicators that are not already covered on Level II. Raw data of selected Level II plots are available for indicators *4.3 Naturalness, 4.4 Introduced tree species* and *4.8 Threatened forest species*. Available raw data have either to be re-evaluated following the explicit indicator classifications (see indicators *4.4* and *4.8*) or have to be supplemented by minor new data assessments (see indicator *4.3*). Data according to the indicator *4.5 Deadwood* (data potential category 4) instead, are already fully available within the ForestBiota project.

Such enhanced Level II monitoring as demonstrated in the ForestBiota project can provide several additional datasets to analyse and describe different cause-effect mechanisms in the future. Level II assessments enable to identify certain indicators of certain cause-effect mechanisms, like the abundance of certain forest species influenced by an increasing or decreasing deposition of air pollutants. However, if representative harmonised datasets are required for international or national policy making, different options to enhance representative Level I monitoring should be considered in future, e.g. by collecting datasets on any of the cause-effect indicators identified on Level II.

Independent from the point of view of data representativity, it can be concluded that most of the collected raw data on Level I and Level II could be more or less “easily” re-

evaluated according to specific individual indicator requirements. *Easily re-evaluated* means, that only a few changes and modifications in data evaluation are necessary to cover the listed MCPFE indicators (see Annex 2). Minor new data assessments are necessary only for the indicators *4.2 Regeneration* and *4.3 Naturalness*. The reasons for re-evaluating available datasets (either raw data or evaluated data) are different. According to the data potential classifications in Annex 2 it can be clearly seen that most of the currently available datasets are limited with respect to the required spatial resolution. As mentioned already, all Level I (and Level II) data are available as trans-national plot-wise data that have to be re-evaluated for single countries. Another important reason for re-evaluation is that datasets are available but not according to the specific indicator classifications (see data potential category 3 and 4). A third reason is that datasets are available, but according to different reporting units than explicitly required by the MCPFE (see for example indicator *1.4 Carbon stock*, data are available in *g/kg* but have to be converted into *tonnes of CO2 equivalent/ha*).

With respect to future developments and capacity building it can be concluded that the current data situation and data potentials for adequate MCPFE reporting could be improved by implementing minor amendments in raw data evaluation. Most of the indicators could be theoretically classified into data potential category 4 or 5 if the necessary adjustments in data evaluation would be implemented in the future. Rather limited instead are the described future data potentials with respect to the indicators *1.1 Forest area, 1.2 Growing stock, 3.1 Increment and fellings* and *4.8 Threatened forest species*.

The indicator *4.8 Threatened forest species* is an indicator that surely will never be fully covered by Level I or Level II assessments. The data collection on different taxa on Level I and Level II is limited. The assessments of *threatened bird species* or *mammals* require surely more different approaches than currently applied on Level I and Level II.

Representative assessments on the indicator *1.1 Forest area* are rather limited. However, some relevant information might be supplied according to the indicator classification *forest types*. Available datasets on tree species on Level I could be re-evaluated according to forest types classifications – distinguishing *coniferous, broadleaved* and *mixed* forests. There is a similar situation for the indicators *1.2 Growing stock* and *3.1 Increments and fellings*. Forest growth or increments generated

from Level I and Level II growth assessments are certainly less representative than any available NFI data (see also below). Future potentials with respect to these three indicators are rather given in combination with available NFI data, e.g. using Level I data as international reference data to calibrate and harmonise available NFI data to an international standard (see EC JRC *Pilot study for harmonising National Forest Inventories in Europe* (2006-2008))[98].

Considering the aspect of using synergies in monitoring, assessment and reporting activities, but also considering adding value of already available datasets, it is of further interest to analyse in how far other international relevant institutions and data sources also provide datasets for single MCPFE indicators. Table 13 shows other international institutions or organisations that potentially cover the same indicators as covered by the joint monitoring of ICP Forests/Forest Focus. Due to the complexity of a detailed data potential classification, data potential categories are only depicted for the ICP Forests/Forest Focus.

With respect to the screening approach of Chapter 4 and according to Table 13, it can be seen that several other international institutions and sources are also potentially relevant to provide adequate datasets for listed indicators. It can also be seen that some institutions like UNECE and EEA refer directly to ICP Forests/Forest Focus data, e.g. on *2.1 Deposition of air pollutants* and *2.3 Defoliation*. Reference is also given regarding the indicator *2.4 Forest damage*. UNECE, OECD and EEA refer – at least to some extent – to available forest damage data.[99] This underlines that the indicators *2.1 Deposition of air pollutants, 2.3 Defoliation* and *2.4 Forest damage* can be regarded as the most important Level I and Level II data. These are datasets that are often used as major reference data by other international and national institutions to describe forest health and vitality on the pan-European level. Level I and Level II data are also internationally relevant according to the indicators *2.2 Soil condition* and *1.4 Carbon stock* (*of forest soils*). More complex international soil data are compiled only by the EC JRC European Soil Information System (EUSIS).

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[98] http://www.worldforestry.de/research_dev_harmoni.htm

[99] Forest damage is a complex indicator that covers various forest damage causes (*abiotic, biotic* and *human induced* causes). UNECE, OECD and EEA also include other national statistics to describe multi-complex situations of forest damage in Europe.

Table 13: ICP Forests/Forests Focus data potentials in comparison to other relevant international institutions

	Indc. 1.1 Forest area	Indc.1.2 Growing stock	Indc.1.3 Diameter distribution	Indc. 1.4 Carbon stock	Indc. 2.1 Deposition	Indc. 2.2 Soil condition	Indc. 2.3 Defoliation	Indc. 2.4 Forest damage	Indc. 3.1 Increment	Indc. 4.1 Tree species	Indc. 4.2 Regeneration	Indc. 4.3 Naturalness	Indc. 4.4 Introduced tree species	Indc. 4.5 Deadwood	Indc. 4.6 Genetic resources	Indc. 4.8 Threatened species
ICP Forests/ Forest Focus	2	3	3	3	5	5	5	4	3	3	2	2	2	4	X	2
CoE												X				
CSD	X								X			X				
EC JRC	X			X		X		X								
EEA	X				S		S	M	X			X				X
EFI	X	X	X	X				X	X	X				X		
ESA	X	X		X				X								
Eurostat	X	X							X							
FAO	X	X		X				X	X	X	X	X		X		X
IPCC		X		X												
IPGRI										X					X	
IUCN													X			X
OECD	X	X						M	X		X	X				X
UNECE	X	X	X	X	S		S	M	X	X	X	X	X	X		X
UNEP	X							X				X				X
UNFCCC				X												
WorldBank	X															
WRI	X															

Legend: X other data; S same data; M mixed; 1-5 highest data potential category of ICP Forests/Forest Focus (see Data Potential Classification Scheme and Annex 2)

Nevertheless, most of the other institutions refer to other national data collections with respect to the listed indicators. NFI information is most relevant for indicators *1.1 Forest area, 1.2 Growing stock, 1.3 Age structure and/or Diameter distribution, 1.4 Carbon stock, 4.1 Tree species, 4.2 Regeneration, 4.4 Introduced tree species and 4.5 Deadwood.*

Especially indicators like *1.1 Forest area (forest types), 1.2 Growing stock* and *3.1 Increment and fellings* are classic NFI indicators, to which almost all other international sources and institutions refer directly or indirectly. However, available Level I, but especially the more complex BioSoil data assessment in the future, can be regarded as

important supplementary data on the trans-national level – datasets that are collected according to a pan-European harmonised sampling. Equivalent data coverage, like assessing diameter distributions according to a dbh threshold of 5cm could be used to supplement or interlink available NFI data. Generally it can be concluded that important future capacities for data harmonisation and data streamlining will be given by more cross-indicator linkages between national and international data assessments.

Developed and partly already approved approaches like ForestBiota or BioSoil seem to be appropriate for collecting further datasets on a harmonised pan-European level in the future. Very promising future potentials for capacity building of Level I and Level II monitoring are specifically seen in new data collections on *forest biodiversity* indicators, such as indicators *4.1 Tree species composition, 4.2 Regeneration, 4.3 Naturalness, 4.4 Introduced tree species, 4.5 Deadwood* and *4.8 Threatened forest species*. Highly relevant, especially under the context of climate change, would be supplementary data on *carbon* either with respect to forest biomass or to carbon stocks in forest soils – datasets which could be used to supplement, e.g. NFI data.

Regarded also as relevant for future capacity building is the general Level I and Level II programme potential. Level I and Level II can be seen as a solid programme for much further harmonised data assessments and method developments that cover more than 40 countries on a comparable basis. Although specific concepts or even methodologies of possible data assessment are not available yet, Level I and Level II can be considered as an ideal data collection programme e.g. to collect datasets regarding the indicator *4.6 Forest Genetics*. Samplings of gene codes of various tree species or provenances on Level I and Level II would be important additional information to describe forest genetic resources, their distributions and capacities within Europe. Such an assessment would require that Level I assessments be supplemented by further laboratory analyses. This, but also other possible programme potentials, should be of concern when discussing and deciding about future perspectives and strategies of the joint monitoring on Level I and Level II.

Finally it can be concluded that this case study of detailed data potential classification of the joint monitoring of ICP Forests/Forest Focus has clearly demonstrated that the data potentials of most of the relevant international data sources can be regarded as much more diverse than it is simply described in Chapter 4. The different categories of

data potentials allow a much more differentiated description of what is actually available and what the potentials for capacity building are. This case study suggests that many more indicators could actually be covered by adequate datasets at the international level if data potentials would be identified and analysed thoroughly and minor adjustments in data assessment or data evaluation would be re-considered by responsible institutions and organisations. Detailed data potential classifications enable not only capacity building, they also support the harmonisation and streamlining of various international and national activities of monitoring, assessment and reporting on SFM.

7 Outlook: The Idea of a C&I Information Network

7.1 Introduction

The various data assessments carried out at the pan-European level (as listed in the source list, see Table 7, Chapter 4.2) cover a wide range of information needs, and therefore a broad scope of user demands. Several forest monitoring actions such as the UNECE TBFRA 2000 or the FAO FRA 2000/2005 or the OECD Compendium of Environmental Data are planned and conducted as multi-resource assessments. Within these various monitoring, assessment and reporting processes it is desirable to extend existing monitoring activities, but also to increase the efficiency and cost effectiveness. Therefore the major objective is to seek synergy and cooperation among existing forest and environmental monitoring, assessment and reporting activities as well as to define interfaces between the activities. Despite the already existing cooperation between the various monitoring activities, especially regarding the reporting towards various commitments, there is still a high potential to improve both the efficiency of data collection, maintenance and dissemination, but also the quality and range of information provided to various policy- and decision-makers.

One option to increase the added value of multiple available datasets and sources would be to design and develop an integrated pan-European Information System that quantifies European forest extent, status, and changes over time and space e.g. reflected by the pan-European C&I. To link available and relevant data sources according to the pan-European C&I and to determine metadata on all sources with respect to the pan-European C&I would result in a complex C&I Information Network.

Such a C&I Information Network would satisfy information needs of various international reporting and international decision-making processes. It would guarantee added value for MCPFE Member States and reduce their reporting burden as it could be used as a tool for harmonised data provision. Therefore it would increase cost-efficiency and facilitate synergies of various monitoring, assessment and reporting activities.

Furthermore, a C&I Information Network would support capacity building to develop further existing structures and networks at the national, Community or pan-European levels. It would support the streamlining of multiple data flows within and between institutions and organisations either on the international or national levels. A C&I Information Network would enable the ongoing data collection and data dissemination processes and data flow structures to be reviewed, but would also support cross-sectoral co-operation.

Interlinking the different institutions and data sources with respect to different levels and the pan-European C&I would strongly support the ongoing activities and efforts of the EC to develop a *European Forest Monitoring Centre* (EC, 2006; Landmann, 2006) that e.g. incorporates a structured *European Forest Data Centre* (see also Chapter 6.2). Close linkages are therefore also given to the EC financed project developments of the EFIS, NEFIS and the currently ongoing EFICP project. However, the major objective of the following chapters is, to sketch different possibilities but also restrictions to model a complex but comprehensive C&I Information Network. The pan-European C&I are taken as a common baseline to integrate forest-related datasets from various monitoring, assessment and reporting activities to achieve a maximum added value of existing information and datasets within one complex network.

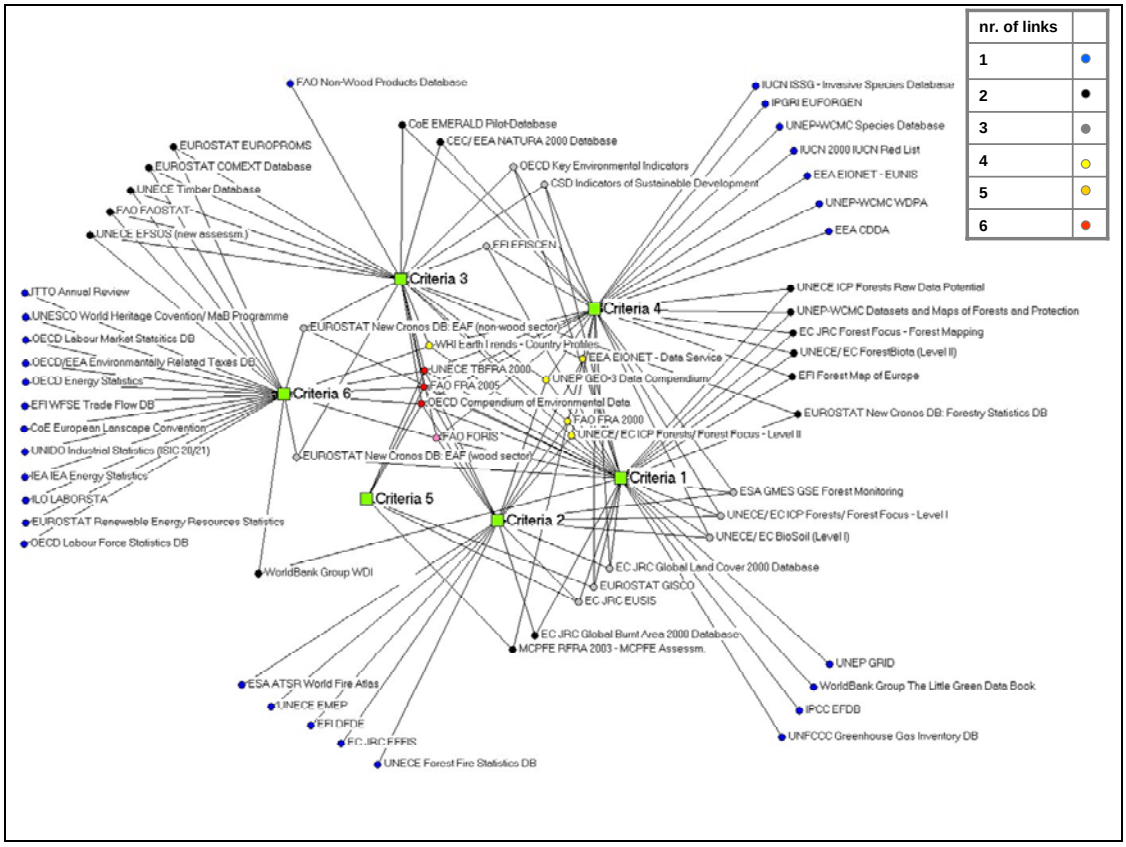
7.2 Outlook 1: A C&I Information Network based on Approach 1

Taking the results of the screening approach and network analysis as described in Chapter 4 as a basis, it is possible to generate a network model that clearly shows which of the 35 indicators are covered by which international institutions and data sources.

The network diagram in Fig. 36 illustrates what international sources provide datasets to which of the six pan-European criteria (c.f. Chapter 4). The more datasets the sources provide the more central they are. This network model is a typical *two-mode network* that seems to be rather confusing and complex. The network model in Fig. 37 and Annex 3 instead illustrates a more structured C&I network. Similar to a database or information system this kind of generated C&I Information Network enables all relevant international institutions and data sources structured to be found and listed according to each of the 35 pan-European indicators.

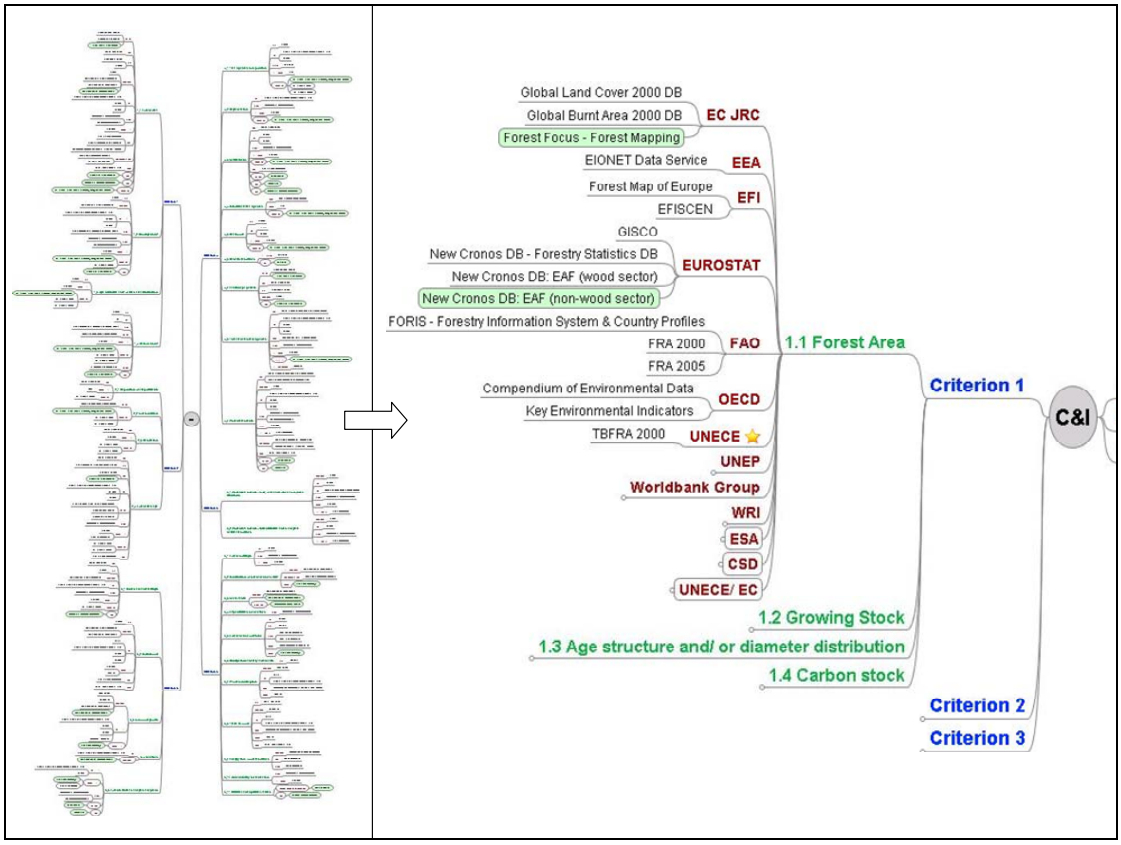
The C&I Information Network relies on the outputs of Chapter 4 and was modelled using mind-mapping approaches as provided by software solutions of Freemind 0.8.0 [100] or Visio 2003 [101]. Like in a folding map, mind-maps allow nodes to be opened and closed to go from one structured level to another. The depicted C&I Information Network allows users to go from one criterion to explicit indicators, from one indicator to the list of relevant institutions, and from one selected institution to the final selected data source. The entire C&I Information Network is unfortunately too large to be fully depicted within this Chapter, therefore only the outline and one example are illustrated below (see Fig. 37).[102] However, this C&I Information Network can serve as an outline for a pan-European Information System that is structured and outlined according to the six pan-European criteria and 35 indicators.

Fig. 36: Two-Mode Network: data potentials of international sources with respect to the six pan-European criteria (see also Chapter 4).



[100] http://freemind.sourceforge.net/
[101] http://office.microsoft.com/en-us/visio/default.aspx
[102] The entire C&I Information Network is depicted in Annex 3.

Fig. 37: C&I Information Network – Outline for pan-European Forest Information System.



The C&I Information Network could be enhanced by metadata records. Each of the sources could be theoretically described by metadata as according to the schema of *Dublin Core Metadata Initiative (DCMI)*[103] or according to the *NEFIS Metadata Schema* (see Schuck et al., 2006).[104] Metadata are an important means that enable data providers to describe all kinds of various sources, and data users to identify different sources (see Chapter 2.6). The Metadata Schema in Table 14 is a draft metadata schema that partly relies on the NEFIS Metadata Schema developed in 2003-2005.[105] The modified schema includes source descriptions regarding networking structures like data flows, data collection processes, data maintenance, and any other institutional cooperation.

A C&I Information Network as illustrated in Fig. 37 and Annex 3, enhanced by explicit metadata records according to the suggested metadata schema, would fulfil various information demands as the user would have several options to select the source that

[103] http://dublincore.org/
[104] Metadata collection according to relevant sources has been started but is not fully compiled yet.
[105] See also: http://www.efi.int/projects/nefis/

best fulfils his/her specific data requirements with respect to each of the 35 pan-European indicators.

Table 14: Metadata Schema for Networking Classifications of International Data Sources (see also DCMI or NEFIS Metadata Schema).

Source:
URL:
Maintained by:
Type of Source (database, information system, report, other):
Data Format:
Background General (content, purpose, etc.):
Political Background (reporting obligation, agreement, resolution, convention):
Spatial Resolution
Coverage (number of countries or name of country group):
Geographical reporting unit (country, nuts, pixel, plots, others):
Data for Country XY available: Yes/ No
Temporal Resolution
Frequency of information update:
Information available since:
Year of last update:
Data Assessment (data collection process, methodology):
Applied Definition System:
Validation Process (Are data attended with any reliability statement?):
Data Access (public, restricted):
Networking Information (Data Flow Charts)
Linked Institutes (initiative of…, collaboration between…):
Linked Sources (information comes from…, information goes to…):

7.3 Outlook 2: A C&I Information Network – Data Flow Charts (Examples)

Flow charts are helpful means to simply describe complex relations and processes as well as the connectivity of actors or modules. Flow charts are commonly used in electronic data processing but also in business/economic issues to help to visualise the content, or to find flaws in and the logic of a process. Flow charts are means of network analysis that do not describe the actors' relation by explicit network parameters, but rather provide various options for illustrating connectivity.

Data flow charts are used to describe the flow of datasets through a selected data-processing system or process. Data flow charts help to find advanced solutions for data coordination like data dissemination, data storage, data processing between various involved and relevant institutions and data sources. Developing data flow charts facilitates a better understanding of complex interconnectivity among and between international institutions and relevant data sources within the multiple processes of monitoring, assessment and reporting on SFM. They are helpful means to understand:

- Which sources or institutions are linked with which other sources or institutions?
- What are the relations between linked institutions and sources with respect to data collection, dissemination and storage?
- Where do the datasets come from and go to?
- Where are data synergies – either from the perspective of data flow or from the perspective of data maintenance?
- Which institutions/ sources are the most central ones within the explicit data flow context?

Three examples are selected to describe different data flows and institutional linkages from different perspectives. The first two charts focus on the two most relevant Joint Questionnaires within the pan-European monitoring processes – the *OECD/Eurostat Joint Questionnaire on the State of the Environment* and the *Joint Forest Sector Questionnaire (JFSQ)* of ITTO, FAO, UNECE and Eurostat.

Fig. 38: Data Flow Chart – OECD/Eurostat Joint Questionnaire

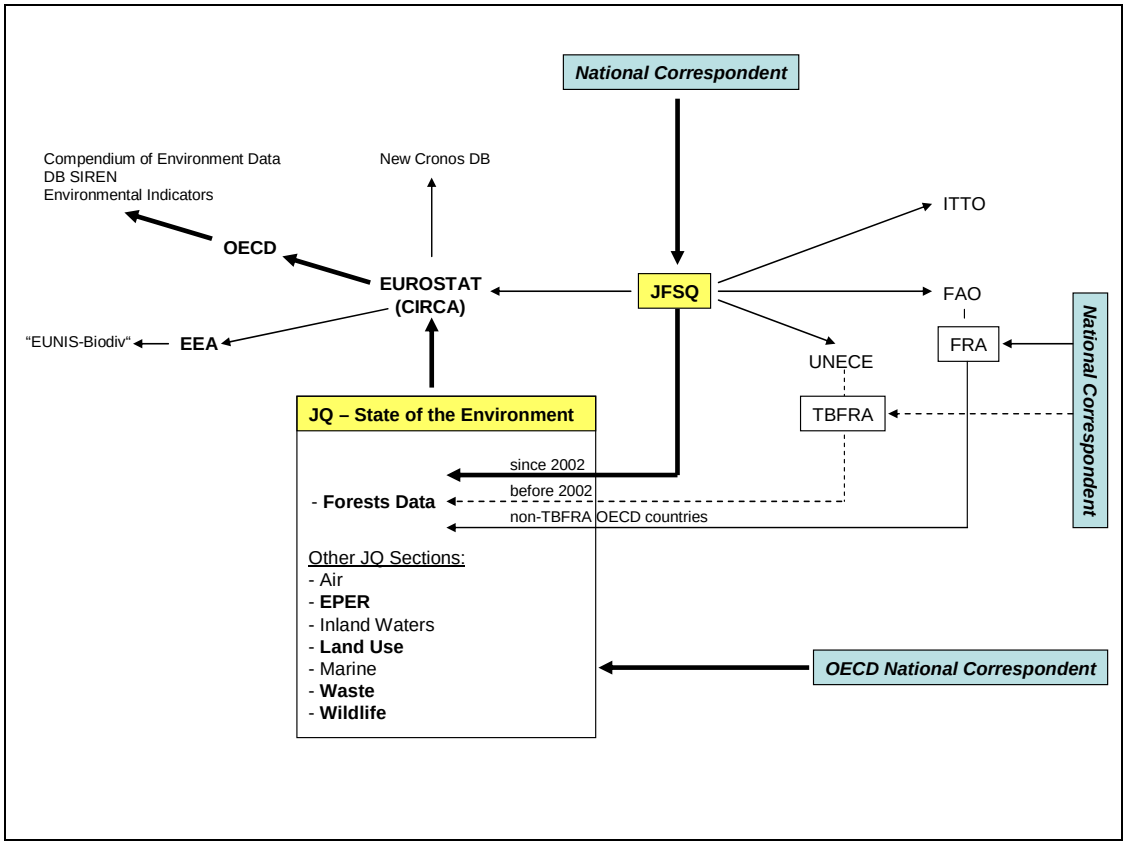
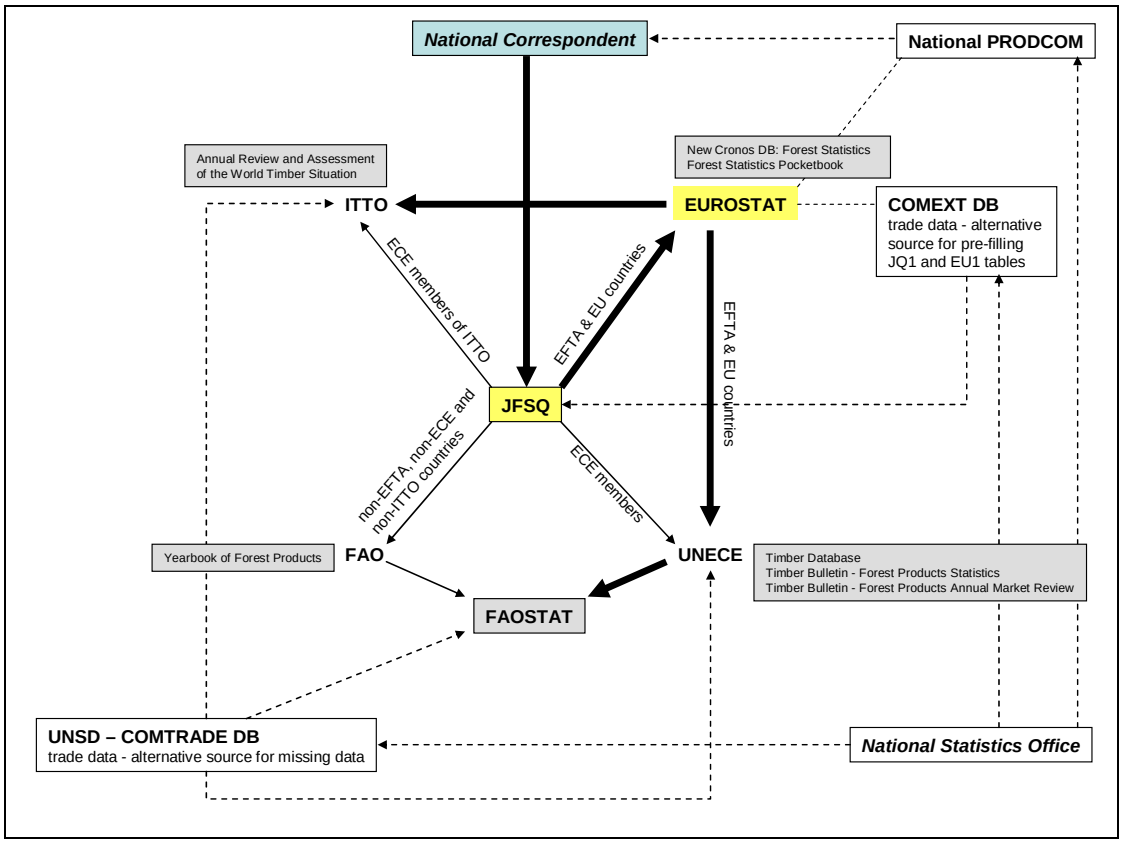


Fig. 39: Data Flow Chart: Joint Forest Sector Questionnaire (JFSQ)



The flow chart in Fig. 38 describes the data flows of the joint OECD/Eurostat questionnaire on environmental data. The Joint Questionnaire was initially developed by the OECD *Working Group on Environmental Information and Outlooks (WGEIO)*. Datasets that are collected in this specific questionnaire are closely linked to OECD work on natural resource accounts and on OECD environmental indicators. Data collection benefits from a close cooperation with Eurostat and UNECE. The questionnaire has eight different sections covering various environmental datasets that are finally stored and compiled in the OECD Compendium of Environmental Data. The Compendium of Environmental Data is a regular OECD database and publication that has been updated and compiled every two years since 1985. The OECD also uses the same datasets to update its SIREN database[106]. For Eurostat and countries of the EU, the Joint Questionnaire provides datasets for related Eurostat and EEA databases and publications. Although all datasets are finally stored and maintained by the OECD, dataset distribution and coordination is done by the principal repository of Eurostat (CIRCA)[107].

Potentially relevant for the pan-European C&I are the Joint Questionnaires on *Forests, Land Use, Waste, Wildlife* and *Environmental Protection Expenditures and Revenues* (EPER). Until 2002 the **Joint Questionnaire on Forests** covered datasets on:

- *Forest area by species group*
- *Forest area by major uses, by management (indicating naturalness) and by protection status (according to IUCN categories)*
- *Forest area balance: net land-use changes*
- *Growing stock and woody biomass on forest*
- *Growing stock on forest by major tree genera*
- *Depletion and growth of forest resources in terms of volume*
- *Forest ownership*

The OECD/Eurostat Joint Questionnaires with their different sections are continuously reviewed and revised depending on developments at international and EU levels.

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[106] System of Information on Resources and the Environment
[107] Communication and Information Resource Centre Administrator

Revisions of the questionnaires are processed within the framework of joint OECD/Eurostat meetings, with the participation of other relevant international bodies, e.g. UNECE, FAO, Convention Secretariats, the EEA, etc.

Until 2002 most forest related tables (and the definitions used) were closely co-ordinated with the UNECE/FAO TBFRA 2000. To avoid duplication of work, other international data sources such as the FAO FRA were also used. Since 2002, only the "*Land Use section*" collects datasets on forests, e.g. on *forests and other wooded land classified by forest types*. Other forestry datasets are provided through the ITTO/FAO/UNECE/Eurostat Joint Forest Sector Questionnaire (JFSQ) although explicit datasets on forest economics or forest products have not been covered before.

The ITTO/FAO/UNECE/Eurostat Joint Forest Sector Questionnaire (JFSQ) (see Fig. 39) can be regarded as the most harmonised joint data collection process on timber trade and forest products data. Datasets collected by the JFSQ are used in several timber market relevant databases and publications that are also relevant for the reporting of pan-European C&I. The data flow chart in Fig. 39 illustrates in a simplified schema the complex data collection and dissemination process of the JFSQ (including future potential data flows). The information for that flow chart rely on (a) general available descriptions of the JFSQ as manuals or metadata descriptions, and (b) the comprehensive joint EFI/Eurostat study "*Improvement of Statistical Information System for Forest Products Production and Trade Statistics of EU and EFTA*" (Wardle, et al., 2003). This study was conducted in 2001 as it had been recognised by EC that it was time to implement a study to analyse various sources of statistics on foreign trade of forest products in the Member States and EFTA countries and to determine the reasons for differences and incompatibilities between relevant data sources. The study was especially put in the context of the activities of the FAO/UNECE/Eurostat/ITTO *Interagency Working Group on Forest Sector Statistics*, which focussed on the improvement of the JFSQ. Recommendations were made to use COMEXT data as an additional source for timber trade statistics as Eurostat already compiles several statistics on the trading of goods from data through its COMEXT division. The UNSD COMTRADE database is also considered to be an alternative source for trade data on global level (e.g. covering data for FAO and ITTO).

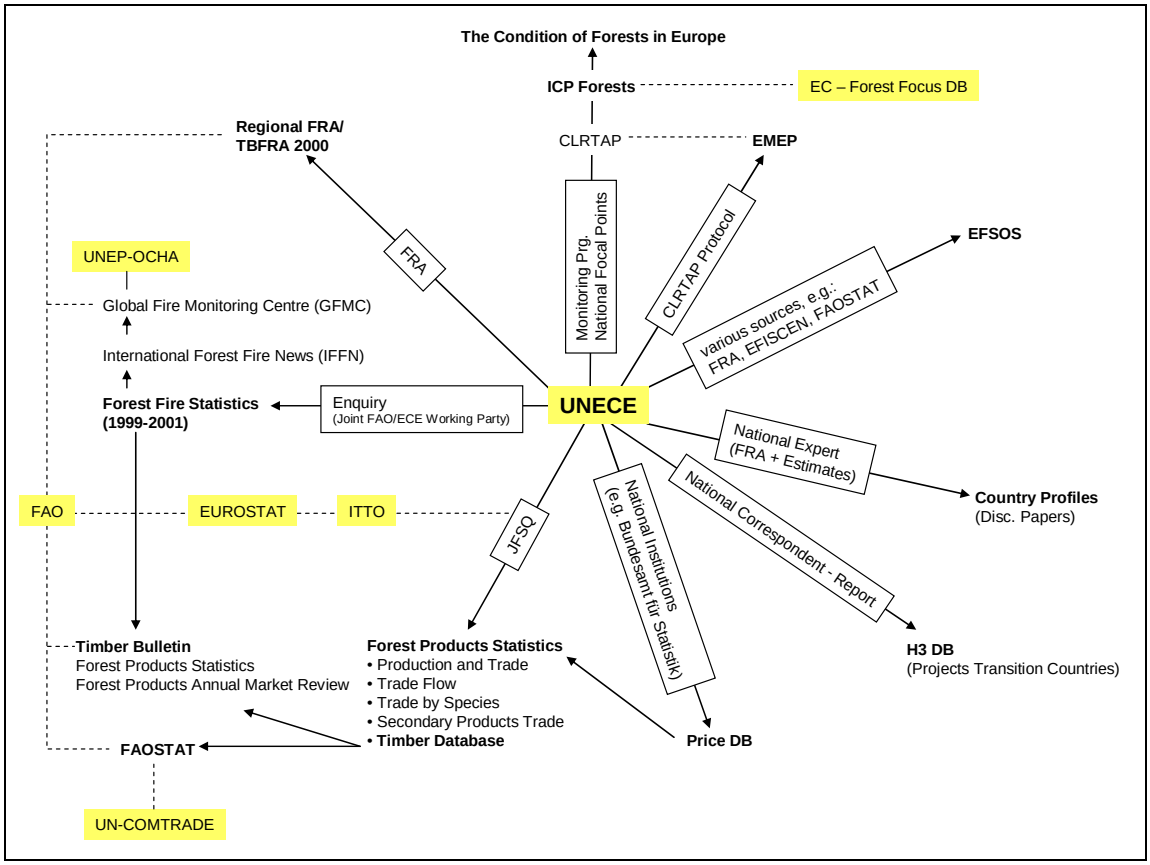
The idea behind the JFSQ is that participating organisations collect information through one questionnaire with a set of product aggregations and definitions common to all four organisations, thus eliminating duplication of effort nationally and internationally. The JFSQ consists of a series of standard questionnaires and organisation-specific questionnaires. The datasets are compiled in several different data sources and maintained by the four involved organisations.

Since 1999, Eurostat collects all datasets for EU and EFTA countries and is responsible for validating and distributing the datasets to the other partners in the JFSQ process. The major objective is that all four international organisations have identical datasets for countries they all report on. The JFSQ reduces multiple requests for information from member countries. Previously, the same datasets were requested from the national correspondent at four separate intervals by the four different organisations during the year. The JFSQ now includes the former *FAO Forest Products Questionnaire,* the *FAO/UNECE/Eurostat Timber Bulletin Questionnaire* and the *ITTO Forest Products Enquiry* that many countries received from individual organisations until 1998.

Although the JFSQ is an excellent example of joint harmonised data collection and dissemination, there are still several problems. According to the UNECE Timber Section, the most challenging are the increasing demands for reliable information that are accompanied by a decreasing ability to supply. The synchronising of datasets across the various databases is substantially difficult as well, partially due to timing issues, partially due to technical issues of database construction, and partially due to differing demands for outputs (Korotkov et al., 2005).

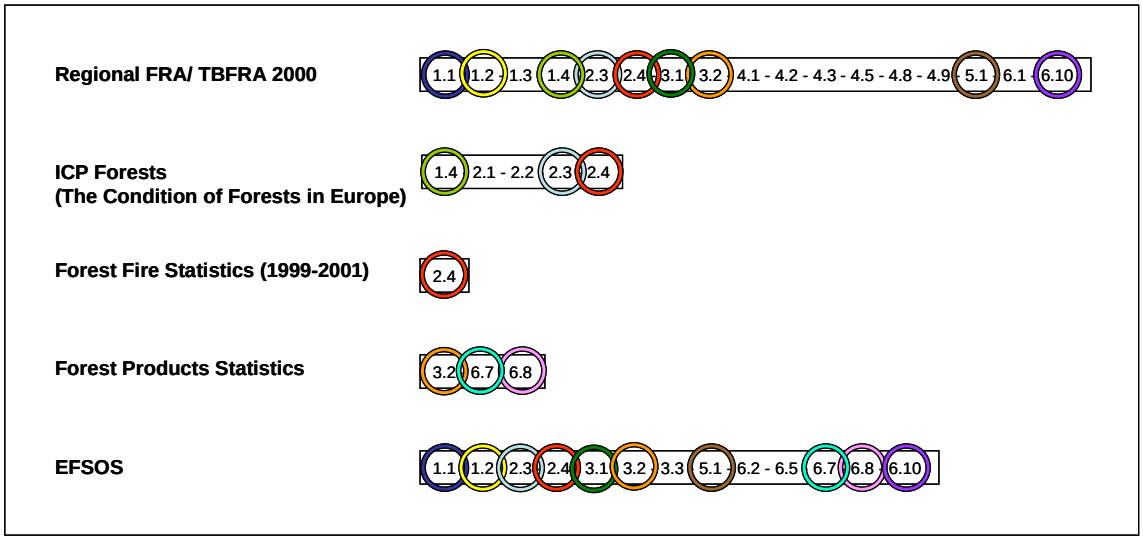
The third chart (see Fig. 40 below) has a slightly different perspective on data flows. It describes the UNECE as a data host, rather than any data flows between various institution and sources. It puts the UNECE into the centre, focusing on its data coordination and data maintenance. The UNECE is responsible for several timber and forest related data sources that are, to different extents, potentially also relevant for the reporting of pan-European C&I. Dataset origins are described for each of the listed sources (see arrow caption). Joint data cooperation is partly also indicated, at least for the examples JFSQ, the UNECE Timber Bulletin, Forest Products Statistics, the Price database and the joint UNECE/FAO FAOSTAT database.

Fig. 40: Data Flow Chart: UNECE and relevant data sources



Five of the eleven listed UNECE sources are potentially relevant for the reporting of pan-European C&I (see Fig. 41). Reviewing the data potential of these five sources it can be seen that data synergies partly exist among the sources. On the other hand it also shows that although some indicators are covered by more than one source, the datasets are not necessarily the same. They are partly of different content, definition or coverage. Examples of the same indicator coverage but different datasets are given according to the indicators *1.4 Carbon stock, 2.4 Forest damage* or *3.2 Roundwood*.

Fig. 41: UNECE C&I relevant sources and potential data synergies



The indicator *1.4 Carbon stock* is assessed by the TBFRA 2000 but also an issue within the ICP Forest Condition Report (Level I). Carbon data according to the TBFRA 2000 are assessed by a questionnaire and focus primarily on carbon in the forest biomass; available ICP Forests data instead as published in the Forest Condition Report cover carbon data with respect to forest soils. However, both datasets are relevant for C&I reporting as the indicator *1.4 Carbon stock* is classified into *carbon stock of forest biomass* and *carbon stock of forest soils*.

The UNECE maintains three different sources that cover datasets with respect to the indicator *2.4 Forest damage*. The TBFRA 2000, for example, provides datasets on all kind of forest damage categories like forest damage caused by fires, storms, insects and diseases or also by browsing and grazing. Also covered by the TBFRA 2000 are datasets on defoliation rates caused by factors like the deposition of air pollutants (see ICP Forests data). The ICP Forests Forest Condition Report instead concentrates on defoliation rates and developments. The UNECE Forest Fire Statistics cover datasets on the number and size of forest fires classified by forest types and causes. The datasets are published annually in the Timber Bulletin, and also in the UNECE/FAO International Forest Fire News every two years. The UNECE Forest Fire Statistics are linked with the Global Fire Monitoring Centre which is supported programme by the United Nations Environment Programme (UNEP) and the Joint United Nations Office for the Coordination of Humanitarian Affairs (OCHA).

Even timber market relevant datasets like datasets according to the indicator *3.2 Roundwood* are not necessarily the same within the UNECE sources. The UNECE Forest Products Statistics or also the UNECE/FAO FAOSTAT covers datasets on *roundwood value and quantity* as required by the MCPFE indicator. The TBFRA 2000 instead only covers *annual removals underbark*; these datasets are taken from the official national statistics of roundwood cut for sale and industrial production.

However, the selected examples for simplified data flow charts show clearly that several interlinkages between the various pan-European relevant data sources already exist. Institutions partly already cooperate with each other to harmonise and streamline monitoring, assessment and reporting of various forests relevant information. The central objectives within all harmonisation and streamlining initiatives are to minimise the national data reporting burden, but also to achieve data consistency and comparability within and between different international institutions and organisations.

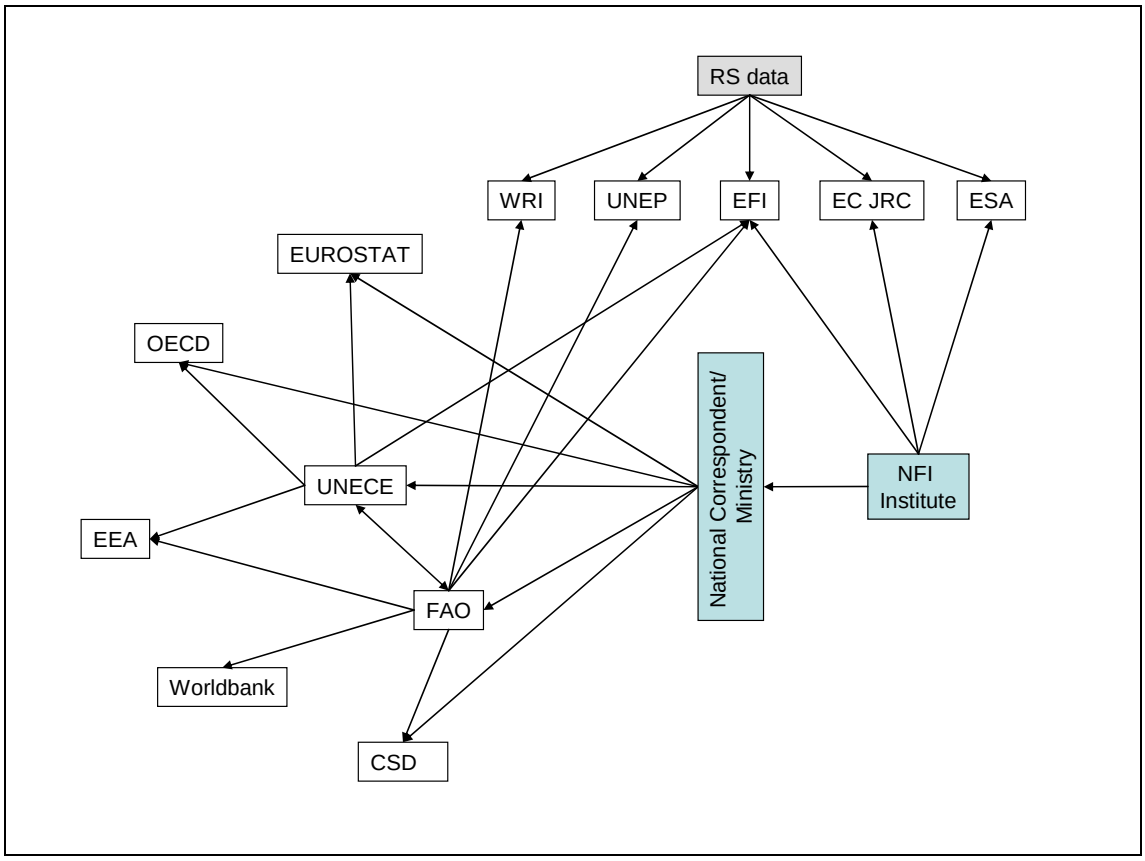
The two Joint Questionnaires – the *OECD/Eurostat Joint Questionnaire on the State on the Environment* and the *Joint Forest Sector Questionnaire (JFSQ) of ITTO, FAO, UNECE and Eurostat* – are good examples of achieved harmonised institutional cooperation and various potentials of using data flow synergies. The data flow chart of explicit *UNECE sources* instead demonstrates clearly that data synergies might partially exist between the different sources, but that the thematic focus of each source might be different. Datasets – and therefore also the data collection process – are not necessarily the same although partially the same indicators are covered. Synergies between the sources might therefore be limited.

7.4 Outlook 3: A C&I Information Network – The Concept of a Subway Map

Less descriptive, but more analytic, are data flow charts in combination with approaches of network analysis. The depicted data network in Fig. 42 describes the international data flow of national *forest area* data. The list of relevant international sources relies on the data potential screening as described in Chapter 4. National level sources are represented by the National Ministry or explicit National Correspondent, and the NFI institute that is mainly responsible for collecting data on national forest area. In addition to national sources, remote sensing sources (RS data) are also included in the depicted

forest area data network. Remote sensing data are used by international institutions as complementary data to assess forest area and land-use coverage and changes independently from national assessments. The network linkages between relevant institutions are based on available metadata descriptions and their analysis. Without explaining the different linkages in detail, the depicted network is a good example to show different levels of linkages and data flows.

Fig. 42: International data flow – Example: *Forest area* data



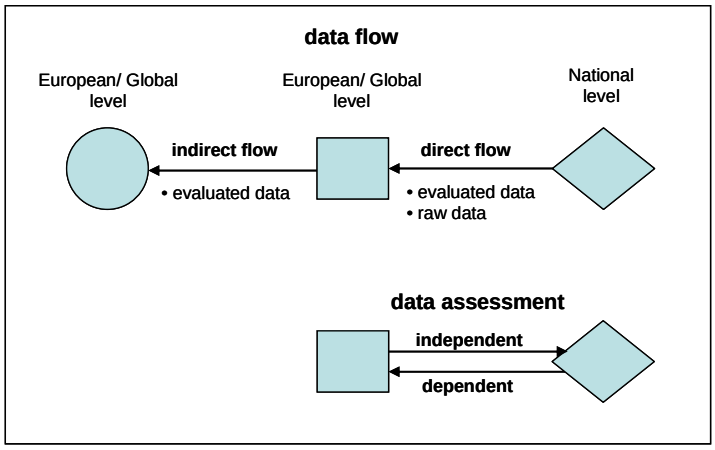
According to the depicted *forest area* data network **three major groups of data flow** can be distinguished:

- the *direct data flow* from national level to international level (e.g. National Correspondent – UNECE)
- the *indirect data flow* from an international institution to another international institution (e.g. FAO – WorldBank)
- the *combined data flow*, that incorporates a direct data flow from national level, but also datasets that are already covered at international level (e.g. (a) UNECE

– EFI and (b) NFI institute – EFI). The combined data flow can also include remote sensing data that are used as supplementary data but independently to direct national datasets or indirect international datasets.

With respect to the example of the *forest area* data network it can be seen, that the different options of data flows like data dissemination and data reception also reflect the various purposes and uses of datasets. Institutions that conduct research projects are often in direct contact with the responsible NFI institutes or include also remote sensing data for specified data evaluations and analysis. Institutions that are rather focused on high level policy making instead often collect datasets either from the National Ministry or via other international institutions that already collected various national datasets from countries.

Fig. 43: Concept: data assessment - data flow



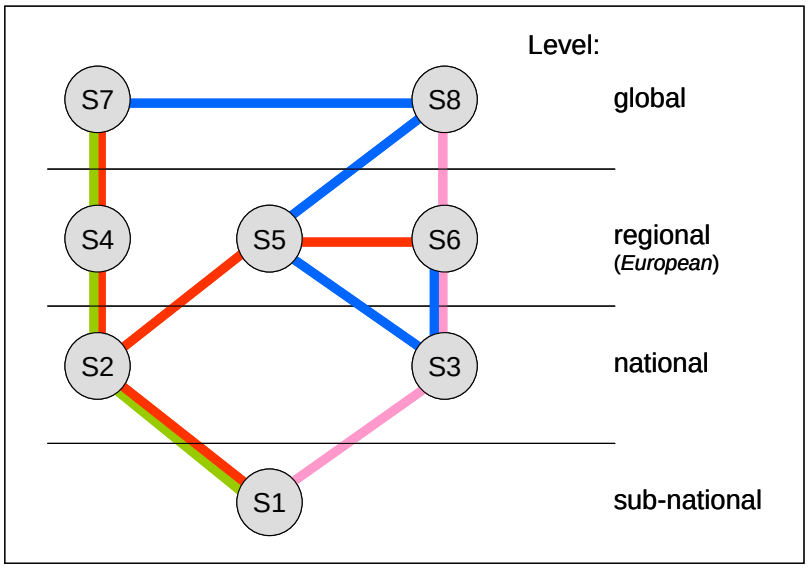
Analytic data flow charts are an important means to better understand and structure complex relations and data flows between various sources and institutions. An understanding of the harmonisation and streamlining of multiple data assessments can be achieved by structuring data flows according to whether (a) the datasets are collected directly or indirectly, (b) the datasets are collected independently or dependently from national assessments, or (c) only evaluated datasets (results) or also raw data are collected. This structuring will allow identification of possible improvements in data storage and data dissemination of multiple sources at international or national levels (see also Fig. 43).

Metadata descriptions that incorporate descriptions on networking structures as on data flows or institutional cooperation (see suggested metadata schema in Table 14) are a

central means to analyse and evaluate the complexity of international institutional relations and pan-European data collection and dissemination processes. Theoretically, similar to the example of the forest area data network, further data flow networks could be generated that describe the various data flows respective pan-European indicators. These networks could be combined or interlinked within one final network that describes the complex institutional relations and data flows incorporating all institutions and sources that are relevant within the pan-European process of monitoring, assessment and reporting on SFM. Due to the enormous complexity of such a network, but also due to the limited framework of this study, only examples are developed to show the theory behind and to demonstrate the various possibilities of generating a complex multi-level C&I Information Network.

Data flows or linkages between various sources or institutions could also be described by valued ties. Network graphs with valued ties allow description of, for example, data quantity or data quality by different colours or thicknesses of lines. Like in a subway or other public transportation map, different institutions or data sources within one context (e.g. all sources relevant for criterion C1 "*Forest Resources and Carbon issues*") could be interlinked by different levels and categories of data flow (e.g. different data or indicators symbolised by different colours).

Fig. 44: Data flow network of different sources (Sn) at different levels (*Concept of a Subway Map*)



Much more complex data flow networks that describe not only *data quantity* but also aspects of *data quality* are possible as well, like data reliability or temporal and spatial resolution of collected datasets. It would also be possible to describe whether the

collected or disseminated datasets are harmonised or not harmonised, or whether the datasets are approved by any reliability statement or not. However, to generate a valued network graph, reliable indices are needed to describe and evaluate network information that is organised in a one-mode network matrix (see Chapter 3.5.2, Introduction to Network Analysis). Based on metadata descriptions it is possible to derive certain indices that describe datasets and data flows with respect to *data potential* or *data quality*. The possibilities to generate a *data potential index* for each source and indicator are described and demonstrated in Chapter 6.3 (see ICP Forests/Forest Focus case study). Such an index would inform the data user whether the selected source encompasses a high or low data potential for adequate indicator reporting. In addition a *data quality index*[108] would indicate in highly aggregated form whether the available dataset is of low, medium or high quality (e.g. 1= low quality, 2=medium quality, 3=high quality).

7.5 The multiple aspects of assessing and describing resource quality

To derive a *data quality index*, different analysis and considerations of various quality aspects are necessary. The following examples below briefly show different aspects that have to be considered to describe datasets or resource quality either by metadata descriptions or by the means of analytic statistics.

The organisation Statistics Finland[109] for example compiled a list of different quality criteria to describe quality of their datasets and sources. The list includes: *relevance, accuracy, timelines and promptness, accessibility and transparency, comparability* and *coherence and consistency*.[110] Defining information quality by one single index can be regarded as challenging not only due to the variety of quality aspects that have to be considered but also due to the subjective nature of quality. Therefore Naumann et al. (2000) and Pipino et al. (2002) suggested different information quality criteria to assess and to score objectively the quality of, for example, information gathered from the Internet (see Table 15).

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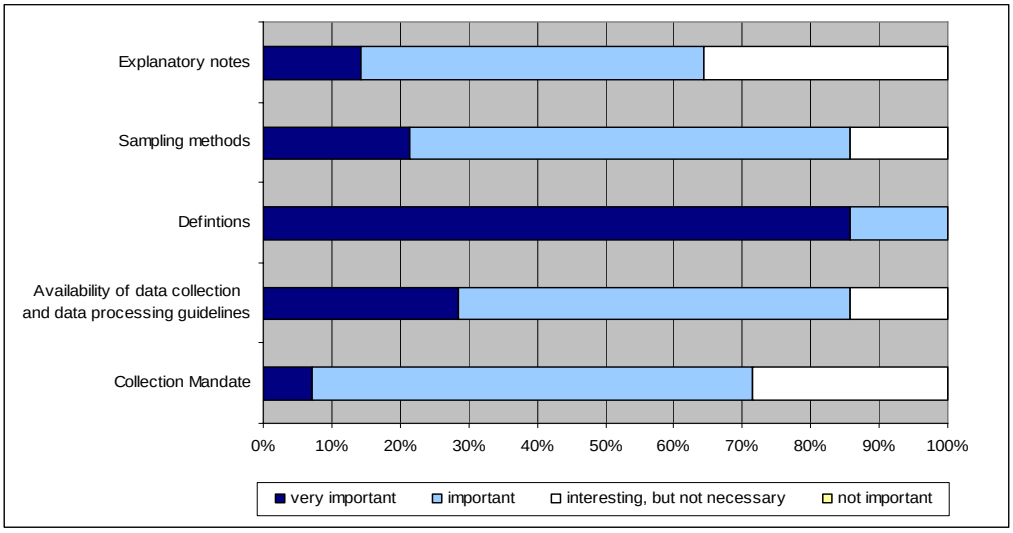
[108] A data quality index describes a single aggregate measure of data quality (see Pipino, 2002).
[109] Statistics Finland operates administratively under the Finish Ministry of Finance, but is fully and independently responsible for its activities, services and statistics.
[110] http://tilastokeskus.fi/tk/tt/laatuatilastoissa/lm010204/su_en.html

Table 15: Classification of Information Quality Criteria (see Pipino, 2002)

Dimensions	Definitions
Accessibility	the extent to which data is available, or easily and quickly retrievable
Appropriate Amount of Data	the extent to which the volume of data is appropriate for the task at hand
Believability	the extent to which data is regarded as true and credible
Completeness	the extent to which data is not missing and is of sufficient breadth and depth for the task at hand
Concise Representation	the extent to which data is compactly represented
Consistent Representation	the extent to which data is presented in the same format
Ease of Manipulation	the extent to which data is easy to manipulate and apply to different tasks
Free-of-Error	the extent to which data is correct and reliable
Interpretability	the extent to which data is in appropriate languages, symbols, and units, and the definitions are clear
Objectivity	the extent to which data is unbiased, unprejudiced, and impartial
Relevancy	the extent to which data is applicable and helpful for the task at hand
Reputation	the extent to which data is highly regarded in terms of its source or content
Security	the extent to which access to data is restricted appropriately to maintain its security
Timeliness	the extent to which the data is sufficiently up-to-date for the task at hand
Understandability	the extent to which data is easily comprehended
Value-Added	the extent to which data is beneficial and provides advantages from its use

Within the NEFIS project a metadata schema was elaborated that includes a structured *quality report* as one of the 15 different metadata elements (see Schuck et al., 2006; Landis et al., 2005; Mikkola et al., 2005). Within the NEFIS evaluation (Requardt, 2005) listing or linking to *definitions* was regarded as the most important element of the quality report (see Fig. 45). Furthermore, a short introduction to the *sampling method* is included, that allows relevant insight into the methodological approaches that were applied to generate the dataset. Information about the *collection mandate* or the *availability of data collection and data processing guidelines* are also considered to be relevant. In addition *explanatory notes* can serve as a pool for describing resource details that have not been included under the other quality report headings, e.g. a description of the harmonisation approach applied to adjust national datasets in order to meet international reporting obligations.

Fig. 45: Importance of elements for describing the quality of an information resource (NEFIS evaluation, Requardt, 2005; Schuck et al., 2006)



Specifically regarding forest inventory data a set of additional quantitative measures was discussed. This included the availability of *standard error* for main target variables, the total *sample size*, and *check assessments for measurement quality control*[111] (see Landis et al., 2005; Schuck et al., 2006). Within the NEFIS project it was concluded that non-experts may interpret this kind of information wrongly or that absence of information may give a wrong impression of questionable datasets. This kind of information was therefore considered to be only useful, if accompanied by further comprehensive explanations as listed above.

From a biometric point of view, the *reliability* of results can be quantified by giving their *precision, accuracy, mean square error* and *bias* (Köhl, 2000). The reliability of data cannot be related to a single error source. In order to improve the interpretation of survey results and to review the benefit of the retrieved information a total **error budget** has to be quantified (Gertner and Köhl, 1992). Such a quantified error budget considers various error sources like:

- sampling errors;
- assessment errors including measurement and classification errors;
- prediction errors caused by models;

[111] The NEFIS project used the term *resampling for measurement quality control*. As *resampling* is a term also used to describe different concepts of inventory design, the correct term in the context of quality control is *check assessment* (see EC Project: Scale Dependent Monitoring of Non-Timber Forest Resources Based on Indicators Assessed in Various Data Sources (MNTFR), 2001 (CT98 4045)).

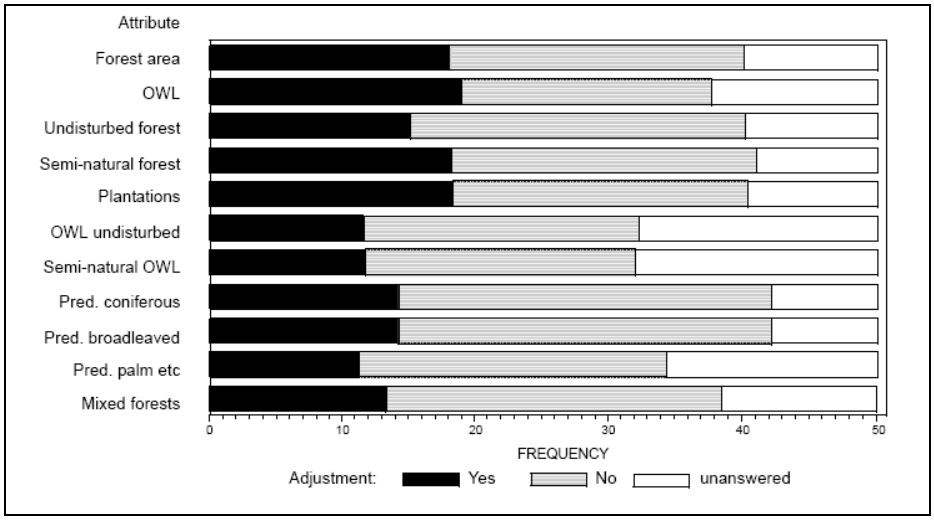
- definition errors;
- non-statistical errors.

These types of errors occur in all assessment and monitoring programmes and have been intensively studied (e.g. Hansen et al., 1961; Fuller, 1987; Groves, 1989; Gertner and Köhl, 1992a/1992b). The following examples below show that especially datasets collected at the international level can incorporate many different error sources.

According to most international reporting obligations, original country data, collected on the basis of national definitions, measuring and sampling techniques, have to be adjusted to international standards and definitions. Although several harmonisation and standardisation initiatives are ongoing (see Chapter 2.5) there are still differences in national data comparability and data quality. The differences in national nomenclature and definitions lead to the situation that attributes – even if identically named – reflect different concepts (see EC EFICS 1997; Köhl et al., 2000; Päivinen and Köhl, 2005). While the different nomenclatures are not error sources in national assessments they may result in considerable bias if datasets from various countries are collected without any adjustments on a common nomenclature (Köhl et al., 2000).

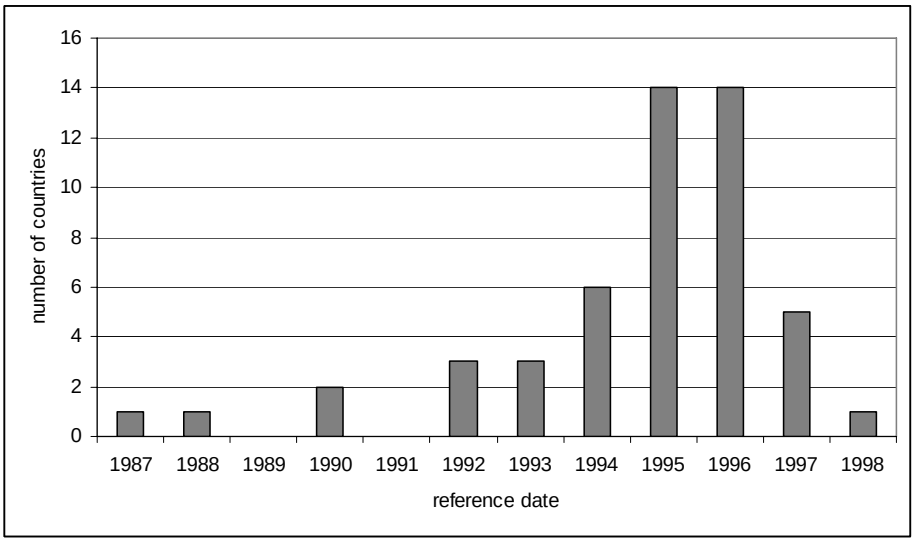
Within the UNECE TBFRA 2000 the reporting countries were asked to apply adjustments, if the national nomenclature diverged from the TBFRA definition. The methods applied to adjust national datasets to the TBFRA definitions (e.g. model based adjustments, survey based adjustments) were reported to and cross-checked by the UNECE. In a few cases expert opinion were used to adjust national figures (see UNECE/FAO, 2000). For some attributes only a small number of countries applied any kind of adjustments (see Fig. 46). This was mainly due to the fact that national definitions meet the TBFRA definitions or the required attribute is not of concern in the national assessment. Within this respect another limiting factor for data quality and interpreting international level data is non-response. Non-response refers to the failure to obtain national datasets on some attributes or entire countries for the required set of attributes (see UNECE/FAO, 2000; Köhl, 2000).

Fig. 46: Example TBFRA 2000: Adjustment of selected attributes (UNECE/FAO, 2000)



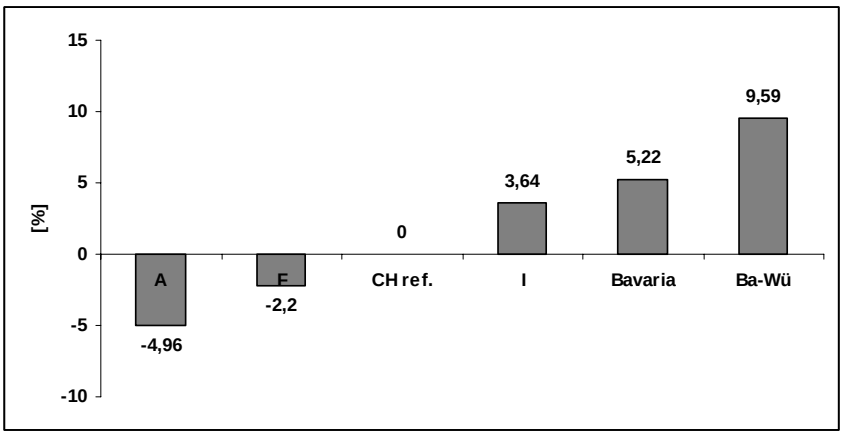
At the very beginning of the preparatory phase of the UNECE TBFRA 2000 it was discussed if a common point in time should be specified to which all data should be related. A survey including all western European countries showed that in none of those countries inventory results are updated to the explicit requested reference date, even if the assessment periods cover several years. The reference period of individual nations reporting to the TBFRA inquiry are presented in Fig. 47 and range from 1987 (Germany) to 1998 (Iceland). The example of the TBFRA 2000 shows that if international datasets are interpreted, it has to be taken into account that national datasets do not necessarily relate to a single point in time. This affects in particular the interpretation of reported changes.

Fig. 47: Example TBFRA 2000: number of countries per reference date (UNECE/FAO 2000)



Another limiting factor in interpreting collected datasets is that in national or also international reports, sampling errors are often the only error source that is published. The interpretation of figures and assumptions on their reliability can only be made if the types and size of the incorporated errors is known (Köhl et al., 2000). Even if sampling errors are published only a part of the reliability of figures can be judged. Especially attributes on nominal and ordinal scales may be subject to observer bias. The different forms of observer bias – e.g. in the scope of ICP Forests monitoring and the assessment of crown transparency have been analysed by Köhl (1993) and Gertner and Köhl (1995). Although the ICP monitoring on defoliation is based on standardised guidelines for a harmonised sampling and assessment, as adopted by the parties of the CLRTAP and as laid down in the EC Regulation on monitoring air pollutants ((EEC) No. 1696/87), there are, due to the effect of subjectivity on the national level, still differences of mean defoliation assessments (see Fig. 48). This example shows that even standardised definitions are subject to observer bias, as they can be subject to individual (national) interpretations (Köhl, 2000). The differences found between observers from different countries reflect the differences reported for crown defoliation in all available UNECE ICP Forest Condition reports, meaning that data comparability and its interpretation for decision making on international level is limited.

Fig. 48: Differences of mean defoliation assessed between observers from different nations (Austria, France, Italy, Germany - Bavaria, Germany - Baden-Würtemberg) in relation to the Swiss standard (Köhl et al., 2000).



To indicate and to assure data quality of ICP Forests data, the ICP Expert Panel developed guidelines to give a basic structure for the compilation of reports on quality assurance according to different quality indicators (see Fischer and Fürst, 2004). The

ICP Expert Panels are asked to report following the structure outlined in order to facilitate the compilation of a more comprehensive report for available ICP Forests data.

Referring to Cline and Burkman (1989) four main measures are aimed at maintaining the high quality of ICP monitoring either in the field or in the laboratories:

- Quality management (QM)

  focusing on the monitoring design: e.g. selection and design of plots and sub-plots, sampling design.

- Quality assurance (QA)

  focusing on definitions and standards in field assessments: e.g. precise descriptions of harmonised sampling methods, use of harmonised references.

- Quality control (QC)

  focusing on calibration, training, re-assessments and plausibility checks: e.g. intercalibration courses, ringtests[112], training courses, data checks in the field and in the laboratory.

- Quality evaluation (QE)

  focusing on the assessment of data accuracy by means of statistics: e.g. calculation of country specific systematic deviations of assessment results.

Quality indicators are reported regularly in percentages. Such quantitative figures help the ICP Expert Panels to follow the development of the data quality internally and serve at the same time as documentation for external data users.

Data quality within the ICP Forests/Forest Focus monitoring is also assured by different database tests and consistency checks (see UNECE/EC, 2004). Basically three different tests are conducted in the database management:

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[112] Ringtests are part of an external quality assurance programme for a measuring method. Usually a reference institute sends identical samples which have to be analysed for special parameters to different laboratories.

- Compliance tests

  The compliance test is a formal test that validates the format of entered data, e.g.: checking dates, numeric format, alphanumeric format, etc.

- Conformity tests

  Conformity tests check available data according to plausible ranges. For the measured values which are not classified according to coded lists, plausible ranges are defined based on the ranges of the legacy data.

- Uniformity tests

  Uniformity test are more qualitative and cannot be fully automated as they are the first step in data evaluation. Nevertheless, the automated process for producing tables, graphs and maps will allow preparation of most of the material needed for correct data validation.

Consistency checks are especially important to assure data quality and consistency when data are disseminated and copied from one source or database to another (see examples of data flows, Chapter 7.3). Consistency checking is the process by which inconsistencies between a set of data and its replica are identified and corrected if necessary. As part of synchronisation processes, a consistency check performs verification to ensure that all the data on the replica is consistent with the protected data.[113]

However, the examples above show that there are a number of factors that influence data quality and its interpretation. The examples show that several different quality criteria and error sources have to be considered to describe quality of available datasets and sources. Error budgets as described by Gertner and Köhl (1992) can be regarded as one appropriate tool to describe data quality in consideration of various sources of error. Instead the possibilities of defining a quality index, based on available metadata descriptions are rather limited.

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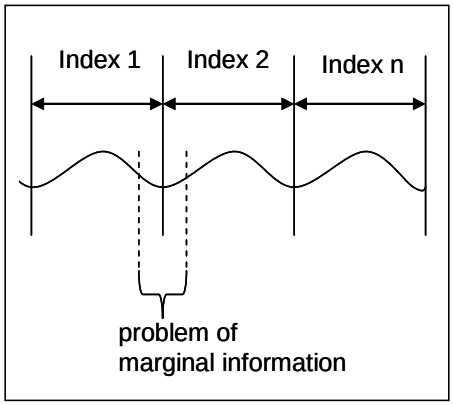
[113] See: http://www.microsoft.com/technet

Fig. 49: Defining an Index



The problem of metadata descriptions and therefore the problem of defining a data quality index is the problem of marginal information (see Fig. 49). The subjective interpretation of metadata information complicates any definition of clear borderlines or thresholds between one index to another. What is clearly allocated within index 1 and what could be theoretically also be classified by the index n?

Detailed classification schemes as demonstrated for the classification of *data potentials* are necessary to allow a more objective classification of *data* or *resource quality* via a simple index. Reliable information is needed for policy and decision making. Therefore its clear indication or description should be highly considered in any development of a C&I Information Network. Developing a multi-level valued C&I Information Network as suggested above, requires that available datasets and sources are provided with sound metadata descriptions and available information on error sources. Only then can the use and applicability of available datasets and sources for adequate reporting be comprehensively validated and interpreted.

8 Discussion and Conclusions

This study shows different approaches to describe and analyse C&I data potentials and data flows of international data sources which are relevant for the improvement of pan-European monitoring, assessment and reporting on SFM. In addition, it gives insights into the theory of C&I network correlations, pointing out and discussing new aspects relevant for the implementation of C&I as an instrument for identifying different cause-effect mechanisms and conflicts of interests, that have to be considered when developing forest management and monitoring concepts at different levels.

Based on the approaches outputs, two major aspects of C&I implementation are discussed: (a) aspects explicitly relevant for the monitoring, assessment and reporting on SFM and (b) aspects explicitly relevant for forest management purposes and concepts. Finally, conclusions and synthesis of both aspects are underlined providing an outlook for further research and policy action.

8.1 Aspect A: C&I for monitoring, assessment and reporting on SFM

Within the first approach "*Where to find which forest data*" (**Approach 1**), a list of international data sources relevant for the reporting on the pan-European C&I was compiled, structured and analysed according to the C&I requirements. This list can be regarded as a C&I structured update of the MCPFE document "*Where to find forest data*" (MCPFE, 2003). Although very specific sources may have been omitted, the list of 81 sources in total can be regarded as comprehensive and representative of pan-European activities of monitoring, assessment and reporting on SFM. Based on that list and using pan-European C&I as a baseline, Approach 1 provides a first overview on the quantitative data coverage, describing which data are frequently or rarely covered within the current pan-European monitoring, assessment and reporting on SFM.

Although the quantitative amount of sources and therefore the amount of available datasets per indicator does not mean that one single source would not be sufficient for

adequate data supply, it can be recognised that some criteria and indicators are notably well covered and that others have clear data deficits. According to the selected list of international data sources and with respect to the 35 quantitative indicators, nine *core indicators*[114] and eleven *deficit indicators*[115] were identified. These do not only describe the pan-European information preferences, but also the current international capacities to monitor, assess and report on the various aspects of SFM. In addition, they can be considered to indicate varying *validity* of different indicators to implement SFM at the pan-European level (see Chapter 8.2).

Comparing the data supply for indicators to each of the six pan-European criteria it can be seen that one indicator is notably more covered by international data sources than other indicators of that criterion. This one indicator is regarded as *the* key indicator to describe the respective SFM relevant theme. Concerning criterion C1 (*Forest Resources*), indicator *1.1 Forest area* is most covered within the pan-European monitoring, assessment and reporting. As expected, it can be regarded as the central indicator of all 35 indicators. The monitoring, assessment and reporting on criterion C2 (*Health and vitality*) concentrates mainly on indicator *2.4 Forest damage*, specifically covering datasets on forest fires. For the criterion C3 (*Productive functions*), indicator *3.2 Roundwood* and for criterion C4 (*Biodiversity*) indicator *4.9 Protected forests* are notably more covered than other indicators of the respective criterion. Although neither of the two indicators of criterion C5 (*Protective functions*) is identified as a core indicator, more datasets are currently available according to indicator 5.1 Protective forest – soil, water and other ecosystem functions. Concerning criterion C6 (*Socio-Economic functions*) it can be clearly seen that none of the eleven indicators is defined as a core indicator. However, the indicators *6.7 Trade in wood* and *6.8 Wood consumption* are the most covered. This indicates that the current international monitoring, assessment and reporting on the socio-economic aspects of SFM are focused rather on the timber market aspects than on any other socio-economic aspect. It can be concluded, that current capacities at international level to report on indicators

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[114] **Core indicators** (see definition in Chapter 4.3.1): *1.1 Forest area, 1.2 Growing stock, 1.4 Carbon stock, 2.4 Forest damage, (3.1 Increment and fellings), 3.2 Roundwood, (4.8 Threatened forest species), 4.9 Protected forest, (6.8 Trade in wood).*

[115] **Deficit indicators** (see definition in Chapter 4.3.1): *(1.3 Age structure and/or Diameter distribution), 3.4 Services, 4.4 Introduced tree species, 4.6 Genetic resources, (6.2 Contribution of forest sector to GDP), 6.3 Net revenue, 6.4 Expenditures for services, 6.6 Occupational safety and health, (6.9 Energy from wood resources), (6.10 Accessibility for recreation), 6.11 Cultural and spiritual values.*

like *6.3 Net revenue, 6.4 Expenditures for services, 6.6 Occupational safety and health, 6.9 Energy from wood resources* or *6.11 Cultural and spiritual values* are rather limited.

Comparing the international data coverage of the six criteria, criteria C1 (*Forest Resources*) and C5 (*Protective functions*) can be regarded as well covered at the international level. The monitoring, assessment and reporting capacities according to criterion C3 (*Productive functions*) and as mentioned above according to criterion C6 (*Socio-Economic functions*) are limited. Reporting on the productive functions (C3) is specifically limited with respect to the indicators *3.3 Non-wood goods* and *3.4 Services*.

In order to investigate future capacities and potentials to monitor, assess and report missing or more detailed SFM related data, a list of relevant future potential sources has been selected and analysed. According to that list it can be recognised that there is a trend towards: (a) more detailed data assessments on *forest resources*, specifically on *carbon* issues and *land use* aspects (see e.g. GMES GSE Forest Monitoring Services and Products); and (b) more forest biodiversity data (e.g. future capacities of the joint monitoring of ICP Forests/Forest Focus). With respect to the socio-economic data, future capabilities are given by the Eurostat Economic Accounts of Forestry (EAF) or the UNECE EFSOS report. However, some of the identified C&I data deficits in the current pan-European monitoring, assessment and reporting will still remain. There are some indicators that are not covered by the future potential sources, and are therefore identified as indicators for which definitely more capacities and efforts in monitoring, assessment and reporting are needed. These indicators are: *4.6 Genetic resources, 6.6 Occupational safety and health, 6.9 Energy from wood resources, 6.10 Accessibility for recreation* and *6.11 Cultural and spiritual values*.

In addition to the overview of indicator data coverage on the international level, Approach 1 also shows which sources and institutions are the most relevant within the pan-European monitoring, assessment and reporting on SFM. UNECE, FAO and OECD have high potentials to cover several of the 35 indicators. Also relevant are Eurostat, EEA, EFI and the EC JRC. Furthermore it can be recognised that only a few sources can be regarded as multi-resources covering four or more SFM criteria. Typical multi-resources are for example the UNECE TBFRA 2000, the FAO FRA 2000/2005 and the OECD Compendium of Environmental Data. However, most sources are very specific sources covering only one particular aspect that is relevant to SFM and the pan-

European C&I, e.g. the IUCN Red List of threatened species or the EFI Database on Forest Disturbances in Europe (DFDE). Moreover it can be said that some sources are *directly* relevant while others are rather *indirectly* relevant to monitoring, assessment and reporting on SFM. Directly relevant means, that the source origin and background is explicitly related to forests or forestry. Indirectly relevant means that sources are of different non-forest scope and content, but cover one or two SFM relevant aspects, like the IEA Energy Statistics, the ILO LABORSTA or the OECD Labour Market Statistics.

Differences between Global level sources and particular European level sources can be recognised as well. These differences occur for example in the spatial resolution of available datasets, as most of the sources collect or maintain datasets only for those countries and regions that are listed members of the specific organisation, see e.g. differences between EU, UNECE, OECD or UN sources. The different coverage is often also expressed by differences in scope and content of the explicit source, which again influences the method of collecting the data. As demonstrated in the study Outlook (see Chapter 7) some sources (e.g. TBFRA 2000 or JFSQ) collect national datasets directly at national level, while others (e.g. EEA EIONET or Worldbank WDI) receive national datasets indirectly from another international source. Reviewing the list of sources it can be concluded that especially multi-resources collect and disseminate datasets in joint data cooperation initiatives – facilitating data collection on a harmonised and streamlined basis. Joint data cooperation, for example, is ongoing within the joint monitoring of the ICP Forests/Forest Focus, the data collection of the OECD Compendium of Environmental Data, the JFSQ maintained by Eurostat, UNECE, FAO and ITTO, or also the joint UNECE/FAO data collection processes towards the forthcoming MCPFE in Warsaw in 2007. However, the study Outlook as well as Approach 1 demonstrate, that although data synergies exist partially between the different sources, the thematic focus or the scope of most sources is often different and specified. As a result, available datasets – and therefore also the data collection processes – are not necessarily comparable. Even if the same indicators are covered, there are often differences in spatial and temporal resolution or in applied definitions and terms. The use of potential synergies might therefore be limited.

From the perspective of MCPFE and its policy demands – specifically under the scope of SFM monitoring and implementation – it can be concluded that some SFM data requirements are less considered and therefore partly not covered at the international

level. For the international but also national responsible data collection bodies and initiatives, this means that further capacity building and improvements in data collection, data evaluation, data maintenance, and data dissemination are necessary to fulfil and report on all MCPFE demands in the future. If certain SFM aspects are considered to be relevant not only to implement but also to monitor SFM on a comparable highly aggregated basis as described by the pan-European C&I, further efforts and resources (e.g. technical, personnel and financial capacities) are needed to strengthen and improve the current monitoring, assessment and reporting on SFM.

However, the implications of the overview presented in Approach 1 "*Where to find which forest data*" is partly limited as the data potential of selected data sources was investigated focussing on the basic indicator information requirement itself. Detailed MCPFE indicator requirements like specific *indicator classifications* and *reporting units, temporal* and *spatial resolution* or *used definitions* have not been analysed. Due to the limited framework of this study a detailed data potential analysis regarding MCPFE requirements was conducted in a case study of the joint monitoring programme of the ICP Forests/Forest Focus (see **Approach 3**). The analysis in Approach 1 showed that several other international institutions such as the EEA, the UNECE or Eurostat refer directly to ICP Forests data to report on forest health and vitality. The MCPFE also contacted the PCC of the ICP Forests in 2003 and in 2006 to provide national datasets on the indicators *2.1 Deposition of air pollutants, 2.2 Soil condition* and *2.3 Defoliation*. Approach 3 shows that the joint monitoring of ICP Forests/Forest Focus has several potentials to extend the current data assessment into a harmonised pan-European multi-resource, covering not only datasets on forest health and vitality, but also on forest biodiversity, forest production and carbon issues. This kind of analysis is relevant as, with the termination of the EC Forest Focus regulation in 2006 (Council Regulation (EC) No 2152/2003) and the discussions related to a future EC LIFE+ regulation for 2007-2013, the future objectives of the joint programme of ICP Forests and Forest Focus are presently under discussion.

By means of a detailed *data potential classification scheme* developed in Approach 3 it was shown that the joint monitoring of ICP Forests/Forest Focus has a data potential for 16 indicators in total. This includes data potentials from the monitoring on Level I, the

monitoring on Level II and the two EC financed demonstration projects *Forest Biota*[116] and *BioSoil*[117]. However, only Level I assessments, and if conducted in future those of the BioSoil demonstration project are representative for MCPFE reporting. Thus at the moment only five indicators are covered by representative datasets, and of these only three (*2.2 Soil condition, 2.3 Defoliation* and *2.4 Forest damage*) fulfil almost all MCPFE requirements. Level II plots as well as ForestBiota assessments are rather non-representative assessments based on selected case studies in which certain cause-effect mechanisms are assessed and analysed, like the effects of *air pollutants* on *forest growth* or on *forest biodiversity*. Level II and ForestBiota assessments provide the basis for identifying certain cause-effect indicators (or symptoms of certain cause-effect mechanisms) which could be assessed on Level I if representative datasets on national and pan-European levels are required.

Applying the *data potential classification scheme*, it was shown that there are several future data potentials to supplement the current monitoring programme towards specific MCPFE requirements. According to the first data potential screening in Approach 1 only nine indicators have been regarded as potentially available on Level I and Level II. On the other hand, Approach 3 demonstrates that despite a few new assessments, a large amount of already available datasets (either *raw data* or already *evaluated data*) could be re-evaluated according to the MCPFE requirements. With respect to these additional data potentials seven further indicators could be covered in future – in particular covering indicators of criterion C1 (*Forest resources*) and of criterion C4 (*Biodiversity*). The analysis of detailed data potentials describes different future perspectives to supplement representative Level I monitoring – e.g. by implementing Level II monitoring on Level I by collecting data on *forest biodiversity* or by linking NFI assessments with Level I assessments specifically covering data on *forest resources*. If it is of interest to assess and describe certain cause-effect mechanisms by a representative transnational monitoring, possibilities of supplementing Level I by using Level II assessments should be considered and discussed. The different possibilities of linking NFI assessments with Level I monitoring are already under discussion in several

[116] ForestBiota assessments have been conducted on about 100 selected Level II plots. Data collection and data evaluation has been finalised.
[117] BioSoil assessments are conducted on Level I plots. Data collection and data evaluation is still ongoing (status: autumn 2006).

countries (like in Germany, Italy or Spain) or they have already been implemented (like in Sweden, Poland, Switzerland or Germany-Bavaria).

Generally it can be concluded that the case study of detailed data potential classification of the joint monitoring of ICP Forests/Forest Focus has clearly demonstrated that the data potentials of most of the relevant international data sources can be regarded as much more diverse than described in the overall overview in Approach 1 (see Chapter 4). The different classifications of data potential categories allow a much more differentiated description of what is actually available and what the potentials for future capacity building are. The case study shows that much more indicators could be actually covered by adequate datasets on the international level, if data potentials would be identified more thoroughly and minor adjustments in data evaluation would be re-considered by responsible institutions and organisations. It can be said that detailed data potential classifications enable not only capacity building in the future, but also support the harmonisation and streamlining of various international and national activities of monitoring, assessment and reporting on SFM. Considering the benefits of detailed data potential analysis this study recommends that also other international or even national institutions and sources (like NFIs) conduct a similar kind of analysis. By doing this, detailed data potentials for a harmonised MCPFE reporting could be described and analysed and necessary adaptations in data assessments and data evaluations could be discussed and implemented, if regarded as important by the responsible authorities.

Finally, based on the first three study approaches and its outputs, different options to model a *multi-dimensional C&I Information Network* were described in an **Outlook** (see Chapter 7). A fully developed C&I Information Network as sketched out in the Outlook, would help to (a) provide various SFM relevant datasets to various users by means of a C&I structured European Forest Information System, and also (b) structure and better coordinate the pan-European monitoring, assessment and reporting on SFM by the means of multi-dimensional data flow charts or networks.

The major objectives of a C&I Information Network are to (a) seek possible synergies and cooperation among existing forest and environmental monitoring, assessment and reporting activities, and (b) define interfaces between these activities. The different options to model a C&I Information Network clearly show that a more structured analysis of data potentials, data flows and international cooperation is necessary to

improve the coordination of international data collection, storage, maintenance and dissemination. The descriptive *data flow charts* in combination with the more analytic *network analysis* approaches are quite promising for such an analysis. These kind of analytic data flow charts are important means to better understand and structure complex relations and data flows between various sources and institutions. Structuring data flows according to (a) whether datasets are collected directly or indirectly, or (b) whether datasets are collected independently or dependently from national assessments, or (c) whether datasets have been evaluated/processed or whether raw data are collected provides important information not only for understanding but also for improving the harmonisation and streamlining of multiple data assessments at the international and national levels.

Although the first draft of the C&I structured outline for a *European Forest Information System* is not finalised yet (e.g. by adding explicit metadata descriptions to each of the sources), the value of multiple available datasets and data sources has already been increased by simply interlinking and structuring all relevant international sources according to the pan-European C&I. The C&I Information Network outlined in the Outlook and in Annex 3 enables to provide datasets for each indicator according to various available sources. By this, different demands on specific definitions, spatial and temporal resolution of data can be satisfied adequately. The user can select the source that fulfils his/her explicit needs to its best extent.

Using C&I as a baseline to structure pan-European monitoring activities is also of particular interest in the ongoing discussions and achievements of the EC to develop a *European Forest Monitoring Centre* (see EC, 2006). The approaches used in this study, and especially the idea of modelling a C&I Information Network, can serve as one possible concept to support the future tasks of the European Forest Monitoring Centre, which are: the *harmonisation of data assessments*, the *streamlining of reporting*, and the *improvement of data evaluation* (see Landmann, 2006).

8.2 Aspect B: C&I for management purposes and concepts

The varying *validity* of each indicator and each criterion is not only expressed by its international data coverage, it can also be expressed by its linkages and correlations to other indicators and criteria. The interconnectedness of the social, economic and

ecological dimensions within the concept of sustainability, but also within SFM, is widely acknowledged and recognised. Based on this general theory **Approach 2** demonstrated the different correlations and cross-indicator linkages between the 35 pan-European indicators and the six criteria. By applying approaches of network analysis each indicator relationship and interaction within the entire set of pan-European indicators was displayed and analysed. The information on which indicator is linked to which other indicators relies on the indicator descriptions provided by the MCPFE background document (MCPFE, 2002a). According to this document indicators are not all interlinked. Therefore it can be concluded that the MCPFE indications of indicator linkages partly remain rather incomplete. The analysis showed that mainly the socio-economic indicators like *6.3 Contribution of forest sector to GDP, 6.3 Net revenue, 6.4 Expenditures for services* or *6.5 Forest sector workforce* are rather isolated compared to some other indicators which are very central (e.g. *1.1 Forest area, 1.2 Growing stock, 2.1 Deposition of air pollutants, 2.3 Defoliation, 2.4 Forest damage, 4.9 Protected forests, 5.1/5.2 Protective forests*). As expected, considering the outputs of Approach 1, the most central indicator is the indicator 1.1 Forest area.

Looking at the different *centrality* of each indicator (expressed either by the *outdegree* or *indegree*) it seems that indicators like *2.1 Deposition of air pollutants* or the two indicators of criterion C5 (*Protective forests*) are at first sight "unfoundedly" more central within the indicator correlation network than for example several other indicators, especially those of criterion C6 (*Socio-Economic functions*) or of criterion C4 (*Biodiversity*). This higher centrality of some indicators in comparison to other indicators leads to the assumption that subjective interpretation and a different understanding of C&I as well as the different influence of individual experts involved within the MCPFE C&I development process are partly reflected by the varying numbers of links that each of the indicators shows.

As Approach 1 and Approach 2 reflect different views on C&I *validity*, either from the view of indicator network centrality, or from the view of current data potentials at the international level, the question that arises in Approach 2 is: *Are the same indicators which are less covered by international data sources also less central and interlinked within the indicator correlation network?* Or the other way around: *Are the same indicators which are often covered by international data sources also of high centrality within the indicator correlation network?*

Comparing the distribution of indicator degree (network centrality) and the indicator data coverage, a similar indication of validity is described for 26 of the 35 pan-European indicators. This comparison partly indicates that the current data preferences within the current monitoring, assessment and reporting on SFM correspond to the current indicator implementation status described by the C&I correlation network. Traditional forest data such as National Forest Inventory data and data concerning forest health and vitality are relatively central in the network and well covered at the international level. On the other hand, most of the socio-economic and biodiversity data (data requirements which are rather new) are not well interlinked and insufficiently covered at the international level. This leads to the conclusion that further efforts are needed to cover and interlink all multiple SFM aspects to fully satisfy various requirements and support decision making processes for implementing SFM at different levels.

To implement SFM, as defined by the pan-European C&I, the 35 pan-European indicators should be seen as an intricately linked network. To strengthen C&I interconnectivity Approach 2 gives some further suggestions to set pan-European indicators into relation. The basic indicator network model has been supplemented at least for those indicator correlations which seem to be reasonable and missing within the MCPFE background document. In particular, an attempt was made to interlink those indicators which are not interlinked or which are more isolated from other indicators.

For example, missing or only described to some extent in the MCPFE background document are network correlations between the indicators *1.1 Forest area, 1.2 Growing stock, 1.4 Carbon stock, 3.2 Increment and fellings, 3.2 Roundwood, 6.7 Wood Consumption, 6.8 Trade in wood* and *6.9 Energy from wood resources*. Linkages are given between these indicators as it can be assumed that an increasing interest in using wood, either for energy purposes or as construction materials, leads to an increasing wood consumption that affects (a) timber market situations (basically described by the indicators *3.2 Roundwood, 6.7 Wood Consumption* and *6.8 Trade in wood*), and (b) the availability of timber resources (basically described by the indicators *1.1 Forest area, 1.2 Growing stock* and *3.2 Increment and fellings*). Strong linkages in that context could also be seen to the issue of climate change and the related policy objective reducing carbon dioxide concentration in the atmosphere. Forestry and timber industry have a certain potential to contribute to the reduction and stabilisation of the carbon dioxide

concentration in the atmosphere.[118] One option is taking into account the different potentials for carbon sequestration, e.g. by increasing biomass production (indicators *1.2 Growing stock, 3.2 Increment and fellings*) or also by increasing and supporting the use of timber products, like as a substitution of fossil fuels (*6.9 Energy from wood resources*) or as a substitution of raw materials (indicator *3.2 Roundwood*). This particular example shows that the knowledge and understanding of cause-effect relationships within the different SFM aspects (e.g. described by the indicator correlations) is of particular importance in defining appropriate management concepts, strategies and solutions for different scenarios and policy objectives.

To strengthen C&I interconnectivity, and therefore to support C&I implementation in the long term, it is required that possible further indicator linkages should be discussed for different scenarios by different expert groups, incorporating experts from the national and international levels. In this respect, it would also be useful to group the pan-European indicators according to the widely acknowledged *DPSIR*-concept, indicating whether an indicator is a *driving force*, a *pressure*, a *state,* an *impact* or a *response* indicator (see EEA, 1998; Smeets et al., 1999). Structuring the indicators according to the *DPSIR*-concept would not only clarify the indicator relationships and linkages, it would also strengthen the general understanding of each indicator meaning and purpose. Generally this study suggests revising the MCPFE background document specifically considering indicator descriptions and linkages.

The indicator network in Approach 2 clearly shows that some indicators have a higher *indegree* than *outdegree* (e.g. *1.4 Carbon stock* and *4.3 Naturalness* are affected by a higher number of indicators than they affect); other indicators have a higher *outdegree* than *indegree* (e.g. *2.1 Deposition of air pollutants* or *4.9 Protected forests* are less affected by other indicators than they directly affect). This means, that different cause-effect mechanisms are described clearly in the indicator network. According to the examples above, the two indicators *2.1 Deposition of air pollutants* and *4.9 Protected forests* are indicators that rather describe a cause of a certain cause-effect mechanism. Instead indicators like *1.4 Carbon stock* or *4.3 Naturalness* describe rather an *effect* within a certain cause-effect mechanism. This shows once again that the understanding of the different indicator meanings and relationships is crucial for defining the

[118] See: http://www.carboeurope.org/

appropriate management or also monitoring concept. Indicators that are central in the C&I network, either because they *affect* or they are *affected by* other indicators, should therefore be of particular concern when defining forest management strategies or concepts of forest monitoring.

Approach 2 finally questions the assumption that all six SFM criteria are mutually interlinked to each other. Taking into account the correlation network of the 35 indicators as described by the MCPFE background document and comparing the indicated number of linkages with the potentially possible number of linkages, the highest correlation strength is given between criteria C2 (*Health and Vitality*) and C5 (*Protective functions*). Criteria C1 *(Forest Resources*) and C2 (*Health and Vitality*), and criteria C1 (*Forest Resources*) and C5 (*Protective functions*) are also strongly interlinked. On the other hand, no correlation is indicated between criteria C6 (Socio-Economic functions) and C5 (*Protective functions*), and between C3 (*Productive functions*) and C4 *(Biodiversity*). To interlink these criteria potential indicator correlations would be, for example: interlinkages between the indicator *6.4 Expenditures for services* and *5.1/5.2 Protective forests*, or also between *3.5 Forests under management plan* and *4.9 Protected forests*. The marginal role of, for example, criterion C6 and its socio-economic indicators is also reflected by the numbers of possible *intra-linkages* within each criterion. According to the 11 indicators of criterion C6, only 2 of 110 potentially possible intra-linkages are described by the MCPFE background document, namely the correlation between the indicators *6.7 Wood consumption* and *6.8 Trade in wood*. Instead relative high intra-connectivity is described for the indicators of criterion C2 (*Health and Vitality*), realising about 80% of the potentially possible intra-linkages.

This observation leads to two different assumptions. The first assumption is that the different correlations between the different SFM aspects were (a) not fully considered or (b) favoured for different reasons during the process of developing the MCPFE background document. The second assumption is, that it is simply a matter of fact that certain indicators such as some socio-economic indicators or the biodiversity indicators are less *inter*- or *intra*-linked within the concept of SFM, as they can be regarded rather as a "by product" of primarily managing and maintaining forest resources, taking into account only the objective of timber production, the protective functions and taking care about forest health and vitality.

As described in Approach 2 the C&I correlation networks are *directed networks*, meaning that a link from one indicator to another does not necessarily imply that there is a link in the other direction. These kinds of cause-effect relationships between the different SFM aspects are contrary to the so called "*wake theory*" (or *Kielwassertheorie*). The *wake theory* assumes that all SFM aspects such as forest biodiversity or forest health and vitality or protection functions are mutually provided in the wake of forestry that focuses primarily on timber production (see: Dieterich, 1953; Rupf, 1960; Glück, 1982). In recent years the *wake theory* has been more and more replaced (see Glück, 1982) by the concept of *multipurpose forest management* (see Rametsteiner, 2000; Schütz, 2001; Denzler, 2002). Multipurpose forest management or multifunctionality describes a concept where forests are considered to serve several purposes, such as timber production, nature protection, protective functions or socio-economic functions, at the same time in one forest management unit. Due to the rising importance of ecological and social aspects in multipurpose forestry, a strict distinction formerly drawn between production forests, protection forests and nature conservation has become more blurred today (Rametsteiner, 2000). However, in contrast to both these theories, and in particular to the *wake theory*, the example of criteria correlations clearly shows that some SFM aspects are more correlated to each other than to others, and that the benefits of SFM do not only depend on the sustainable production of timber resources. Although this study clearly shows that indicators like *1.1 Forest area, 1.2 Growing stock, 2.1 Deposition of air pollutants, 2.3 Defoliation, 2.4 Forest damage, 4.9 Protected forests, 5.1/5.2 Protective forests* are regarded as central to achieve SFM at the pan-European level, linkages to other indicators demonstrate the multiple interdependencies between SFM aspects – interdependencies that have to be identified and considered when attempting to achieve the objective of a mutual balanced SFM.

One question that arises in this context is: In how far is it actually possible to consider all SFM aspects and related objectives (e.g. described by the pan-European C&I) mutually in one management concept (a) at the same time, and (b) in one forest management unit? Or can it even be assumed that the concept of multipurpose forest management is only a theoretical concept which is often limited in its implementation as it is "fragile" to too many conflicts of interests?

According to the criteria network model in Approach 2, three major theoretical situations for different management concepts can be distinguished:

- **Situation A** – all six SFM aspects (criteria) are mutually interlinked and considered in one management concept (see concept of *multipurpose forest management*);
- **Situation B** – the correlation strengths between the different SFM aspects (criteria) are different, thus priorities have to be set within the management concept focusing primarily on one or two SFM aspects and related management objectives (see e.g. *wake theory*);
- **Situation C** – all six SFM aspects (criteria) are not correlated with each other, thus the different SFM aspects have to be considered separately from each other (e.g. by defining a segregated management concept for different forest management units).

A strict differentiation between these three scenarios is certainly not possible. The possible interfaces in between will become rather complex when further aspects like the spatial distribution or temporal distribution (time frames) of different management concepts and related objectives are taken into account. Questions that arise are: *What is the minimum area where multi-purpose forestry can actually be implemented without encountering unsolvable conflicts of interests? What are the time horizons in which different management concepts and priorities can be implemented? Should there be a segregated or an aggregated approach to implement SFM at national or at sub-national levels? Where are the differences between defining objectives in National Forest Programmes or in management concepts at FMU level? Which different indicators are actually needed to implement and to monitor SFM at pan-European, national or sub-national levels? How intricately linked are different indicators at different levels under consideration of different policy objectives?* These are only some questions that have to be taken into account when discussing different scenarios for establishing different concepts for forest management and forest monitoring at different levels.

However, the indicator network models clearly show that to some extent different priorities can be combined in a multipurpose forestry concept, ensuring that other forest purposes will not completely be neglected. For example, increasing forest health and vitality in one forest management unit can ensure effective forest protective functions, maintenance of forest biodiversity, sustainable timber production, and social benefits like recreation purposes at the same time. On the other hand the indicator networks also

show that in the case of particular cause-effect relationships different conflicts of interests might arise – e.g. between the objective of increasing carbon sequestration in forests and increasing the use of wood as a substitution of fossil fuels and the objective of increasing forests biodiversity, e.g. by increasing the number of old trees and the amount of deadwood.

Especially the last example shows that multipurpose forest management often leads to conflicts of interests that require decisions to be made between different options (see also: Rat für Nachhaltige Entwicklung, 2004). The understanding of cause-effect mechanisms is crucial in defining an appropriate forest management concept that takes into account different policy objectives. Based on the outcomes of Approach 2 it can be concluded that network analysis is one appropriate tool to depict and analyse different cause-effect mechanisms between different SFM aspects. Network analysis can be applied to (a) recognise, and (b) define different scenarios for solving different conflicts of interests that might arise in a multipurpose forest management. In addition to network analysis the *DPSIR*-concept can be applied to structure and describe the different indicator functionalities and inter-dependencies in more detail. Not considered within this study, but also widely regarded as useful to define different management strategies in consideration of different policy objectives, are different approaches of *multi-criteria decision making (MCDM)* (see e.g.: Tarp and Helles, 1995; Kangas, 1992; Mendoza and Prabhu, 2003; Wolfslehner and Vacik, 2003; Sheppard and Meitner, 2005). The generic process of MCDM is to (a) identify objectives and alternatives, (b) develop criteria or attributes, (c) weight criteria or attributes, (d) rank alternatives, and finally (e) choose one alternative (see Yazdani, 2002). Combinations between MCDM and approaches of network analysis are possible (see Yazdani, 2002; Mendoza and Prabhu, 2003; Wolfslehner and Vacik, 2003). As MCDA is often applied only at FMU level, it could be of interest to conduct further research specifically in combination with C&I network analysis approaches either at the pan-European or national levels. Both approaches could be applied to provide scientific background for formulating National Forest Programmes which (a) provide clear guidance on national and sub-national level, and (b) are flexible in considering different policy objectives and management scenarios.

It can be concluded that C&I network analysis is not only an appropriate tool to analyse different management scenarios and to define different management concepts, it also

helps to define and to improve explicit monitoring strategies and concepts that enable assessment of progress and achievements towards defined management priorities and objectives. Promoting and achieving trans-national objectives based on multilateral policy agreements requires reliable and comparable data. Monitoring, assessment and reporting activities should therefore strengthen their capacities to provide harmonised reliable datasets, especially for defined core indicators – indicators which can be regarded as central in achieving SFM.

8.3 Synthesis and Final Conclusions

This study clearly shows that a large number of datasets according to the pan-European C&I are already available at the international level. The study highlights the current capacities and deficits within the pan-European monitoring, assessment and reporting on SFM. By taking C&I as a baseline, different information preferences are structured according to different sources and responsible institutions. A few multi-resources like the FAO FRA, the UNECE/FAO TBFRA or the OECD Compendium of Environmental Data cover more than four of the six pan-European criteria, while most relevant sources are rather specialised, covering only one or two indicators.

Taking the joint monitoring of the ICP Forests/Forest Focus as an example, detailed differentiated data potentials and future capacities for supplementing current monitoring towards MCPFE requirements are demonstrated. By investigating data potentials in more detail (taking into account different *definitions*, different *temporal* and *spatial resolutions* as well as available *raw data potentials*) it has been demonstrated that much more adequate datasets can be provided in future by slightly modifying and adopting data assessments and evaluations towards MCPFE requirements.

Harmonising and streamlining international and national monitoring, assessment and reporting activities requires also investigating data flows and networking structures between different sources and data managing institutions at different levels. Possible approaches were demonstrated for selected examples in the study Outlook. Furthermore, the Outlook provides the outline for a C&I based Pan-European Forest Information Network, by structuring and listing pan-European relevant sources according to the six criteria and 35 indicators.

Besides aspects mainly related to the issue of monitoring, assessment and reporting on SFM, the theory and relevance of C&I correlation networks for implementing C&I for management purposes and concept development was demonstrated. Linking and setting pan-European indicators into relation by applying approaches of network analysis is one approach to display different cause-effect mechanisms between different SFM aspects, e.g. described by the pan-European C&I. Approach 2 and the discussion above show that the understanding of cause-effect mechanisms between different SFM aspects is fundamental to identifying appropriate management but also monitoring concepts in consideration of various policy objectives at different levels.

With respect to the different approaches in this study, it can be said that the implementation of SFM and the monitoring of SFM are strongly correlated to each other. If one particular SFM aspect is considered to be relevant and central to achieving a certain management objective, the interest in monitoring its status and future development is increasing. Strengthening C&I interconnectivity might therefore be helpful in fully considering all SFM aspects, not only within forest management strategies but also within ongoing pan-European monitoring activities.

Finally it can be concluded that this study with its different approaches and outputs supports the general objective and ambition of minimising the *national* and *international* level burden concerning the challenging and complex task of monitoring, assessment and reporting on SFM. Nevertheless, this study also shows that further research is still needed. Having in mind the concept of a C&I Information Network that structures and interlinks various sources at different levels, it would be useful to also identify C&I relevant national sources and interlink national sources with international sources as identified in this study. Only by doing this, data flows and data potential synergies from the national level to the international level can be fully identified and analysed.

The hypothesis of the CICI conference in 2003 (CICI/FAO, 2003) (see Chapter 3.3) can be underlined and confirmed – assuming that (a) *"…the capacity for C&I reporting depends on the technical and organisational capacity on national and international level"*, and (b) *"…little new data need to be generated or collected. It is simply a question of connecting disjointed information strands and collating or processing the information that exists in those strands"*. The future challenge lies in the improvement

of the technical and financial capacities for managing and processing the large amount of datasets from various sources for various purposes. Using synergies between different national data sources as well as between national and international data collection initiatives, and also building harmonised bridges between various reporting obligations are fundamental to guaranteeing that efforts in SFM reporting and data assessment are not duplicated. The harmonisation and streamlining of data supply and data demands as well as the improvement of data evaluation processes are the keys to making certain core information available on a comparable basis. Implementing SFM at all levels requires reliable, comparable and clear structured information that is effectively supplied to various users, responsible for policy and decision making.

With respect to the different study approaches and outputs the questions that finally arise are: *How many diverse sources are actually needed and how much reliable information has to be considered to monitor, assess and report on SFM at the national or international levels? How many different indicators are actually needed to implement SFM as a concept of mutual balanced multipurpose forest management in consideration of different objectives at different levels?*

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10 List of Abbreviations

BFH	Federal Research Centre for Forestry and Forest Products (Germany)
BUWAL	Bundesamt für Umwelt, Wald und Landschaft (Schweiz)
C&I	Criteria and Indicators
CBD	UN Convention on Biological Diversity
CCD	UN Convention to Combat Desertification
CDDA	European Common Database on Designated Forest Areas
CDM	Clean Development Mechanisms
CICI	Conference on the Contribution of Criteria and Indicators for SFM
CIFOR	Center for International Forestry Research
CIS	Commonwealth of Independent States
CLRTAP	Convention on Long-Range Transboundary Air Pollution
CoE	Council of Europe
COP	Conference of the Parties
COST	European Cooperation in the field of Scientific and Technical Research
COST E43	COST Action Programme on Harmonisation of National Forest Inventories in Europe: Techniques for Common Reporting
CPF	Collaborative Partnership on Forests
CSCE	Conference on Security and Cooperation in Europe
CSD	UN Commission on Sustainable Development
DCMI	Dublin Core Metadata Initiative
DG AGRI	European Commissions Agriculture Directorate General
DPSIR	D(driving forces), P(pressures), S (state), I (impact), R (response)
EAF	Economic Accounts for Forestry
EC	European Commission
ECCI	Expert Consultation on Criteria and Indicators for SFM
ECNC	European Centre for Nature Conservation
ECOSOC	Economic and Social Council of the United Nations
EEA	European Environment Agency
EEC	European Economic Commission
EfE	Ministerial Conference on Environment for Europe
EFFIS	European Forest Fire Information System
EFI	European Forest Institute
EFICP	European Forest Information and Communication Platform

EFICS	European Forest Information and Communication System
EFIS	European Forest Information System
EFSOS	European Forest Sector Outlook Studies
EFTA	European Free Trade Association
EIONET	European Environment Information and Observation Network
ELM	Expert Level Meeting
ELM	Expert Level Meeting
ENFIN	European National Forest Inventory Network
ESA	European Space Agency
EU	European Union
EUFORGEN	European Forest Genetic Resources Programme
EUNIS	European Nature Information System
Eurostat	Statistical Office of the European Union
EUSIS	European Soil Information System
FAO	Food and Agriculture Organisation of the United Nations
FMU	Forest Management Unit
FORIS	FAO Forestry Department country profiles site
FRA	Global Forest Resources Assessment
FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GFIS	Global Forest Information System
GMES	Global Monitoring for Environment and Security
GSE	Global Monitoring for Environment and Security Services Element
IAF	International Arrangement on Forests
ICP Forests	International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests
IEA	International Energy Agency
IEEAF	European Framework for Integrated Environmental and Economic Accounting for Forests
IFF	Intergovernmental Forum on Forests
ILO	International Labour Organisation
IPCC	Intergovernmental Panel on Climate Change
IPF	Intergovernmental Panel on Forests
IPGRI	International Plant Genetic Resources Institute
ISIC/NACE	Statistical Classification of Economic Activities in the European Union
ISO	International Organisation for Standardisation
ITTO	International Tropical Timber Organisation
IUCN	International Union for Conservation of Nature and Natural Resources
IUFRO	International Union of Forestry Research Organisation

JFSQ	Joint Forest Sector Questionnaire
JQ	Joint Questionnaire
JRC	Joint Research Centre
MaB	Man and Biosphere
MAF	Ministry of Agriculture and Forestry in Finland
MCPFE	Ministerial Conference on the Protection of Forests in Europe
NEFIS	Network for a European Forest Information Service
NFI	National Forest Inventory
NLBI	Non-Legally Binding Instrument
OECD	Organisation for Economic Co-operation and Development
PCC	Programme Co-ordinating Centre
PEBLDS	Pan-European Biological and Landscape Diversity Strategy
PEFC	Programme for the Endorsement of Forest Certification schemes (formerly Pan-European Forest Certification scheme)
PEOLG	Pan-European Operational Level Guidelines for Sustainable Forest Management
QDCI	Quantitative Data Coverage Index
RFRA	Regional Forest Resources Assessment
ROD	Reporting Obligation Database
RS	remote sensing
SBSTA	Subsidiary Body for Scientific and Technological Advice
SEBI 2010	Streamlining European 2010 Biodiversity Indicators
SFM	Sustainable Forest Management
TBFRA	Temperate and Boreal Forest Resource Assessment
UML	Unified Modelling Language
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Development Programme
UNEP-WCMC	UNEP World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
UNIDO	United Nations Industrial Development Organisation
WDI	World Development Indicators
WGEIO	Working Group on Environmental Information and Outlooks
WRI	World Resource Institute
WSL	Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft

11 Annex 1: Pan-European C&I – List of quantitative Indicators

Criteria	No.	Indicator	Full text
C 1: Maintenance and Appropriate Enhancement of Forest Resources and their Contribution to Global Carbon Cycles	1.1	Forest area	Area of forest and other wooded land, classified by forest type and by availability for wood supply, and share of forest and other wooded land in total land area
	1.2	Growing stock	Growing stock on forest and other wooded land, classified by forest type and by availability for wood supply
	1.3	Age structure and/or diameter distribution	Age structure and/or diameter distribution of forest and other wooded land, classified by forest type and by availability for wood supply
	1.4	Carbon stock	Carbon stock of woody biomass and of soils on forest and other wooded land
C 2: Maintenance of Forest Ecosystem Health and Vitality	2.1	Deposition of air pollutants	Deposition of air pollutants on forest and other wooded land, classified by N, S and base cations
	2.2	Soil condition	Chemical soil properties (pH, CEC, C/N, organic C, base saturation) on forest and other wooded land related to soil acidity and eutrophication, classified by main soil types
	2.3	Defoliation	Defoliation of one or more main tree species on forest and other wooded land in each of the defoliation classes “moderate”, “severe” and “dead”
	2.4	Forest damage	Forest and other wooded land with damage, classified by primary damaging agent (abiotic, biotic and human induced) and by forest type
C 3: Maintenance and Encouragement of Productive Functions of Forests (Wood and Non-Wood)	3.1	Increment and fellings	Balance between net annual increment and annual fellings of wood on forest available for wood supply
	3.2	Roundwood	Value and quantity of marketed roundwood
	3.3	Non-wood goods	Value and quantity of marketed non-wood goods from forest and other wooded land
	3.4	Services	Value of marketed services on forest and other wooded land
	3.5	Forests under management plans	Proportion of forest and other wooded land under a management plan or equivalent

C 4: Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystems	4.1	Tree species composition	Area of forest and other wooded land, classified by number of tree species occurring and by forest type
	4.2	Regeneration	Area of regeneration within even-aged stands and uneven-aged stands, classified by regeneration type
	4.3	Naturalness	Area of forest and other wooded land, classified by "undisturbed by man", by "semi-natural" or by "plantations", each by forest type
	4.4	Introduced tree species	Area of forest and other wooded land dominated by introduced tree species
	4.5	Deadwood	Volume of standing deadwood and of lying deadwood on forest and other wooded land classified by forest type
	4.6	Genetic resources	Area managed for conservation and utilisation of forest tree genetic resources (in situ and ex situ gene conservation) and area managed for seed production
	4.7	Landscape pattern	Landscape-level spatial pattern of forest cover
	4.8	Threatened forest species	Number of threatened forest species, classified according to IUCN Red List categories in relation to total number of forest species
	4.9	Protected forests	Area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements, according to MCPFE Assessment Guidelines
C 5: Maintenance and Appropriate Enhancement of Protective Functions in Forest Management (notably soil and water)	5.1	Protective forests – soil, water and other ecosystem functions	Area of forest and other wooded land designated to prevent soil erosion, to preserve water resources, or to maintain other forest ecosystem functions, part of MCPFE Class "Protective Functions"
	5.2	Protective forests – infrastructure and managed natural resources	Area of forest and other wooded land designated to protect infrastructure and managed natural resources against natural hazards, part of MCPFE Class "Protective Functions"
C 6: Maintenance of other socio-economic functions and conditions	6.1	Forest holdings	Number of forest holdings, classified by ownership categories and size classes
	6.2	Contribution of forest sector to GDP	Contribution of forestry and manufacturing of wood and paper products to gross domestic product
	6.3	Net revenue	Net revenue of forest enterprises
	6.4	Expenditures for services	Total expenditures for long-term sustainable services from forests
	6.5	Forest sector workforce	Number of persons employed and labour input in the forest sector, classified by gender and age group, education and job characteristics

	6.6	Occupational safety and health	Frequency of occupational accidents and occupational diseases in forestry
	6.7	Wood consumption	Consumption per head of wood and products derived from wood
	6.8	Trade in wood	Imports and exports of wood and products derived from wood
	6.9	Energy from wood resources	Share of wood energy in total energy consumption, classified by origin of wood
	6.10	Accessibility for recreation	Area of forest and other wooded land where public has a right of access for recreational purposes and indication of intensity of use
	6.11	Cultural and spiritual values	Number of sites within forest and other wooded land designated as having cultural or spiritual values

Σ = 35 quantitative indicators

12 Annex 2: ICP Forests/EC Forest Focus – C&I Data Potential

Indicator	Source / Data Potential Situation	Adjustments/ Modifications	DP Class	
1.1 Forest Area • availability for wood supply • forest type	**Level I:** Forest area is not an explicitly provided parameter of the assessments of ICP Forests. However, Level 1 plot distribution might serve as a rough reference for a European forest map. There is a clear potential to use Level I data as basis for installing a forest type classification in Europe that might be applied later on within NFIs. -> Raw Data Potential ➔ Forest Area classified by forest type Limitations: accuracy and representativity and plot selection criteria of Level I might need to be re-checked.	Merging ICP data with NFI as a basis for calibrating maps on forest types.	**2**	**b**
1.2 Growing Stock • availability for wood supply • forest type	**Level II:** Growth studies by periodic non-destructive measurements are mandatory on Level II plots (every 5 years). Measurement of diameter at breast height [dbh] (1,3 m from ground level) on all trees with at least 5 cm diameter over bark. At least 15 years of data will be required from the plots before reliable estimates of increment change can be obtained. ➔ Growing Stock ➔ (Growing Stock classified by forest type)	Re-evaluate data according to forest types	**3**	**abd**

	Data Potential is limited as Level II data can not be regarded as representative for MCPFE countries or entire Europe.			
	BioSoil (Level I) dbh measurements on 16*16 km grid ➔ Growing Stock ➔ (Growing Stock classified by forest type) ongoing since 2006		**2**	
1.3 Age Structure and/ or Diameter Distribution • availability for wood supply • forest type	**BioSoil (Level I):** ➔ Diameter Distribution	Evaluation strategy still under development	**2**	
	Level II: Measurement of diameter at breast height [dbh] (1,3 m from ground level) on all trees with at least 5 cm diameter over bark. Growth studies by periodic non-destructive measurements are mandatory on Level II plots (every 5 years). ➔ Diameter Distribution ➔ (Diameter Distribution classified by Forest Type) Only stand age.	Re-evaluate data according required diameter classes Re-evaluate available data according forest types Plot wise representative data not available No country wise aggregation possible	**3**	**d**
1.4 Carbon Stock • biomass • soil	**Level I:** Organic carbon assessment on Organic layer (F+H horizons) mandatory; Mineral layer 0-10, 10-20 cm mandatory, 20-40, 40-80 cm optional ➔ Carbon Stock of soils	ICP measurement unit is g/kg. Required is: - tonnes of CO2 equivalent/ha - tonnes of CO2 equivalent/ha/yr Re-calculate according to required reporting	**3**	

		units not possible for all plots (Bulk density and coarse fragments information partly missing)		
	Level II: Case studies with organic carbon assessment Organic layer (F+H horizons) mandatory; Mineral layer 0-10, 10-20 cm mandatory, 20-40, 40-80 cm optional ➔ Carbon Stock of soils ➔ Carbon Stock of woody biomass	Plot wise representative data not available No country wise aggregation possible	**3**	
	BioSoil (Level I): Organic carbon assessment on Organic layer (F+H horizons) mandatory; Mineral layer 0-10, 10-20 cm mandatory, 20-40, 40-80 cm optional. Improved method harmonization , compared to Level I ➔ Carbon Stock of soils	ICP measurement unit is g/kg. re-calculate according required reporting units (see Level I) - tonnes of CO2 equivalent/ha - tonnes of CO2 equivalent/ha/yr	**2**	**b**
2.1 Deposition of Air Pollutants • N, S and base cations	**Level II:** sampling carried out monthly to weekly. mandatory: Ca, Mg, Na, N-NH, Cl, N-NO, S-SO, Alkalinity, N (total) kg/ha available for N, S, selected base cations Only plotwise data available (no aggregated country data) Data already submitted to MCPFE for 2007 report	: EMEP models give interpolated deposition values. Outlook: Probably higher accuracy possible by combining ICP and EMEP ?	**5**	**abd**

2.2 Soil Condition • pH, CEC, C/N, organic C, base saturation • soil acidity and eutrophication • main soil types	**Level I:** Parameters available for upper mineral layer of most plots. Only status data available (1990s). Data already submitted to MCPFE for 2007 report	Clarify with MCPFE: is country wise aggregation desirable here? Harmonisation of horizons to be improved	**5**	**abd**
	Level II: Largely comparable to Level I but lower plot numbers and not representative		**5**	**abd**
	BioSoil (Level I): (improved assessment compared to Level I) For a number of plots there might be the possibility to evaluate temporal changes.		**2**	
2.3 Defoliation • main tree species • defoliation classes moderate, severe and dead	**Level I:** Indicator completely available. Plotwise transnational data and country data from additional national reports available (national crown condition assessment in percentages of trees) Data already submitted to MCPFE for 2007 report		**5**	**abcd**
	Level II: Largely comparable to Level I but lower plot numbers and not representative		**5**	**abcd**

2.4 Forest Damage • abiotic • biotic • human induced	**Level I:** Abiotic factors partly available (storm, snow, wind, other identifiable factors) Biotic factors: completely available Human induced: direct action of man available	New methodology plus data since 2005 Evaluations still to be carried out Plotwise data assumed to be country representative at least for larger countries and for the more frequent damage causes	**4**	**abd**
	Level II: Largely comparable to Level I but lower plot numbers and not representative		**4**	**abd**
3.1 Increment and Fellings • availability for wood supply	**Level II:** Growth studies by periodic non-destructive measurements are mandatory on Level II plots (every 5 year). Measurement of diameter at breast height [dbh] (1,3 m from ground level) on all trees with at least 5 cm diameter over bark. At least 15 years of data will be required from the plots before reliable estimates of increment change can be obtained. ➔ Increment	Case studies available for increment (check for use as a European reference?) Theoretically case studies available for fellings, but mostly no country representative forest management	**3**	**abd**
	BioSoil (Level I): Dbh measurements on all tree species since 2006. The diameter is read in mm and as follows: Subplot 1: dbh > 0 cm Subplot 2: dbh ≥ 10 cm Subplot 3: dbh ≥ 30 cm ➔ Increment	Repetition needed for changes evaluation (m^3/yr)	**2**	

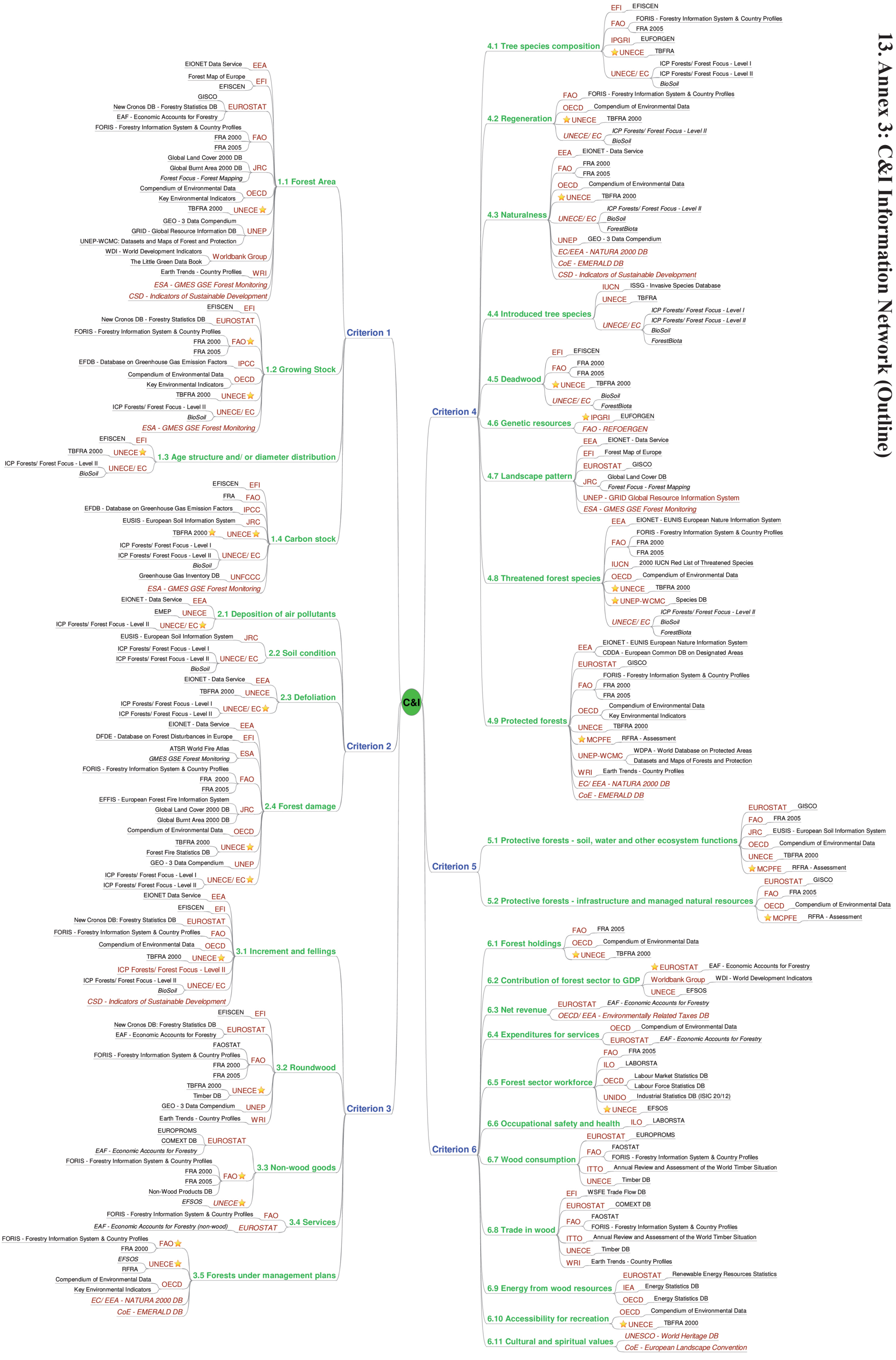
	Currently only Status data (m^3)			
4.1 Tree Species composition • Forest area by number of tree species • Forest Type	**Level I:** Only KRAFT classes 1-3 are selected. In some cases no random selection of tree species, but main tree species only. Rough reference, but not necessarily applicable for country reporting.	Potential for forest type classification: Re-evaluation for "area with number of tree species"	**3**	**bd**
	Level II: More detailed tree species information, but no representativity	Potential for forest type classification	**3**	**bd**
	BioSoil (Level I): All tree species are assessed 16*16 km grid		**2**	
4.2 Regeneration • Natural • Natural enhanced by planting • Planting and seeding • Coppice and sprouting	**Level II :** Ground vegetation information can serve to check the current status at the plots regarding its form of regeneration. -> Raw Data Potential	Minor new data assessments necessary (information on planting, seeding) Re-evaluation of existing Level II data (cover of forest tree species in the Ground Vegetation)	**2**	**ab**
	BioSoil (Level I) Ground vegetation information can serve to check the current status at the plots regarding its form of regeneration. -> Raw Data Potential		**2**	**ab**

4.3 Naturalness • Undisturbed • Semi-natural • Plantations	**Level II** Assessed are tree species and ground vegetation. Limited representativity: Level II plots selected only for most important forest types.	Classify plots e.g. following Natural Vegetation Map (Bohn 2003)Re-evaluate available raw data, in relation to reference	**2**	**ab**
	BioSoil (Level I): ideal platform for method development and implementation, raw data such as detailed tree species list and ground vegetation data are available	Classify plots e.g. following Natural Vegetation Map (Bohn 2003) Re-evaluate available raw data, in relation to reference	**2**	**ab**
	ForestBiota (Level II): In addition to general Level II data (tree species list, ground vegetation) also data on deadwood available Limited representativity: Level II plots selected only for most important forest types.	Classify plots e.g. following Natural Vegetation Map (Bohn 2003) Re-evaluate available raw data, in relation to reference. Ideal Platform for method development	**2**	**ab**
4.4 Introduced Tree Species	**Level I** Tree species information (see 4.1.) available for comparison with reference lists (e.g. SEBI 2010)	Re-evaluation of existing tree species data based on a developed reference list on "which tree species are regarded as introduced/alien/invasive"	**2**	**b**
	Level II Improved tree species information (see 4.1.) and ground vegetation data available for comparison with reference lists (e.g. SEBI 2010)	Evaluation of ground vegetation in this respect is beyond the requirements of MCPFE	**2**	**b**
	BioSoil (Level I): Tree species information (see 4.1.) and ground vegetation data available for comparison with reference lists (e.g. SEBI 2010)	Re-evaluation of existing tree species data based on a developed reference list on "which tree species are regarded as introduced/alien/invasive".	**2**	**b**

	ForestBiota (Level II): Only selected Level II plots	Re-evaluation of existing tree species data based on a developed reference list on "which tree species are regarded as introduced/alien/invasive".	**2**	**b**
4.5 Deadwood • Volume of standing • Volume of lying • According Forest type	**ForestBiota (Level II):** Assessed are lying and standing deadwood (coarse woody debris stumps snags) No country wise aggregation. Potential for harmonisation of NFI methods.	Re-evaluate data according to forest types	**4**	**abd**
	BioSoil (Level I): Assessed are lying and standing deadwood (coarse woody debris stumps snags)	Re-evaluate data according to forest types	**2**	**b**
4.6 Forest Genetics • In situ/ ex situ conservation • Seed production	**Level I:** Ideal platform for method development Re-consider other alternatives to assess forest genetics as explicitly requested by the MCPFE	---------- platform potential ----------	**X**	
	Level II: Ideal platform for method development Re-consider other alternatives to assess forest genetics as explicitly requested by the MCPFE	---------- platform potential ----------	**X**	
4.8 Threatened Forest Species • Birds • Mammals • Other Vertebrates • Invertebrates • Vascular Plants • Cryptogames and Fungi	**Level II** Vascular plants as well as terriculous cryptogams assessed every 5 years. Comparison with red lists possible. Potential to include further species groups in the future	Re-evaluation of existing data for vascular plants and cryptogams	**2**	**b**
	BioSoil (Level I): Ground vegetation only vascular plants, data are assessed as on Level	Re-evaluation of existing data for vascular	**2**	**b**

	II, data are available for a larger number of plots Potential to include further species groups in the future	plants and cryptogams		
	ForestBiota (Level II): See Level II plus in addition epiphytic lichens Potential to include further species groups in the future	Re-evaluation of existing data for vascular plants and cryptogams	**2**	**b**

13. Annex 3: C&I Information Network (Outline)



I certify that the English of the Ph.D. thesis "Pan-European Criteria and Indicators for Sustainable Forest Management: Networking Structures and Data Potentials of International Data Sources" written by Aljoscha Requardt from University of Hamburg (Institute for World Forestry) has been reviewed and is correct.

The thesis was reviewd by Tim Green (British citizen):

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14 May 2007