

## Article

# National Implementation of the Forest Europe Indicators for Sustainable Forest Management

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**Abstract:** The development of criteria and indicators (C&I) to generate information about the status quo and measure changes in sustainable forest management (SFM) has become ever more important. Forest Europe has developed C&I as a policy instrument to monitor and report about SFM. Forest Europe signatories considered the definition of SFM and related C&I as the most recognized achievements of the process. The results of our survey verify this statement. C&I for SFM are implemented at the national level in half of the Forest Europe signatory countries. C&I have served as a structure and framework for the national derivations. Our results confirm the importance of C&I for monitoring and reporting on the status and trend of forests and forestry in Europe. However, Forest Europe has failed so far to go beyond description toward target-based assessments. This was originally not envisaged for the indicators but is increasingly requested by decision-makers and stakeholders. The future development of indicators for SFM should focus on their appropriateness for the assessment of objectives, goals, or targets, because the ability to monitor the respective national efforts has become a critical tool of international but also national governance.

**Keywords:** C&I; criteria and indicators; Forest Europe; indicator implementation; forest monitoring; assessment; reporting



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## 1. Introduction

For decades, the state and future of the world's forests, including Europe's forests, have been a concern among scientists and forest experts but have also become an increasing matter of public concern. The efforts toward harmonized definitions and comparable national data on forests and their management-related issues having an impact on sustainability resulted in the development of a set of criteria and indicators (C&I) for sustainable forest management (SFM). This has contributed to the development of a joint vision of what constitutes SFM and has evolved as a powerful tool to promote and implement SFM.

Since the United Nations Conference on Environment and Development in Rio in 1992, eleven regional and international forest-related processes have developed C&I as a policy instrument to monitor and report progress toward SFM. In this regard, the forest sector has been a frontrunner in addressing the multifaceted and complex issues related to sustainable forest management by the development of forest-related C&I [1].

In Europe, the corresponding regional forest policy process for the sustainable management of the European forests is Forest Europe, formerly named the Ministerial Conference on the Protection of Forests in Europe (MCPFE). It was initiated in 1990 as a regional political initiative and has evolved into a high-level political forum for European international forest policy [2]. Forest Europe develops common strategies for its 46 signatory countries and the European Union on the sustainable management of their forests. Since

1990, eight high-level Ministerial Conferences on the Protection of Forests in Europe have taken place [3]. At the Second Ministerial Conference, held in Helsinki in 1993, SFM was defined in Resolution H1: “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” [4].

In this paper, we focus on the state of national level implementation of the Forest Europe C&I for SFM, exploring current status and trends through a survey of Forest Europe member countries. Based on the results, we examine the diversity of national level C&I for SFM implementation across European countries and key contextual factors that influence further development, revision, and implementation of forest-related C&I.

### 1.1. Development of the Pan-European Criteria and Indicators for SFM

In the Helsinki follow-up process (1993–1998), a first pan-European C&I for SFM set was developed and adopted based on the following definitions which are valid until today: “A criterion describes the different sides of sustainability on a conceptual level. It is a set of conditions or processes by which a forest characteristic or management is judged.” “The indicators show changes over time for each criterion and demonstrate how well each criterion reaches the objective set for it” [5].

Based on the Ministerial Declarations, Resolutions, and Decisions of the various MCPFEs, which can be seen as a common policy framework, all European countries had started initiatives to guarantee, monitor, assess and report on SFM [6]. The six criteria for SFM have remained the same since its adoption in 1994 (cf. Table 1). The set of indicators was improved several times in the meanwhile.

**Table 1.** Pan-European criteria for SFM [5].

| Pan-European Criteria for SFM |                                                                                                               |
|-------------------------------|---------------------------------------------------------------------------------------------------------------|
| 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 socioeconomic functions and conditions                                                   |

### 1.2. Improvement Processes of the C&I for SFM

At the adoption of the first C&I set in 1998, the experts emphasized that the indicators are neither final nor comprehensive since forests have multiple functions, some of which might not be adequately covered, and that the indicators will be analyzed, amended, or further developed during the process [7,8]. In the course of emerging challenges for the sustainable management of forests, C&I for SFM gained increasing attention at the beginning of this century [1,2,9–11]. Several countries, international organizations, and forest-related processes were initiated to develop indicator sets. For instance, the European Commission Standing Forestry Committee started an Ad Hoc Working Group on Sustainable Forest Management Criteria and Indicators [12], the FAO led a global project on SFM indicators [13], and forest-related indicators for the United Nations Sustainable Development Goals were developed [14,15] next to various national implementation activities. Thus, also further work on the pan-European indicators for SFM was initiated in 2002 and in 2014 [16,17].

There was a common appreciation on the necessity for Forest Europe to respond to the demands coming not only from the forest sector itself but also from other sectors such as energy, biodiversity, or bioeconomy. For the assessment of the implementation of specific international commitments such as the European Goals for Forests and the European 2020 Targets for Forests [18], it was also seen as a need to complement the set of indicators with related issues so far not covered by the set, such as degradation. In the revision processes, Forest Europe consulted with a wide range of experts and stakeholders to ensure the adequate reflection of the diversity of national situations and experiences as well as the work undertaken by various bodies in Europe. The following evaluation criteria were applied for the elaboration of adequate indicators based on Linser [19]: Political relevance for MCPFE and other initiatives, visible significance, data availability, cost-effectiveness, technical feasibility, validity, and reliability. An improved set of 34 quantitative and 11 qualitative indicators was the result of the latest revision [20].

In the Vienna Living Forest Summit Declaration and the Madrid Ministerial Declaration, the forest ministers endorsed the use of the improved and updated Pan-European Indicators for SFM [6,20]. In the Bratislava Ministerial Declaration, the forest ministers committed “to continue to work on the C&I for SFM, in cooperation with all relevant partners, with a view to further implement and strengthen monitoring, reporting, and assessment of forest resources and sustainable forest management in Europe and to continue to regularly report on the state of Europe’s forests” [3]. The contemporaneously published five State of Europe’s Forests reports are structured according to the pan-European C&I for SFM and are comprehensive descriptions of the situation and the management of European forests [21–25].

The Forest Europe Expert Group on Implementation of the Updated pan-European Indicators for SFM initiated discussions in 2017 on the use of a selection of key indicators [26], which were so far not realized. For the new Forest Europe period 2021–2024, it is planned to work toward a set of key indicators to improve the narrative capacity of the indicators, also in relation to the next State of Europe’s Forests report [3].

### 1.3. Objectives

The results of a survey conducted in 2015 on the future direction of Forest Europe [27,28] clearly indicated that Forest Europe signatories consider the definition of SFM and related C&I for SFM as the most recognized achievements of the Forest Europe process. Moreover, already in 2011, ITTO expressed that C&I for SFM are the most important policy instrument for monitoring, assessing, and reporting on the implementation of SFM at the national level [29]. Therefore, the objective of this paper is to check the implementation of the pan-European C&I for SFM at national level in the Forest Europe member countries. We analyze (i) the development of national sets of C&I for SFM, (ii) linking of the national set of SFM indicators to national objectives or strategies, and (iii) information and communication function of indicators.

Consequently, we consider information on the application of indicators at the national level as an indispensable input for the further development of this SFM tool and its anchoring in related national forest programs and strategies but also as a signpost for other regional and international C&I for SFM processes, as well as input for related global activities.

## 2. Materials and Methods

An initial survey on the implementation of indicators for SFM in Europe was conducted in 2012 [9]. Since then, additional new elaborations and revisions of national C&I sets for SFM were conducted by various Forest Europe member countries. To obtain more specific and updated information on the current national implementation of the Forest Europe indicators, the Forest Europe Expert Group on Implementation of the Updated pan-European Indicators for SFM proposed that a new survey among the member countries would be the most effective and efficient way. Hereinafter, the Forest Europe Liaison Unit

Bratislava contacted the focal points of the 46 signatories to participate in an online survey developed by the BOKU Vienna Forest Policy Research Network in 2017.

The empirical information was collected via a standardized questionnaire based on Harisson [30], in which the questions were formulated and arranged in a uniform way with closed questions and fixed response options according to Dillman and Messer [31] to receive comparable information. Respondents were also encouraged to provide some more specific, complementary information in open answers.

To tackle our research interest on the derivation, development, and revision of the various C&I for SFM sets and their national implementation, the questionnaire focused in detail on the following issues: development status of national sets of indicators, process of elaboration, adoptions and revisions of the indicator sets, relation to forest policy documents, structure of the national indicator sets, origin of indicators, number of indicators, key indicators or indices, model-based elaboration, national subsets of indicators, data availability, basis for related national report on SFM, inclusion of targets or thresholds, and check of effectiveness of National Forest Programs or of National Forest Strategies.

The questionnaire was available online via an online survey tool (<https://www.surveymonkey.com> (accessed on 1 December 2021)). The survey coverage comprised all 46 Forest Europe signatory countries. Preliminary results of this survey were presented at a Forest Europe meeting in 2017 and were further refined after validation by the attending country experts. In 2020 and 2021, those countries which had originally not replied to the survey and those countries which indicated that they plan to develop C&I for SFM sets as well as those countries with sets under development were contacted again to update their information. In total, national indicator experts from 41 European countries provided information, which represents a response rate of 89% covering 99.9% of the forest area of the Forest Europe member countries.

We requested information on both frequency and form of national implementation of the Forest Europe C&I for SFM. Our comparative approach focused on the identification of commonalities and differences cf. [32,33] to illustrate the diversity and state of national implementation across European countries and how the different contexts can play a role in the further development and revision of the overarching pan-European indicator set.

### 3. Results and Discussion

#### 3.1. Development of National Sets of Indicators for SFM

In 1998, in Lisbon Resolution 2 ‘Pan-European Criteria, Indicators and Operational Level Guidelines for Sustainable Forest Management’, the ministers responsible for forests committed to implement the pan-European C&I for SFM at national level [7]. In 2001, already 14 Forest Europe member countries had derived national sets of C&I for SFM [34].

So far, 24 countries (52%) have a national set of indicators for SFM. Six countries (13%) replied that their national set is under development or planned. Eleven countries (24%) answered that the application of SFM indicators at their national level is not intended, among them countries with large forest areas such as Germany, Sweden, and Ukraine. Five rather small countries (11%) with low forest cover have not replied to the survey.

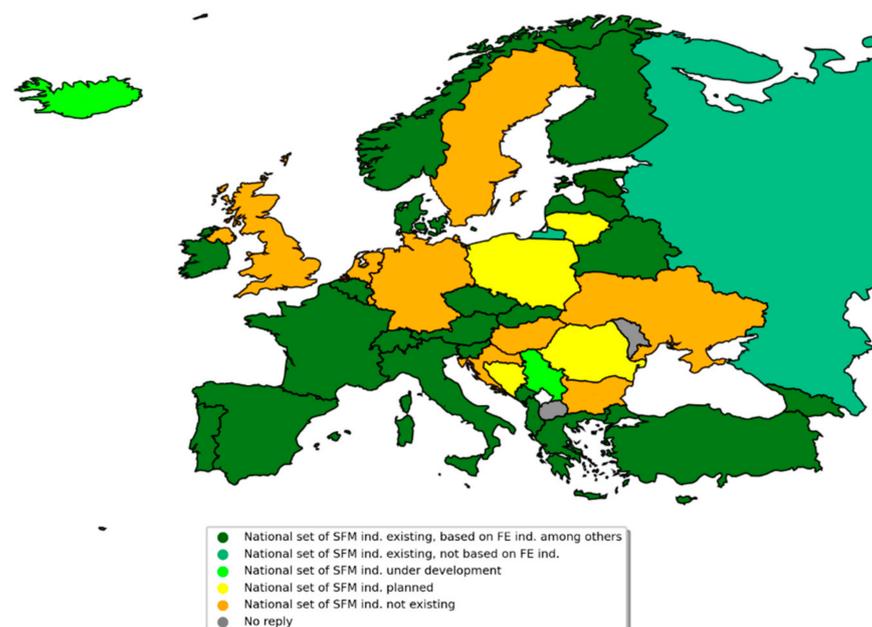
Within the various regional and international C&I for SFM processes, the pan-European C&I set for SFM is the only set that is supported by political commitment on ministerial level of the Forest Europe process [1]. The Forest Europe signatories and observers considered in 2017 that indicators for SFM are among the three most important achievements of the Forest Europe process [27,28]. Results from our survey revealed an implementation rate of 50% of Forest Europe member countries, while a former study of the European Forest Institute [9] showed more than two-thirds of the countries with national C&I sets. This difference may be associated with our question wording which explicitly asked for ‘nationally adopted’ C&I sets in Forest Europe member countries, i.e., they have a formal uptake in national forest policy frameworks. These results indicate still ample potential for further exploitation of C&I at the national level in the future. In addition, there are countries such as Germany with federal state structures where forest policy is devolved

and not coordinated nationally which complicates the elaboration and adoption of national C&I for SFM. Therefore, nationally adopted sets in 24 of 46 countries and related activities under development in several more countries may confirm the importance of C&I for SFM within the Forest Europe process.

Table 2 and Figure 1 present a more detailed overview of the above information, grouped into six implementation categories.

**Table 2.** Categories of implementation of indicators for SFM at national level in 2021.

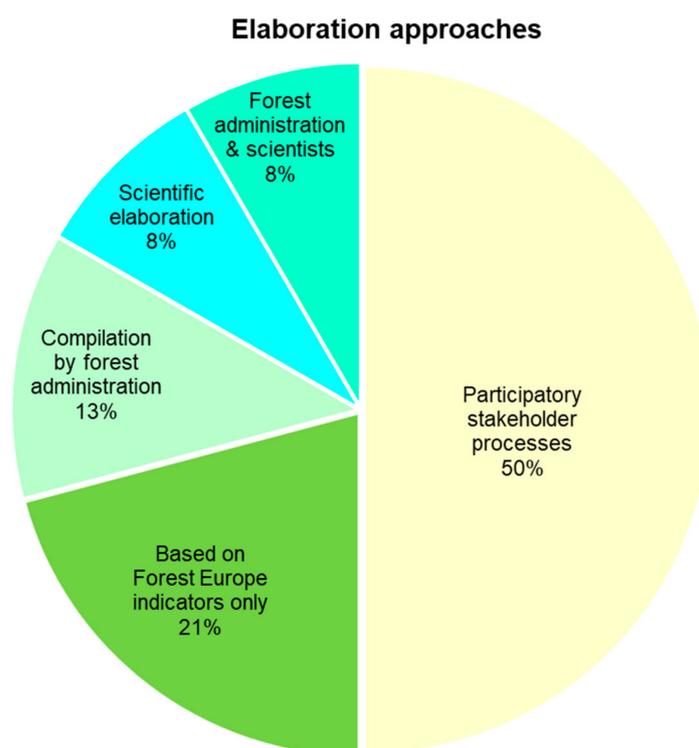
| Color Coding | Categories                                                                                | Number of Forest Europe Signatory Countries and Their International Country Codes                          | Share of Pan-European Forest Cover |
|--------------|-------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------|
| Dark green   | National set of SFM indicators existing and at least partly based on the pan-European C&I | 23 (AL, AT, BY, BE (Wallonia), CH, CY, CZ, DK, EE, ES, FI, FR, GE, GR, IE, IT, LV, ME, NO, PT, SI, SK, TR) | 13.7%                              |
| Medium green | National set of SFM indicators existing, but not based on pan-European C&I                | 1 (RU)                                                                                                     | 78.1%                              |
| Light green  | National set of SFM indicators under development                                          | 2 (IS, RS)                                                                                                 | 0.3%                               |
| Yellow       | National set of SFM indicators planned                                                    | 4 (BA, LT, PL, RO)                                                                                         | 2.0%                               |
| Orange       | National set of SFM indicators not existing/not intended                                  | 11 (BG, DE, GB, HR, HU, LI, LU, MT, NL, SE, UA)                                                            | 5.8%                               |
| Grey         | No reply to the survey received                                                           | 5 (AD, MC, MD, MK, VA)                                                                                     | 0.1%                               |



**Figure 1.** Availability of national sets of SFM indicators in Forest Europe (FE) member countries.

There are several key factors that C&I may make an effective tool or not. In the inception phase of indicator development, science and scientists play a significant role in addressing the extraordinary complexity underlying the sustainability debate. This has contributed to the opinion that the assessment of sustainability was fundamentally a scientific request and, therefore, amenable to scientific resolution [35]. However, scientific dominance has not prevailed in the elaboration process of national C&I sets in pan-Europe. Only in Belarus and Italy was the elaboration of extensive national sets of SFM indicators in the hands of scientists. Scientific elaboration supported by forest experts was conducted in two countries, and in three countries, the national sets were compiled by the forest administration.

Political commitment to a national C&I process involves active participation of all stakeholders in the development process, hence gaining strong consensus and true stewardship. Rametsteiner et al. [36] highlighted that the decision on “who participates and decides” during an indicator development process is more significant than the technical aspects on how to develop indicators. Ideally, a C&I process should facilitate a participatory approach which is accompanied by scientific design and process management [37], which was realized by twelve countries. Those open, transparent participatory stakeholder processes are often long-term and costly exercises. Such broad processes may not be conductible in many countries and led to the application of the Forest Europe indicators without any national amendments in five countries (see Figure 2).



**Figure 2.** Share of approaches applied in the elaboration process of national sets of C&I for SFM.

The first national indicator set for SFM was already developed in 1995 by France, followed by the Czech Republic in 1997 and Russia and Belgium (Wallonia) in the late nineties. Most sets were adopted after the Earth Summit in Rio which requested the development of national indicator sets in the Agenda 21 [38]. Another driver was the first revision of the Forest Europe indicator set (2001–2003). The most recent national set was adopted in 2020 by Georgia, elaborated in a very broad participatory process.

Due to an increased knowledge on SFM, new emerging issues, improved data availability, and further improvements of the pan-European indicator set, many countries had gone through a process of evaluating the indicators in terms of applicability to their own

country and added additional indicators to reflect their particular conditions. In 2010, the first national C&I set was revised, leading to further revisions of nine national indicator sets in the following decade. A specific situation is in Spain where the set was periodically revised in the years 2006 and 2012 but not formally adopted subsequently. The Czech Republic reported small changes of the national set throughout the years, and Portugal always used the Forest Europe indicator set in its current version without adopting the changes.

As a lesson learned from our work, the national C&I processes need to be iterative, adaptive, and ongoing, incorporating additional information of particular national importance as well as new information according to emerging issues, improved data availability, and advanced monitoring systems.

### 3.1.1. Structure of the National Indicator Sets

Pan-European forests differ vastly in their ecology, structure, and forest management based on different national conditions and objectives [25]. Hence, the pan-European C&I are a joint framework for monitoring and international reporting. We found a high degree of similarity in the criteria identified by the countries. The existing indicator sets and sets under development of 22 countries are structured according to the six Forest Europe Criteria for SFM (see Table 1). Eight of those sets contain also additional criteria.

The national indicator sets of the Czech Republic, Estonia, and Georgia are not based on Forest Europe Criteria for SFM but are structured under topics of their national forest programs. The Russian indicators are structured under criteria of the Montréal Process on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests, as Russia participates also in the Montréal Process.

The integration of knowledge and information from all fields related to forests and forestry is needed to ensure a development toward SFM. The concept of superordinate criteria and subordinate indicators for SFM ensures this. It is affirmed by 85% of the countries using Forest Europe criteria and indicators for SFM as a basis for their national sets. The overall number of indicators ranges between 14 and 286 indicators, with an average of 62 indicators per set. All but the Russian indicator set are based on Forest Europe indicators. In six countries, Forest Europe indicators are the only indicators in the national set. The amount of Forest Europe indicators in the other sets range from 8 up to all 45 Forest Europe indicators, including qualitative indicators, plus few indicators which were deleted from the pan-European set in the last improvement process but were maintained nationally. On average, 32 Forest Europe indicators are part of the national sets.

Indicators derived from the FAO Forest Resource Assessment (FRA) [39] were reported as part of six national indicator sets. The number of indicators included from FRA range from two to the whole set and are overlapping with the respective Forest Europe indicators. Between one and three indicators from various global conventions are part of the national indicator sets of Albania, Finland, Georgia, Portugal, and Spain. Additional indicators of national importance are part of 17 national indicator sets, ranging between 2 and 152 indicators with an average of 34 indicators of particular national importance. The Russian indicator set contains several indicators from the Montréal Process, and the one from Turkey contains some indicators from the Near East Process and the Dry-Zone Africa Process to serve its extraordinary ecological needs.

With regard to qualitative indicators, the eleven Forest Europe qualitative indicators are part of five national sets of indicators. They focus on the overall policies, institutions, and instruments to achieve SFM at national level and are reported descriptively. No other qualitative indicators were specified in any of the sets.

The low national implementation rate of the qualitative Forest Europe indicators is due to the fact that they have been fundamentally revised in 2014–2015, and thus so far, only been implemented in those countries with recent national revision processes. Qualitative indicators have always gained less attendance than the measurable quantitative indicators by the national correspondents, stakeholders, and decision makers who all tend to prefer

the hard facts of quantitative indicators [20–23,25]. However, the revised Forest Europe qualitative indicators, which are now more closely connected to the quantitative indicators, are expected to gain more attraction also on a national level.

### 3.1.2. Inclusion of Targets or Thresholds as Tools for Assessments of SFM

Decision making as an adaptive process benefits from the inclusion of particular targets to be reached or thresholds not to exceed, as tools for the assessment of the state of forests and the progress being made toward the European 2020 Targets for Forests [18]. However, the role of C&I as an assessment tool has been under scrutiny for at least the last ten years and how they can contribute to measuring progress toward SFM [9]. Targets or thresholds for individual indicators as tools for assessment of SFM have been developed as part of the State of Europe's Forests Reports 2007 [22], 2011 [23], and, on a pilot basis, in the SEMAFOR project [40]. Such targets or thresholds are politically sensitive and difficult to homogenize on country levels across, in particular if they become normative. Indeed, there is criticism voiced that C&I fail to facilitate such assessments [41], but there also needs to be clarity on the original purpose and design of C&I [9,42]. It is important to understand that the Pan-European C&I for SFM are the outcome of a voluntary political process and hence differ from scientific indicator concepts such as critical loads or critical levels. In such political processes, a new assessment approach on selected indicators could be a way forward, or as a softer variant, a benchmarking amongst participating countries.

In Austria, Russia, and Slovenia, all indicators for SFM have defined targets or thresholds. In ten countries (CZ, BY, BE (Wallonia), EE, IE, FI, GR, SK, PT, CH.), at least some indicators are related to national targets or thresholds deducing that those indicators have an increased importance. The future development of national indicators, but certainly also global, regional, or international indicators for SFM, should focus on their suitability for the assessment of goals and targets, because the ability to monitor the respective national efforts has become a critical tool of international but also national governance [11]. Kelley and Simmons [43] argue that the ability to implement assessment indicators with defined targets is an exercise of social power, with the potential to modify important policy outputs at various levels. In any case, the next step in of the evolution requires close cooperation between science, interested stakeholders, and the political arena to further develop a sound, reliable, and well-accepted C&I instrument.

### 3.2. Linking the National Set of SFM Indicators to National Objectives or Strategies

In Vienna Resolution 1 [44], the signatories aimed to support the concept of national forest programs in Europe to address national needs and contribute to the implementation of forest-related global commitments and internationally agreed actions. In our survey, 22 countries, including those where the national set of indicators is under development, reported that their national set of SFM indicators is related indeed to the objectives of a national forest program, national forest strategy, or any other national forest policy document.

Yamasaki et al. [45] highlighted that action must take place once goals, and targets have been agreed or set to maintain the momentum. In this respect, 14 countries (AT, BY, CZ, DK, EE, FI, GE, LV, PT, RU, SK, SI, CH, TR.) related their national indicators to assessable goals and targets of a national forest program or strategy and actively use their indicator sets to monitor the necessary data and information to check the effectiveness of the national forest programs or strategies. Linking the national set of SFM indicators to national objectives or strategies is planned in seven countries (BE (Wallonia), FR, GR, IS, LT, ME, ES.). Such an effectiveness check by national indicators for SFM is not undertaken in Norway and is not applicable in Denmark as neither a national forest program nor a respective strategy exist there. Four countries (CY, ME, RU, NO.) reported that their national sets of SFM indicators are not linked to any such documents. Those C&I for SFM sets without relation to national objectives or strategies might lack the coherence necessary to direct the focus of the indicators under each criterion.

While it is evident that the pan-European C&I provided a profound structure for national forest policy-making processes, a new form of functionality needs to be developed now as C&I should also be able to respond to current problems and issues, develop narratives that reflect the current reality, and create a systemic approach for policymaking [3].

### 3.3. Information and Communication Function of C&I Sets

#### 3.3.1. Key Indicators, Indices, and National Subsets of Indicators

Headline, core, or key indicators have recently gained prominence in cases where easily comprehensible information and communication is strived for [11,20,25,46–49]. Seven countries (AL, AT, FI, GR, RU, SI, CH.) reported a selection of 3–21 key indicators out of their national sets for particular communication purposes. Five countries (AL, AT, ES, GR, CH.) reported also the use of related indices, such as the Biodiversity Index, Simpson Diversity Index, Bird Index, and Forest Sustainability Performance Index where forest-related data are fed in.

The outreach and acceptance of C&I for SFM are limited beyond the boundaries of the forest sector. Two studies [9,46] have shown that data and information from SFM indicators are little known or used by other sectors. One reason is that the specific information collected for the forest sector is often not compatible with the information needs of other sectors. This is particularly true for political areas that are cross- or multi-sectoral, such as the environment, rural development, or bioeconomy sectors. The new Forest Europe Work Programme [3] puts a particular focus on communication across the boundaries of the sector and encourages countries to strongly collaborate in this segment. Our results show that thematic subsets of indicators are a feasible means to address specific forest-related policy issues and were indeed elaborated by seven countries (AL, CZ, FR, GR, ME, RU, ES.) inside the framework of their general indicator sets. Their subsets comprise forest-related indicators for biodiversity, desertification, climate change, economic activities, non-wood forest products, contribution of forests to welfare, institutions, research, and international activities.

In the past five years, the Global Core Set of Indicators was developed by the Collaborative Partnership on Forests in a series of expert workshops with the contribution of Forest Europe experts and under global public consultation. It consists of 21 key indicators, which address topics identified in high level political commitments on forests and forest management and helps focus data collection efforts on the questions of the highest policy importance [47,48]. Most of the Global Core Set indicators correspond with Forest Europe indicators. The Global Core Set is the basis of recent country assessments in the State of Europe's Forests 2020 report [25] and the Global Forest Goals Report 2021 [49] and could be a role model for national key indicator derivations, while there are still some data and information needs to solve, also in several countries in pan-Europe.

#### 3.3.2. Model-Based Elaboration

Extensive forest-related data are monitored and collected by the national inventories and statistical agencies and subsequently presented in indicators. However, a large number of indicators may make an overall interpretation difficult. In case of extensive indicator sets, a consolidation of the indicators into an indicator-based model with carefully chosen and expressive indicators may be beneficial to communicate information about a special field of concern as well as about human activities that affect it. Three national sets of SFM indicators are based on models. Belgium (Wallonia) applies the Pressure-State-Response Model [50,51]. The MEDMONT System [52,53] is the basis for the quite extensive Greek indicator system, and the Cockpit Model [54] is applied in Switzerland for their large number of indicators.

The use of indicator models is a means to consolidate and structure the wealth of C&I information. Examples from three countries demonstrate that they provide quick optical overviews about status and trends and may also better enable highlighting emerging issues and draw attention to the effectiveness of policies. The use of models becomes

critical if the number of indicators is small, which is often the fact for the rather low number of social indicators within the C&I for SFM [1,9,55–57], respectively the lacking availability of the particular data [1,21–24,58]. The unclear underlying assumptions and algorithms may decrease the comprehensibility of the models and create black-boxes instead of transparency [59]. Excessive reductionism of inherently complex systems can also lead to misleading results and thus poorly informed stakeholders and decision makers [36]. Hence, translating complex information into simple indices that do not require excessive effort to integrate into a forest monitoring system was so far not accomplished by the applied models.

### 3.3.3. Data Availability for All National SFM Indicators

Almost all countries, with the exception of the very small European countries without any or very low forest cover, regularly report—in different completeness—indicator-based forest-related data and information to national and international organizations [21–25,58]. Eight countries (BY, CZ, DK, EE, GR, LV, SI, TR.) can report national data for all of their national indicators. In Austria, France, and Spain, data are not available for only a few indicators. In all other countries, additional reporting mechanisms need to be established to obtain all necessary data and information for a full overview on their indicators for SFM.

Although the availability, quality, and validity of forest-related data and information have increased impressively in the past decades, complete data availability is still a big issue with regard to available resources and feasibility [25,60]. The monitoring, reporting, and assessment of some indicators, in particular those on biological diversity, protective functions, and socioeconomic functions have been found to be difficult to obtain [21–25,58]. Abandoning indicators that are difficult to report might lead to imbalances in the effigy of SFM that C&I are to create. Deriving forest-related information by means of new technologies such as from earth observation can help to provide adequate data in the near future. Missing available data do not per se indicate insufficient monitoring activities but could also display an intention to monitor respective data and anticipate future information needs to cover all aspects of SFM.

### 3.3.4. Basis for a Related National Report on SFM

Public perception and expectations of forests and forestry have evolved in the last quarter century. Nowadays, forest experts, stakeholders, interested citizen, and decision makers want to know the status on forests and forestry. In half of the countries (AT, CH, CZ, DK, EE, ES, FR, LV, RU, SI, TR.) with existing national C&I sets, the results of the related monitoring and reporting have been factored into national reports on SFM. It is planned in the near future to use national indicator sets as a basis of a national report on SFM in five countries (BE (Wallonia), GR, IS, LT, PT.).

For dialogue and communication, indicator-based national reports on SFM are more appealing and easily comprehensible than open-access databases or indicator fact-sheets. The use of regular C&I-based reporting is not only important for informing forest managers, stakeholders, and the public but serve as an important basis of information for decision makers to secure budgets for SFM and other forest policy measures. Given that the future of forests and forestry may highly depend on public perception and its expectations, evidence-based communication will be a crucial force to shape public opinion and to inform decision-makers.

## 4. Conclusions and Outlook

The development of the pan-European C&I for SFM of the Forest Europe process and the related national implementation has made major strides over the recent years in covering all fields of interest and concern and to establish related monitoring methodologies and capacities to report about the sustainability of forest management. The implementation of the C&I for SFM varies widely between the various countries as the development and

implementation process is complex and can be costly. However, the pan-European C&I for SFM have served as a structure and framework for the national derivations.

The pan-European C&I and the derived national sets have only made minor strides with regard to the assessment of SFM in an easily comprehensible way for decision makers, stakeholders, and the broad public. In that, the inclusion of targets or thresholds as a tool for the assessment of SFM should receive more attention both on pan-European and on national level. The results presented here are expected to encourage countries within the Forest Europe process but also countries within other international or regional forest-related processes, to support the participatory development, and the implementation of national C&I sets under consideration of objectives and targets related to national forest programs or strategies. Vice versa, the national implementation could contain best practices that are of relevance to the regional or international process, i.e., a mutual learning processes in both directions.

As we write this, indicators gain more and more attention in Europe. There are ongoing discussions on climate change effects, forest damages, and biodiversity loss in forests. The abruptness of visible impacts leads to emerging needs in monitoring to explain actual effects. As a consequence, two sorts of discussions emerge. Do we measure the right things, and are the measurements timely enough? The first point is related to whether we have the correct parameters and the discussion on targets and thresholds for individual indicators to assess the development toward SFM. For instance, a current UNECE project is trying to refine the indicator on forest damages in response to these needs. In addition, the issue of biodiversity indicators is still at stake, presuming that there are still too many proxy indicators in this theme. The second focus on the issue that current data reporting happens in 5 years' terms and sometimes fails to explain sudden events (as, e.g., the forest dieback in 2018/2019). Questions have to be solved how to combine terrestrial and satellite data sources and how to properly interpret them.

It can be concluded that the indicator approach to measuring, monitoring, and reporting on SFM at national and supranational levels proved to be valid and useful even after 30 years. Attention to data quality and completeness continues to be important for effectiveness, which is a major issue also with regard to capacities and political support in the countries. It is clear that modern technologies will play a significant role for the further development of C&I for SFM reporting, both to improve data evidence and to support the reporting countries.

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## Abbreviations

|         |                                                               |
|---------|---------------------------------------------------------------|
| BOKU    | University of Natural Resources and Life Sciences Vienna      |
| C&I     | Criteria and indicators                                       |
| FAO     | Food and Agriculture Organization of the United Nations       |
| FE      | Forest Europe                                                 |
| FRA     | Forest Resources Assessments of the FAO                       |
| ITTO    | International Tropical Timber Organization                    |
| MCPFE   | Ministerial Conference on the Protection of Forests in Europe |
| MEDMONT | Monitoring in the Mediterranean Areas                         |
| SEMAFOR | System for the Evaluation of the Management of Forests        |
| SFM     | Sustainable forest management                                 |

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