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25 Years of Criteria and Indicators for Sustainable Forest Management: Why Some Intergovernmental C&I Processes Flourished While Others Faded

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Abstract: The use of criteria and indicators (C&I) for data collection, monitoring, assessing and reporting on sustainable forest management (SFM) has been growing since the Earth Summit in 1992, supported by eleven intergovernmental, regional and international forest-related C&I processes. The initial effort led to varying levels of implementation across countries. Several processes never went much beyond the adoption of a first set of C&I while others have made substantial progress. In recent years, interest in C&I for SFM has again increased. In light of the Sustainable Development Goals and emerging global challenges the contribution of C&I to monitor, assess and report on forest conditions and trends is increasingly important. We compare and analyse the structure, activities and progress of the intergovernmental C&I processes. The work is based on document analysis and questionnaires sent to the secretariats of the processes and C&I experts. We found many similarities but also major differences in the structure and content of the C&I sets. The results provide a context for discussing and understanding why some of the C&I processes are successful in their work while others have stalled. Finally, we propose the required ingredients for success for the future activities of the forest-related intergovernmental C&I processes.

Keywords: indicators; criteria; sustainable forest management; sustainable forestry; C&I for SFM processes; regional C&I processes; international C&I processes; intergovernmental C&I process

1. Introduction

1.1. Use of Indicators Raised First in 1992 at UNCED in Rio

Agenda 21 was agreed upon by 179 nations at the United Nations Conference on Environment and Development (UNCED) in 1992 in Rio de Janeiro and laid out the guiding principles for sustainable development in the twenty-first century [1]. As an operational follow-up, indicators were identified as the most appropriate tools for measuring, monitoring, assessing and reporting progress towards sustainability goals. Indicators make complex circumstances measurable and comprehensible to decision-makers and the public [2–8]. In forestry, the guiding principles for sustainable development were derived and applied within the concept of sustainable forest management (SFM). Criteria for SFM and related indicators translated the largely philosophical ideals of SFM into specific factors that could be measured in practical terms and applied in the development of sound ecosystem based management. Criteria and indicators (C&I) thus provide a tacit definition of SFM as well as a means to measure progress towards that goal. This was a major step forward and contributed to the paradigm shift away from sustained yield to a far broader and more holistic view of SFM.

Within the C&I processes, government representatives, often in partnership with civil society and international organisations (e.g., FAO) have created a co-operative framework for sectoral experts and policy-makers to develop, approve and implement specific sets of regional and international C&I to evaluate sustainability of forest management. This has led to C&I processes performing a pioneering role, creating an enabling environment for related activities such as forest certification. The activities and modalities of C&I processes are important in their leading role for SFM definition and promotion. Hence, the intergovernmental C&I processes are the very subject of this paper.

Since UNCED, the different regional and international forest-related processes and organisations have defined SFM and C&I in slightly different ways. However, the following definitions for these terms are broadly supported:

The United Nations describe SFM as: *“a dynamic and evolving concept [that aims] to maintain and enhance the economic, social and environmental values of all types of forests, for the benefit of present and future generations”* [9].

“CRITERIA define the essential elements against which sustainability is assessed, with due consideration paid to the productive, protective and social roles of forests and forest ecosystems. Each criterion relates to a key element of sustainability and may be described by one or more indicators” [10].

“INDICATORS are parameters which can be measured and correspond to a particular criterion. They measure and help monitor the status and changes of forests in quantitative, qualitative and descriptive terms that reflect forest values as seen by those who defined each criterion” [10].

Over the past 25 years or so, indicators for SFM have been developed and used by eleven intergovernmental C&I for SFM processes as a basis for their member countries as:

- Reporting tools for description and diagnosis of SFM for the public and decision makers [3,5,6,11,12].
- Communication tools to facilitate dialogue on SFM and provide clarity on complex issues and to streamline the forestry debate both within countries and among countries [6,12–14].
- Focused tools for the collection and processing of priority information and stakeholder interests and for the provision of links to other sectors and to global initiatives [5,11,13].
- A means of providing a framework for policy making, either as monitoring, goal setting or decision-making instruments or to identify enabling conditions, including financial and technical resources, to implement SFM [5,11,13,15].
- A reference framework for the development of policies on the conservation, management and sustainable development of forests [12–15].
- Assessment tools for analysing the effectiveness of programs and measures and a framework for describing and assessing progress at the national level [5,12,16–18].

- A contribution to the clarification of issues related to environment and trade, including certification of commercial forest products [11,19,20].

1.2. The Genesis of Intergovernmental C&I for SFM Processes

Intergovernmental regional and international C&I for SFM processes were established between 1991 and 2000 and were based on the concept of sustainable development [21] and sustainable forest management [1], both of which require integrating environmental, economic, social, cultural and policy aspects with multiple values beyond wood production.

By 2000 there were 11 active intergovernmental C&I for SFM processes, covering 171 countries. Some of these processes are applied to a specific continent or region while others are applied to a particular type of forests (i.e., boreal, temperate, tropical, dry forests or low-forest-cover). Thus, we always refer to regional and international processes.

Only the following six C&I processes remain active, proactively coordinating and supporting their member countries:

- The International Tropical Timber Organization's (ITTO) C&I for the sustainable management of tropical forests, representing 75% of the world's tropical forests (since 1986, first C&I set in 1992).
- The Pan-European Process on C&I for SFM, under the Ministerial Conference for the Protection of Forests in Europe, known also by its acronym FOREST EUROPE (since 1990, first C&I set in 1994).
- The Montréal Process on C&I for the conservation and sustainable management of temperate and boreal forests, covering 90% of the world's temperate and boreal forests (since 1993, first C&I set in 1995).
- The Amazon Cooperation Treaty Organization (ACTO) Tarapoto Process on C&I for the sustainability of Amazon forests (since 1995, first C&I set in 1995). In 2012 a harmonisation process with ITTO started, which led to the renaming into "process of harmonised C&I of ITTO–ACTO (Tarapoto) for the sustainability of the Amazon forests."
- The Association of Southeast Asian Nations (ASEAN) C&I for the sustainable management of tropical forests in Southeast Asia (since 1998, first C&I set in 2000).
- The Low-Forest-Cover-Countries Process, also known as the Tehran Process (TP for LFCCs) (since 2000, first C&I set in 2011).

Although the African Timber Organization (ATO) ceased operations in 2013, its C&I framework, which was established in 1994 with the support of ITTO and led to a first set in 2001, continued to be implemented by 13 ITTO member countries in Africa until the end of 2016. A unique characteristic of the ATO/ITTO C&I process was, that it was driven by a local and national-level bottom-up approach in comparison to the other C&I processes, which were rather regional-level top-down initiations.

The following four C&I processes were established with support and facilitation of the FAO, in collaboration with partner institutions such as UNEP, CIFOR, ITTO. They are not regional or international processes like the ones listed above, which actively coordinate their member countries but rather FAO coordinated country groups with irregular meetings. In many cases, there has been no activity for many years, sometimes since the original work by FAO to set them up:

- The Dry-Zone Africa Process on C&I for the sustainable management of dry-zone forests in sub-Saharan countries (since 1995, first C&I set in 1995).
- The Near East and North Africa Process on C&I for sustainable management of dry-zone forests (NENA) (since 1996, first C&I set in 1996).
- The Lepaterique Process of Central America on C&I for SFM (since 1997, first C&I set in 1997).
- The Dry Forests in Asia Regional Initiative for the development and implementation of national-level C&I for the sustainable management of dry forests in Asia (also known as India-Bhopal Process) (since 1998, first C&I set in 1999).

While most processes were designed exclusively for national level application, the ITTO, Tarapoto/ITTO, Lepaterique, India-Bhopal and FOREST EUROPE processes also elaborated C&I for use at forest management unit level. Of interest in this paper are however public C&I applications at national levels.

1.3. Objectives of the Paper

Analysing the evolution of intergovernmental C&I for SFM processes was one of six priority areas identified by experts at an international workshop held in Ottawa, Canada, in May 2016 to strengthen collaboration on the use of C&I to guide and track progress toward SFM [22]. Accordingly, the objective of this paper is to examine the development of C&I processes with the aim of identifying elements supporting successful implementation. This objective is achieved through analysing the circumstances of the initiation and development, including structure of individual intergovernmental C&I processes and their activities and modalities. We compare the context, organisational structure and activities of the processes to identify factors that supported or hampered their development. Key factors for success are also derived. The work has implications for global multi-sector indicator sets, market-based certification schemes and local C&I for SFM but they are not addressed in detail in this paper as the focus is on intergovernmental C&I processes. Likewise, the paper does not address the crucial and complex question of how these C&I processes have impacted SFM, saving this question for a subsequent paper [23].

2. Materials and Methods

A discussion at an international expert workshop on strengthening collaboration on C&I to promote and demonstrate sustainable forest management in Ottawa in May 2016 [22] proposed that a survey among the intergovernmental C&I processes would be the most effective and efficient way to obtain recent information about their activities and achievements. The work presented here is associated with the IUFRO WP 9.01.05 on Research and Development of Indicators for Sustainable Forest Management. All authors are active in this IUFRO WP and are representatives or insiders of a C&I process.

So far, up to nine intergovernmental forest-related C&I processes have been analysed [11,24–32]. The broader overview papers on the related C&I development are already around 20 years old [24,25]. There is no recent analysis of the development of all eleven so far constituted intergovernmental regional and international C&I processes.

The empirical information was collected via a paper questionnaire based on Harisson [33], which was sent to the secretariats of the individual processes in late 2016 and on further input from authors of this paper as process representatives or insiders. A semi-standardized procedure, according to Dillman and Messer [34], was used in which the questions were formulated and arranged in a uniform way to receive comparable information. Respondents were also encouraged to provide expert knowledge in free-form.

In order to tackle our research question on the origin and development of the eleven regional and international C&I processes and their national implementation to date, including the ingredients for success why some processes flourished while others faded, the questionnaire focused on the following information categories:

- **The process itself**, such as member countries or countries covered, political commitment of the membership, coordination, achievements, impacts. Due to its complexity, impacts on SFM are covered in a separate paper [23].
- **The respective C&I set**, such as development/revision period, number of criteria, number of quantitative indicators, number of qualitative indicators, allocation of indicators to criteria/UNFF thematic elements [9], allocation of quantitative indicators to SFM related issues, allocation of qualitative indicators to SFM related issues, basis for national C&I sets, new issues considered in most recent revision, inclusion of indicators from other processes or organisations, harmonisation and common understanding of concepts and terms, definitions of indicators.

- **The purpose or usage of the sets**, such as monitoring, data collection, reporting, assessment, key indicators.

Ten representatives or insiders from eight out of the eleven regional and international processes replied to the questionnaire and also contribute to this paper as co-authors. Additional information on the three inactive C&I processes (ATO/ITTO, Lepaterique, Dry-Zone Africa) is based on reports of meetings and workshops conducted during their active phases.

The analysis of the eleven C&I processes, in particular on their different context, organisational structure and development, is based on the comparative method as described by Lijphart [35] to reveal differences and similarities of the processes as well as common achievements and shortcomings. We assumed these differences as being important in explaining the rise, maintenance and dormancy of the various C&I processes. The comparative method was chosen, as the eleven C&I processes are sufficiently similar cases and although they have common characteristics in some areas, they differ in others, making comparisons very worthwhile. We argue that the differences are important drivers influencing the rising and setting of the processes.

3. Results

3.1. Commonalities, Differences and Peculiarities of the Various C&I Processes

The degree of activity and/or involvement in the international, regional and national development and implementation of C&I varies considerably between countries, with some countries developing and implementing C&I under one, two, or even three separate processes (Figure 1). The main applications common to all forest-related C&I processes are:

- *Tool for monitoring and reporting* on SFM, which has helped to improve the availability, quality and comparability of forest-related information.
- *Reference framework* for the elaboration and adaptation of national forest programmes and/or forest-related policies.
- *Information tool* for dialogue and communication within the forest sector and with other sectors and global initiatives.

Increasingly, C&I from intergovernmental processes are also applied as assessment tool for measuring progress towards SFM [16–18].

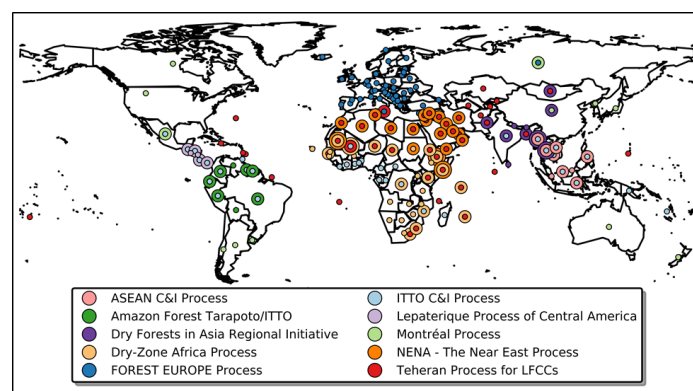


Figure 1. Distribution of the member countries or countries involved in all C&I processes. Total of 171 countries. 52 countries participate in 2 processes. 6 countries participate in 3 processes. Armenia, Azerbaijan, Guinea, Nigeria, North Korea, Paraguay and Uzbekistan do not participate in any regional or international C&I process. ATO/ITTO is above included in ITTO.

The various processes differ in the parameters presented in Table 1. These are explained in more detail below.

Table 1. Overview table on all regional and international processes and relevant parameters. Information based on expert input from the process secretariats and on literature for Lepaterique, Dry Zone Africa and ATO/ITTO processes. The share of the forest areas cannot be added up due to multiple memberships of some countries (cf. Figure 1).

Regional or International Process	Countries Covered, Voluntary (v) or Automatic (a) Membership	Share of World's Forests Covered	Development/Revision Period of Actual C&I	No. of Criteria	No. of Quantitative Indicators	No. of Qualitative Indicators	Coordination Unit
ITTO C&I Process	35 (v)	34%	4th: 2015–2016	7	34	24	Active, by ITTO Secretariat
FOREST EUROPE	46 + EU (v)	26%	4th: 2013–2015	6	34	11	Active, by FOREST EUROPE Liaison Unit
Montréal Process	12 (v)	49%	2nd: 2015	7	44	10	Active, by Montréal Process Liaison Office
Amazon Forest Tarapoto/ITTO Process	8 (v)	19%	4th: 2012–2015	9	16	20	Active, by ACTO secretariat
ASEAN C&I Process	10 (v)	5.3%	3rd: 2015–2017	7	38	29	Active, by ASEAN Secretariat
Tehran Process for Low-Forest-Cover-Countries (LFCCs)	56 (a)	1.7%	1st: 2000–2011	7	69	25	Active by Tehran Process Secretariat for LFCCs
NENA—The Near East and North Africa Process	21 (a)	1.2%	2nd: 2015	7	28	5	None, only national focal points in some member countries
Dry Forests in Asia Regional Initiative (India-Bhopal Process)	10 (a)	9%	1st: 1999	8	36	12	None (Regional secretariat in Bhopal from 2001–2002)
Lepaterique Process of Central America	7 (a)	0.5%	1st: 1997	8	34	19	None
Dry Zone Africa Process	30 (a)	12%	1st: 1995	7	39	8	None
ATO/ITTO C&I Process	13 (v)	9%	2nd: 2001	5	0	33	No ATO secretariat since 2013

3.1.1. Membership and Organisation

Between 7 and 56 countries are involved in each C&I process (Table 1). However, the number of countries involved does not tell the whole story. In terms of forest area covered, the Montreal Process, which has only 12 member countries, accounts for 49% of the world's forests. In contrast, the Tehran Process covers 56 low-forest-cover countries with only 1.7% of the world total forest area.

There are differences between the degree of involvement of countries. In six C&I processes interested member states (MS) and/or unions of MS (e.g., the European Union) from the respective regions or with forest type specific commonalities, as well as observer organisations have actively signed on for voluntary membership. The FOREST EUROPE Process is the only process with a ministerial commitment of the MS to actively contribute to the process goals and objectives.

There is an automatic, definition based membership of MS in five of the C&I processes due to the countries' affiliation to a geographical region, regional political body or definition provided (cf. Table 1). In such situations, the awareness of MS of their membership and MS activities were limited. Those regional activities connected to, for example, dry forests or low-forest-cover countries were initiated and mainly funded by the FAO and other international organisations as well as donor countries. There was only a weak self-organised follow-up after the funding declined.

Another notable difference concerns the coordination in the processes. The level of coordination and institutional support of the processes has diverged over time. There are a number of very active coordination units in some of the processes, such as within ITTO, FOREST EUROPE, Montréal Process and ACTO as demonstrated by the several revisions of the C&I sets. Other processes only spring to life irregularly if FAO conducts a regional or global C&I meeting to bring C&I up again on the agenda of that region. Rametsteiner and Wijewardana [36] mention in this context that coordination through periodic instead of continuous exchange, involves far fewer resources than continuous collaboration. But obviously, active MS participation and true stewardship only result from commitment to the regional or international C&I process.

3.1.2. Development and Implementation of the C&I Sets

The C&I sets of the 11 regional and international processes were developed between 1992 and 2011. The initial attempts to elaborate the first regional or international C&I frameworks were dominated by mainly technical and scientific working groups. All the C&I meetings and workshops were organised by the processes' coordination units or by FAO. The international collaboration with FAO and ITTO, which enabled an exchange of knowledge and experiences with other, more advanced regional or international C&I processes, helped the FAO-facilitated processes to proceed faster in the development of their first C&I sets.

All the sets, except ATO/ITTO, were developed by applying a regional-level top down rather than a local or national-level bottom up approach. This was partly reversed in the past decade through the increased participation of forest-related government representatives, C&I, SFM or forest inventory and data experts, academia, NGOs and other forest-related stakeholders from the local level and from member states in the C&I processes. However, the top-down approach was for instance one of the reasons why the Amazon Forest Tarapoto/ITTO Process has not been implemented yet, because there was no empowerment of grassroots stakeholders and forest technicians, which apply SFM in the field.

Some of the processes, mainly those involving developing countries (ITTO, ATO/ITTO, Dry Zone Africa, Dry Zone Asia, Near East and North Africa), have been strongly supported financially and through capacity building by international organisations, notably FAO, UNEP, ITTO and CIFOR but this has fluctuated over time.

The nature of political commitment on the part of member states also varies across the processes. In the Montréal and FOREST EUROPE processes, the member countries committed to implement and apply the C&I as a reference framework for monitoring, assessing and reporting progress on SFM. In the Amazon Forest Tarapoto/ITTO, ATO/ITTO and in the FOREST EUROPE processes, the C&I

sets were also endorsed by the respective forest ministers. ITTO made significant progress towards implementing the C&I in all of their member countries through a broad front of programs.

3.1.3. Revisions of the C&I Sets

The thinking on SFM is continuously changing as the understanding of forest ecosystems and forest-related socio-economic aspects evolves. Also monitoring and reporting are progressively improving to serve the increasing information needs due to emerging issues and changing forest policy goals. Thus, forest-related indicators should evolve as well. This implies that indicators need to be adjusted over time to keep pace with the new developments [12,37,38].

Seven of the eleven regional and international C&I processes have revised their C&I sets at least once (Table 1) after a phase of testing the initial indicators. Three C&I processes developed their initial C&I sets in the 1990s but have since apparently stalled as no current indicator-related work is evident over the last two decades. They are dependent on reactivation of such kind of activities by FAO and/or other donors.

The fledgling Tehran Process has developed its first set of C&I in 2000–2011 [39]. The ITTO, FOREST EUROPE and the Amazon Forest Tarapoto/ITTO processes have revised their C&I sets four times, using collaborative and broad participatory processes.

C&I revisions addressed various factors, including: altered or emerging needs, inclusivity of environmental, social and economic stakeholder interests, new reporting obligations or priorities from other global processes like the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change or the United Nations Convention to Combat Desertification. Also experiences from other regional and international C&I processes were considered in the revisions.

3.1.4. Allocation of Indicators to Criteria

The eleven C&I processes each have between five and nine criteria for SFM (Figures S2 and S3 in the Supplementary Materials), which are quite similar between processes. Indeed, they are similar enough that they formed the basis for the seven thematic elements of SFM (Table 2) endorsed at the seventh session of the United Nations Forum on Forests in 2007. There are, of course, exceptions, notably, the criterion on “scientific and technological capacities for the development of the forest resource” in the Lepaterique and Amazon Forest Tarapoto/ITTO processes, as well as the criterion on “forest access mechanisms, ancestral rights and consultation with communities” of the Amazon Forest Tarapoto/ITTO process. The ATO/ITTO process covers only four criteria.

In their recent sets, none of the regional and international processes present an equal number of indicators under each criterion. This is due to the fact that the processes do not exclusively use a science-driven, systems approach in the selection of indicators; the indicator sets are the result of participatory processes in which the interests and priorities of the committed participants are reflected in type and number of respective indicators under each criterion [40].

In most sets, the highest number of indicators is assigned to the criterion on protection or maintenance of biodiversity followed by the criterion on socio-economic functions of forest resources. Also, protective functions of forest resources are significantly represented by several indicators in all regional and international processes except FOREST EUROPE, which has only one indicator for this criterion. However, the number of indicators is not only a measure of the seriousness with which a topic is addressed but also an indication of how multidimensional and fragmented a criterion’s topic area is.

Furthermore, Holvoet and Muys [41] explained observed differences between the various C&I sets by biophysical and socio-economic differences between countries and regions. C&I sets from processes with mainly developing member countries often emphasise the economic and social aspects of SFM, placing less consideration on the need for research-based information. In contrast, regional and international sets from developed member countries strongly emphasise the ecological forest

functions and the need for research-based information. Our analysis of the most recent C&I sets can confirm these observations.

3.1.5. Allocation of Quantitative Indicators to SFM Related Issues

Each C&I process conceived and developed its own set of criteria and indicators for SFM reflecting their respective region's unique environmental and socio-economic conditions and population's needs. This is reflected in the differing number of quantitative indicators from only 16 indicators used by the Amazon Forest Tarapoto/ITTO Process up to 69 indicators of the Tehran Process for LFCCs (Figure S4 in the Supplementary Materials). Relevant issues like forest resources, afforestation/reforestation, health and vitality, damages, productive functions, biodiversity, protective functions and economic issues are well covered by indicators in all C&I processes. Carbon stock is not considered in the Dry Forest in Asia Regional Initiative. Non-wood goods and services are also not covered by that regional initiative as well as the Amazon Forest Tarapoto/ITTO Process, which also omits indicator coverage of social issues. The modern focus of human well-being is considered within social issues by ITTO, the Montréal Process, the NENA Process and the Lepaterique Process of Central America. Considering emerging issues, ITTO has included an indicator on "Forest resilience and climate-change adaptation" in its last revision, FOREST EUROPE has reflected on desertification in an additional indicator on forest land degradation.

All processes, except ATO/ITTO, include numerous indicators covering standard measures for SFM (e.g., forest area, protected forest area, etc.). But in all processes, it was also considered important to develop additional indicators reflecting the region's specific needs and capacities. In the case of ATO/ITTO only qualitative indicators are defined at national level, while all other indicators refer to the FMU level. While there are differences in detail between the C&I sets, reflecting the different contexts, there is also substantial conformity between the coverage of the various SFM related issues. Limited data are available in all countries on social issues [42], a fact that is reflected in the relatively low share of social indicators in the C&I sets (Figures S3 and S4 in the Supplementary Materials). However, sets which have been more recently revised, also contain social indicators. Figures S3 and S4 in the Supplementary Materials) show no social indicators for the set of the Amazon Tarapoto/ITTO process as they included four social aspects within economic indicators.

The Tehran Process has the most extensive set of indicators as Iran invested human and financial resources in a respective monitoring system [39]. However, other low-forest-cover countries may not be able to obtain similarly large amounts of data and information.

According to El-Lakany [43], non-wood goods and services make a substantial contribution to the domestic economies of the Near East countries. This can be confirmed in the high share of respective indicators in the NENA regional process. The Dry-Zone Africa Process developed its C&I set based on other regional and international C&I sets and amended those indicators to the environmental conditions and socio-economic needs of the region [44], resulting in a relatively high number of biodiversity and economic indicators.

3.1.6. Allocation of Qualitative Indicators to SFM Related Issues

In most regional and international processes, qualitative or descriptive indicators are focused on governance/policy implementation, institutional strength and law enforcement/compliance, which are subdivisions of the UN seventh Thematic Element "Legal, policy and institutional framework" [9].

Participation as well as tenure (access and use rights) are addressed in about half of the regional and international processes (Figures S5 and S6 in the Supplementary Materials). Financial and economic instruments, information and communication as well as cross-sectoral coordination and integration are not displayed in Figure S5 (Supplementary Materials) but are also issues covered by some of the processes. Social responsibility is a major new issue covered so far only by the Tehran Process.

The number of qualitative indicators varies from 5 to 33 indicators with a share of 15%–40% of total indicators in eight regional or international processes. In two processes the number of qualitative indicators is around half the total indicators (see also Table 1). The ATO/ITTO C&I process applied exclusively qualitative indicators. In general, the number of qualitative indicators is lower than the number of quantitative indicators and concentrates on governance issues mainly in those processes where the countries have established sound forest inventories to obtain sufficient quantitative information.

3.1.7. Data Collection and Reporting Based on Indicators

Data collecting and reporting are needed to analyse global, regional or national forest-related trends and they are of crucial importance to improve SFM and meet its requirement for empirical evidence that forests are actually well managed and protected [45].

Just a part of the regional and international C&I processes and their respective member countries have already used their C&I sets for reporting. An analysis of the FAO Global Forest Resources Assessment 2015 country report data displayed that C&I based reports were published by only 86 countries but that together these countries covered 77% of the total forest area. Nearly all of the forest area in the high, upper middle and lower middle-income countries were covered by C&I reporting but not in developing countries [19].

Most countries in Africa, Central Asia, Central America and the Near East can still only draw on a weak forest-related information base and data exchange, whereas forest monitoring and reporting are key features under ITTO, FOREST EUROPE, Montréal Process and Tarapoto/ITTO process activities. There are also collaborative efforts of some processes to jointly collect and compile data that enables comparisons across national borders. The underlying data are collected about every 5 years by ITTO and by FOREST EUROPE as a basis for regional, respectively international reports. The ASEAN Process collects data every second year and the Tehran Process for LFCCs collects data for some of its countries but not on a regular basis. Monitoring and reporting in the Montréal Process C&I is mainly national and is initiated every five years in most cases or more frequently.

Forest-related data availability has significantly improved but deficiencies still exist, particularly for social data, ecosystem services and non-wood forest products which are often not-commercialised, hampering their measurement and inclusion in the assessment of SFM. Data quality also varies considerably between countries and indicators and is dependent on steady improvements in data collection and reporting capacities in most countries.

To date, regional or international C&I based reports have been published by 5 out of 11 C&I processes. The Amazon Forest Tarapoto/ITTO Process and the Tehran Process have so far each published one regional report [46,47]. ITTO and the Montréal Process have already each published two overview reports, though the Montréal Process reports do not cover the whole range of indicators [48–51]. FOREST EUROPE has so far published four State of Europe's Forests Reports [52–55]. Many of the member countries from the other regional and international processes have reported forest-related data and information to UNECE/FAO and to the Global Convention secretariats (see Chapter 3.2) but have not been sharing more detailed information within their regional or international processes.

The FAO Forest Resource Assessment (FRA) is the main source of information on the state of the forests globally and has requested and reported forest-related information regularly since 1948. FAO introduced in 2012 a new Collaborative Forest Resources Questionnaire (CFRQ) partnership that consists of six organisations or regional and international processes: FAO, UNECE, FOREST EUROPE, ITTO, the Montréal Process and the Observatory of the Central African Forests Commission [56]. In 2017/2018 ACTO has been negotiating a Memorandum of Understanding with FAO that includes its support to also use the CFRQ to collect forest information for the Amazon region. The CFRQ is the successful outcome of the joint commitment of these organisations and C&I processes to streamline and harmonise forest-related data collection while decreasing multiple reporting burden that countries

face. The remaining regional and international C&I processes are not part of the CFRQ due to their different stages of development, particularly regarding harmonised data availability.

Data on forests and forestry collected collaboratively in the CFRQ or separately by the C&I processes serve as a comprehensive reference and information framework on the current state in relation to the fulfilment of the ecological, economic and social functions of forests and their sustainable management worldwide, in the various C&I processes and in single member countries.

3.2. Contribution of C&I Processes to Global to Local Initiatives

Today, indicators for SFM are again high on the political agenda and are applied not only by regional and international but also by a variety of global and national forest-related processes. They are also part of core discussions of sectoral processes, for example, EU sustainability criteria for bioenergy, European core health indicators, C&I for the New EU Forest Strategy or C&I for land use in the Climate Bonds Initiative. Thus, the interest in forest-related indicators is widespread.

3.2.1. Global Level Use of Forest Related Indicators from Regional or International C&I Sets

In addition to pressure from within the forest sector for improved and full-fledged monitoring and reporting of progress towards SFM for the Global Forest Resource Assessments and UNECE/FAO/FOREST EUROPE Reports, there is a need to supply forest related information to high level, multi-sector processes, notably the Millennium Development Goals and the subsequent Sustainable Development Goals (SDGs), the UN Global Forest Goals and associated targets towards 2020 or 2030 but also for the CBD Aichi targets, the UNFCCC Kyoto Protocol and Paris Agreement reporting and UNCCD, in a form which these broader systems can use: simple, objective and comprehensible. International NGOs and initiatives such as Global Forest Watch, WWF, IUCN, OECD, UNEP or the World Resources Institute are also involved in compiling data for forest-related indicators.

The United Nations Forum on Forests developed a non-legally binding instrument on all types of forests adopted in 2007 by the UN General Assembly. Table 2 lists the related four Global Objectives on Forests and seven thematic elements of SFM [9], which are based on the most common criteria of SFM of the various regional and international C&I processes. Based on the four Global Objectives on Forests, the recent UN Strategic Plan for Forests, 2017–2030 presents six, partly similar Global Forest Goals (cf. Table 2) and 26 associated targets to be achieved by 2030 and which support and contribute, among other things, to the achievement of various Sustainable Development Goals [57]. In this context, several provisions of the UN ECOSOC resolution 2015/33 *International arrangement on forests beyond 2015* [58] recognise the significance of the engagement of international and regional processes in the work of the International Arrangement on Forests and more specifically, the work of the UNFF, by fostering an exchange of experiences and lessons learned among countries, regional, sub-regional and non-governmental partners and the CPF, strengthening collaboration in order to facilitate the implementation of the non-legally binding instrument on all types of forests, including the achievement of its global objectives on forests, as well as to facilitate regional inputs to sessions of the UNFF.

Through their participatory development and application of C&I frameworks to SFM and through the lessons learned in doing so, the C&I processes contributed to reaching a global convergence for the related indicator implementation and stimulated the selection and the use of forest-related indicators for global reporting in the FAO's Global Forest Resource Assessments 2010 and 2015 and for the future reporting of the SDGs.

The Collaborative Partnership on Forests, an informal, voluntary arrangement among 14 international organisations and secretariats with substantial programmes on forests, conducted from 2016–2018 the compilation of a global core set of 21 internationally agreed forest-related indicators [59]. This set is intended, in a comprehensive way, to: (a) measure progress towards SFM, including target 15.2 of the SDGs; (b) measure progress in implementing the UN forest instrument, the UN strategic plan for forests 2017–2030 and the global forest goals and targets; and (c) measure progress towards

targets of the SDGs other than target 15.2 and other internationally agreed goals on forests in other instruments. The global core set addresses information needs of global forest-related processes in a balanced way across the different sustainability dimensions and includes also governance aspects addressing major forest-related issues. It is important to note that the global core set does not substitute the regional or international indicator sets but complement them for C&I use at global level [60].

FAO/UNECE supported the development of the Global Core Set and also already uses a core of several regional or international indicators for SFM to improve consistency in reporting on SFM and related assessments.

Table 2. Global requirements that were inspired by regional and international criteria for SFM.

Thematic Elements of SFM [9]	Global Objectives on Forests [9]	Global Forest Goals [57]
1 Extent of forest resources	1 Reverse the loss of forest cover worldwide through sustainable forest management, including protection, restoration, afforestation and reforestation and increase efforts to prevent forest degradation	1 Reverse the loss of forest cover worldwide through SFM, including protection, restoration, afforestation and reforestation and increase efforts to prevent forest degradation and contribute to the global effort of addressing climate change
2 Forest biological diversity	2 Enhance forest-based economic, social and environmental benefits, including by improving the livelihoods of forest-dependent people	2 Enhance forest-based economic, social and environmental benefits, including by improving the livelihoods of forest dependent people
3 Forest health and vitality	3 Increase significantly the area of protected forests worldwide and other areas of sustainably managed forests, as well as the proportion of forest products derived from sustainably managed forests	3 Increase significantly the area of protected forests worldwide and other areas of sustainably managed forests, as well as the proportion of forest products from sustainably managed forests
4 Productive functions of forest resources	4 Reverse the decline in official development assistance for sustainable forest management and mobilize significantly increased, new and additional financial resources from all sources for the implementation of sustainable forest management	4 Mobilize significantly increased, new and additional financial resources from all sources for the implementation of SFM and strengthen scientific and technical cooperation and partnerships
5 Protective functions of forest resources	-	5 Promote governance frameworks to implement SFM, including through the UN Forest Instrument and enhance the contribution of forests to the 2030 Agenda
6 Socio-economic functions of forest resources	-	6 Enhance cooperation, coordination, coherence and synergies on forest-related issues at all levels, including within the UN System and across CPF member organizations, as well as across sectors and relevant stakeholders
7 Legal, policy and institutional framework	-	-

3.2.2. National Level Applications of the Regional and International C&I Sets

In all regional C&I processes some if not all member countries have adopted the regional C&I sets, or national variants thereof, through government-led initiatives. The C&I sets are viewed as an efficient framework for policy dialogue and communication and a means to collect, store and disseminate reliable and scientifically-based information on forests and forestry in order to monitor and assess the state of forests and the sustainability of forest management [12,61–65].

There are national C&I reports from all Montréal Process member countries but harmonising the reporting for a joint publication is not a priority of the Montréal Process. The pan-European C&I set was the basis for the subsequent development of harmonised reporting and national C&I sets in about half of the FOREST EUROPE member states. Five more countries intend to develop or are presently developing national sets. All ITTO member countries are requested to report their progress towards SFM based on C&I. Thirty-two countries submitted a respective report in 2010 [49].

Some of the Amazon-ACTO/ITTO C&I are applied in four of eight member countries. The C&I of the Dry Forests in Asia Regional Initiative were implemented only in India. The NENA C&I set was adapted and adopted in Lebanon and Egypt with the support of FAO. Also, Tunisia and Morocco are applying the NENA set. Due to the difficult political situation in the Near East and in North Africa further implementation is challenging. Nationally derived C&I sets of the Tehran Process exist so far in Iran and in 7 more low-forest-cover-countries but the Tehran Process is so far lacking coordinated financial support to increase implementation in all 56 low-forest-cover-countries. The adopted ATO/ITTO C&I set has been used in Ghana for auditing forest management and in Gabon to improve concession management. Mainstreaming efforts into an overarching monitoring framework as a basis for national reporting has been difficult in the twelve ATO/ITTO countries. A recent FOREST EUROPE survey confirmed that indicators for SFM were considered to be among the three most important achievements of FOREST EUROPE [62]. ITTO [66] even argues that C&I for SFM are the most important and innovative policy instrument for operationalising the SFM concept on national level. However, particularly in some developing countries and due to a lack of resources, national C&I processes may not be well-developed or applied.

National level forest-related reporting is also requested under a number of international conventions like UNFCCC, UNCCD, CBD, goals like the SDGs and organisations like OECD. SDG 15, for instance, consists of indicators used by most C&I processes and many C&I processes have incorporated indicators from the reporting on the global conventions, like carbon sequestration.

3.2.3. Local Level Use of Forest-Related C&I

Regional and international C&I for SFM processes have also inspired a range of private sector, market-based and public-private initiatives to set forest related targets and to monitor and report on SFM in order to eventually seek certification of forest products [15,20,64,67].

SFM certification schemes are market-driven instruments employing C&I at the FMU level to improve market access for forest products and for legality and proof of compliance of forest products [20]. Among the various certification schemes, there are two globally dominant schemes, the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). However, only PEFC has widely taken up regional C&I for SFM as basis for their framework. The FSC principles and standards comply with C&I for SFM even if these are not explicitly linked. The implementation level of C&I differs between regional or international processes and C&I-related forest certification schemes. C&I in regional and international processes are used among national governments to monitor and exchange information on their implementation of SFM and to identify issues to be tackled, while forest certification schemes use C&I to compare compliance of forest management in the management unit with C&I for SFM and to establish proof of SFM in the marketing of forest products. The market-driven character of certification is also reflected in the spatial distribution of its implementation, while 85% of internationally verified certification takes place in the boreal and temperate climatic domains, the certification coverage in the tropics is sparse with merely 6.3% [68].

Local level public indicators for sustainable forest management units, community forest land and concession areas depend on local, small scale and often site-specific environmental factors, such as forest types, biotopes, topography, local economic and social considerations as well as priorities and national laws. Thus, these local level indicators may differ between various forest areas in a country, in accordance with prevailing conditions, priorities and objectives of SFM and they may not be fully compatible with regional, international or national indicators for SFM. But the criteria used at the FMU level are often identical or very similar to those defined at regional, international or national level, even if the specific indicators differ.

Applications of C&I for SFM at the local level may face challenges for various reasons including the fact that they are often top down in their development, failing to consider local conditions and traditions developed by communities to monitor the sustainability of their forest management. This has implications also for forest management plans (FMP) as the main tool for SFM implementation at the local level. For instance, underestimation of social aspects of SFM by excluding local communities from the FMP preparation process in Nepal resulted in a large number of FMPs having lapsed, meaning that communities were not legally able to harvest forest products [69]. The importance and value for locally developed C&I is not covered much in the literature [69–71]. However, the examples found on C&I use on local level [72–75] imply that C&I are a very flexible tool that can be adapted to particular circumstances and needs [15].

3.3. Common Achievements of C&I Processes

Over the past 25 years, the regional and international C&I processes analysed in this paper have developed C&I for SFM as powerful tools, which are well-known—at least within the forest sector—for having a central role in the implementation of SFM. The main achievements of C&I processes lie in (i) contributions to SFM implementation in general, (ii) improving information tools about forests and forestry and (iii) facilitating stakeholder participation (Table 3). Related improvements in individual C&I processes might be still necessary.

Table 3. Common achievements of regional and international C&I processes.

(I) Supporting SFM Implementation	(II) Improving Information Tools	(III) Stipulating Stakeholder Participation
(Ia) Global understanding of what constitutes SFM	(IIa) A vehicle to foster national political processes on SFM as indicators help package complex information into a neutral and usable form for public policy	(IIIa) Possibility of engagement of all forest-related stakeholders (environmental NGOs, timber industry, hunting, recreation, science, ...)
(Ib) Global convergence in the understanding of C&I for SFM	(IIb) A common terminology/language to overcome conflicts, for example, forestry vs. environmentalists and hence support consensus-finding	(IIIb) support interactive definition of SFM objectives, goals and priorities
(Ic) Establishment of appropriate forest monitoring and other data acquisition procedures	(IIc) Streamlined, expanded and structured forest reporting	(IIIc) Integration of science into the political debate towards more evidence-based policy making
(Id) Increased transparency and accountability of data provision	-	-
(Ie) Basis for the derivation of national, local and FMU level C&I sets	-	-

3.4. Shortcomings in Regional and International C&I Efforts

The regional and international C&I processes have made significant progress in developing and implementing C&I for SFM within only 25 years but they were also facing numerous challenges. The following issues have been partly raised in the early stages of C&I for SFM development [6,14,43,44,76] and many of them are still prevalent [12,13]. However, they are in most cases attributable to national implementation processes rather than the regional or international C&I processes themselves.

At the regional or international level, the results reveal shortcomings in capacities for secretariats regarding funding and coordination, weak harmonisation of national terms and definitions and reliable indicator interpretation in a regional or international context and the production of comprehensive regional or international overview reports (except for ITTO, FOREST EUROPE and the Montréal Process).

It appears that problems with proper C&I implementation especially occurred at the national level, where C&I application is related to the feasibility in monitoring and reporting. We see a diversified picture as regards implementation of C&I among countries within and between the various processes with a wide variation in quality of adaptation of the regional or international C&I sets to the national

level: The existence of political will and strategies to further promote C&I are crucial, if missing, leading to insufficient funding, low data availability, lack of expertise and trained personnel, lack of effective promotion and no inclusion into policy- and decision making processes. Missing guidance on how to extend more general and large-scale C&I approaches to smaller spatial scales and how to link them to national policy instruments can also create bottlenecks to achieving national and local levels of C&I implementation. The fragile political situation might also limit C&I uptake in some low-forest-cover countries or in the Near East and in North Africa (NENA region). As one of the responses, FAO/UNEP organised various regional process workshops and other follow-up activities, to facilitate commitment, funding and capacity-building for national C&I implementation, with varying success.

Finally, conceptual and structural shortcomings can be found. This is particular true in cases where the C&I sets are too static in their temporal dimension and fail in their ability to serve as provider of trends, emerging issues and warning signals of adverse developments. The assessment feature of C&I (i.e., to allow for a judgment whether SFM performance develops in a positive or negative direction) is reported to be underdeveloped [12,13]. This would require a stronger and more systemic link between C&I and clear SFM objectives, which is often not the case in political processes staying vague in the details. Hence, it is inherent that some C&I might stay at the symbolic level (cf. [30]), where they measure something that has tangential importance for SFM, because data are available, or special interests of stakeholders are depicted. Regular revisions of C&I system are hence important to cross-check the usefulness of earlier developed sets, their state-of-the art and their responsiveness to new, emerging issues.

4. Discussion

Eleven forest-related intergovernmental C&I processes were initiated following UNCED 1992, where SFM in general and forest decline and forest dieback in particular were major concerns for policy makers and society at large. Two thirds of the processes were from the very start driven by the engagement of their member states, one third needed major support and input from FAO and other organisations to initiate and keep the process going. All processes developed regional or international C&I sets within the first decade after the UNCED that are mostly similar with regard to the criteria used. However, they differ in the amount and kind of indicators used because ideas about sustainable management are not universally applicable but depend on various socio-political meanings and environmental dynamics that depend among others on context-specific attributes like ecozones, culture, values of forests and livelihoods. These differences are important and emphasize the regional or forest-type related focus (e.g., boreal, temperate, tropical, dry-forests) as opposed to generic information, which is regularly collected by the FAO. Thus, a region or forest-type specific orientation is expedient and should belong to every set. The Montréal Process presents an exception to this observation but part of the Montréal Process's success lies in its flexible approach to applying its C&I framework, allowing for better accommodation of the boreal zone and national level conditions but at the same time complicating cross-country comparison. In any case, a core of globally relevant and comparable indicators should also be part of each regional or international C&I set to ensure global comparisons and overviews.

Active national participation and true stewardship can only result from commitment to the regional or international C&I process, an active regional or international coordination unit and related national implementation. Therefore, it is seen substantial to actively involve the member states in C&I processes.

Only about two-thirds of the regional and international processes have revised their sets since their initial development. Accordingly, the efforts in the C&I processes have reflected changes in the perception of forests, focusing nowadays more on economic and social values of forests and forestry and on comparative reporting on SFM. National forest inventories as major data providers for forest-related indicators need to be complemented by new technologies like remote sensing and

new aspects via public opinion and cross-sectoral surveys. This shall help to overcome limitations of in-situ measurements and to obtain information on social values and priorities. Care has to be taken that non-traditional measurement types are compliant with existing approaches for data analysis and interpretation.

Also, sustainability assessments have gained increasing attention recently but the underlying approaches are not yet widely acknowledged. In this regard, the shortcomings listed in Chapter 3.4 are numerous.

It has to be stated that C&I frameworks alone cannot drive attainment of SFM—this requires concrete actions in the form of regulations, incentives and voluntary compliance with SFM guidelines. However, knowledge of the state and trends in management and forest conditions as well as system interactions is essential for informing these actions and the policies that support them. The crucial question of if and how, the C&I processes have positively impacted SFM is complex. In a subsequent paper, we examine impacts of the intergovernmental processes and their C&I sets on (1) enhanced discourse and understanding of SFM, (2) increased engagement of science in SFM, (3) improved monitoring and reporting on SFM to facilitate transparency and evidence-based decision-making, (4) strengthened forest management practices, (5) facilitated assessment of progress towards SFM goals and (6) improved forest-related dialog and communication [23]. Most activities have remained within the forest sector and have found little resonance outside the sector where a general lack of interest by policy makers and society at large prevails. Therefore, the continued work within the various C&I processes will only be effective if they support broad participative stakeholder processes including mutual learning by providing the users of the C&I sets with information they need to know in a form they can understand and relate to. Shields et al. [7] refer in this regard to the “communication challenge”.

With regard to the national implementation of the regional and international C&I sets, it is apparent that for some countries the regional and international C&I are much more symbolic than practically used and are not implemented as an institutionalised system. An important reason for this may be that the process of identification and selection of indicators is dominated by technical and scientific interests but the implementation, monitoring, reporting and evaluation of resulting data are the responsibility of the political and managerial sector. McCool and Stankey already mentioned in 2001 that resolving such systemic impairment requires basic changes in the technical and behavioural systems and a well-functioning coordination [6]. This still needs more consideration by the C&I processes and its member countries.

5. Conclusions

In the past 25 years of C&I for SFM development within various regional and international forest-related C&I processes multiple common achievements have been reached: After an intensive period developing regional and international C&I sets, these sets have been applied in 171 developed and developing countries, in both hemispheres and in all ecological zones facilitating monitoring, reporting and assessment of SFM. Nevertheless, the application of C&I for SFM is uneven across these countries. Some regional processes have no active liaison units and have given up their coordination tasks, waiting for further impetus from FAO and other donors. In such cases, national implementation and related monitoring, reporting and assessment of SFM is low.

Data on at least some indicators are available for 234 countries [77], whereas only 112 countries were conducting forest inventories [19]. Based on this, the regional and international overview reports of FOREST EUROPE and ITTO as well as the FAO Global Forest Resource Assessments allow basic overviews on SFM even for regions without any active regional C&I for SFM coordination. However, comprehensive SFM assessments require comprehensive information on the C&I for SFM set.

The regional and international C&I processes, their C&I for SFM sets and their related reports mainly contributed to a common understanding and language for SFM and to the establishment of C&I based monitoring systems with extensive related databases in some countries and at

UNECE/FAO [77,78]. They offer a potentially helpful means for further harmonisation and for further improving monitoring and decision-making from the global to the local level.

C&I for SFM are now also increasingly adapted to address sustainable development issues across other sectors like bioeconomy, green or circular economy, or climate change. Despite the many limitations of intergovernmental C&I processes, regarding particularly their national implementation, the forest sector is nevertheless a global leader in the development and use of C&I for sustainable management of forests, as part of natural resources, for instance also proving a head start for reporting on the forest-related SDG 15.1.1 and 15.2.1 [79]. The C&I for SFM frameworks and the resulting comprehensive sustainability thinking were also role models for the sustainable management of other natural resources. But this leadership could be even better recognised within the forest community and related decision-makers and stakeholders, as well as by other sectors. C&I for SFM are also the basis of the recent Collaborative Forest Resources Questionnaire of the Central African Forests Commission, FAO, FOREST EUROPE, ITTO, Montréal Process and UNECE. The questionnaire was issued in March 2018.

Overall, the analysis shows a favourable trend of C&I for SFM applications all over the world, which will help ensure forests remain a well monitored part as basis for sustainable decisions about our common future. On the other hand, it seems difficult for the forestry community and the forest-based sector to reach out with information and messages on forests beyond their realm. C&I in the context of forestry tend to be a very sectoral tool that faces difficulties to reach a broader audience on progress towards SFM. This might be a matter for more advanced information campaigns, where C&I can be employed more broadly and might be adjusted towards key parameters and information requirements.

5.1. Prerequisites for Success

The C&I processes reviewed in this paper show some notable successes over the past 25 plus years that they have been used but there have also been some setbacks.

Since the regional and international C&I sets reviewed in this paper rely on an extensive set of data and analyses describing ecological, social and economic dimensions of sustainability, they entail a concomitant large reporting burden and thus a large commitment on the part of national agencies charged with producing the reports. Moreover, much of the data used in the reports comes from outside sources (e.g., forest inventories, national censuses, economic data on wood products, production, trade) and this means that reporting activities have to rely on a much broader data infrastructure than that controlled by national forest agencies. These factors mitigate against sustained implementation of C&I reporting functions, especially in less-developed countries with limited resources. Nonetheless, to the extent that SFM C&I reporting is viewed as a process of continuous improvement, data shortcomings need not be an obstacle—countries can simply report out on the data they have, note gaps and look for solutions to complete relevant information for the next reports.

Success, of course, means more than data availability. It requires both conceptual and operational development to overcome specific shortcomings [13,30]. The first category includes ongoing political and institutional commitment, true stewardship, a coordination unit, a clearer derivation from political goals, broader communication instruments, capacity building and better linkages to official statistics and other sectors' sustainability approaches. The latter requires efficient tools for monitoring, analysis and reporting, harmonised terms and definitions and means of SFM assessment as well as the modification of policy and management actions in case that unsustainable forest management is indicated in the reports.

For the future activities of the forest-related C&I processes, the work with criteria and indicators and their resulting reports, a suite of ingredients for success can be distilled from the genesis and outcomes of the forest-related C&I processes (Table 4).

Table 4. Success factors for C&I implementation.

For the Regional and International Level	For National Applications
Indicators need to be responsive to emerging developments in economy, society and environment and connect actual information as well as past states with prospective, forward-looking elements	A national strategy to enable a sustained implementation process of the regional or international C&I set developed.
Efficient data collection, including joint questionnaires, online reporting tools	Political support for forest monitoring and reporting according to C&I.
Collaboration in harmonising the underlying definitions and data within a C&I process, between the C&I processes and with the requirements of the FAO Global Forest Resource Assessment (FRA) and the Collaborative Forest Resources Questionnaire (CFRQ)	Sufficient underlying data and data generating infrastructure
	Other data acquisition and reporting mechanisms for information beyond forest inventory (e.g., ecosystem services, value of non-wood goods and services, recreation)
Co-ordination and collaboration (i) within C&I processes, (ii) between C&I processes and (iii) between C&I processes and international processes and organisations with regard to harmonisation, data storage and reporting.	
More innovative presentations of information and meaningful stories based on C&I to share with colleagues, stakeholders, broad interested public and decision-makers.	
Marketing of regional, international and national forest reports (i.e., developing an improved understanding how decision-makers, forest administration, forest managers, stakeholders and other sectors are target groups for which these reports need to be specifically tailored).	

5.2. Outlook

In the decade after the UNCED in Rio in 1992, the forest sector and forest management were dominated by the “wood-based” products industry and forestry activities related to these. At the same time, public opinion and high-level policy discussions were strongly influenced by environmental NGOs and the “green” movement. In the second decade of the 21st century, the major focus is now on the protection of forests and their protective functions, on securing local livelihoods, on adaptive management to provide diverse ecosystem services, as well as on the diversification of the forest-based sector to serve the needs of a bioeconomy. Thus, indicators need to be responsive to emerging developments in economy, society and environment realms and connect actual information as well as past states with prospective, forward-looking elements. Impact assessment tools could be enhanced and employed in a common forest-related indicator framework in this respect.

Indicators have so far also been mainly used on a rather technical level for information and decision-making within the forest sector. However, indicators for SFM could be increasingly used to communicate and provide information to a broader public and to other sectors (like biodiversity, climate change mitigation, bioeconomy, energy) [23] as well as supporting new forms of information sharing. New approaches, such as key or headline indicators and subsets of indicators, should be applied to satisfy these needs.

Also with regard to new global challenges, market developments, emerging trends and the changing and diversifying forest sector and the implications that these changes have on forest resources and forest-based products, the C&I processes need to be responsive with revisions leading to novel forest-related indicators in the future. However, the basis has to be a flexible concept. It is not useful to develop static sets, which are outdated within a few years. It is indispensable to continue work on core indicators if SFM trends over time are to be understood properly.

Supplementary Materials: The following are available online at <http://www.mdpi.com/1999-4907/9/9/515/s1>, Figure S1: Allocation of indicators from the C&I processes to criteria/thematic elements., Figure S2: Allocation of indicators to criteria/thematic elements in each C&I process, Figure S3: Allocation of quantitative indicators to SFM related issues in the C&I processes, Figure S4: Allocation of quantitative indicators from C&I processes to SFM related issues, Figure S5: Allocation of qualitative indicators to selected SFM related issues, Figure S6: Allocation of qualitative indicators of the C&I processes to SFM related issues.

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Abbreviations

ACTO	Amazon Cooperation Treaty Organization
ASEAN	Association of Southeast Asian Nations
ATO	African Timber Organization
C&I	Criteria and Indicators
CBD	Convention on Biological Diversity
CFRQ	Collaborative Forest Resources Questionnaire
CIFOR	Center for International Forestry Research
CPF	Collaborative Partnership on Forests
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMP	Forest management plan
FMU	Forest management unit
FRA	Forest Resource Assessment of the FAO
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
LFCCs	Low-Forest-Cover-Countries
MS	Member states
NENA	Near East and North Africa
NGO	Non-Governmental Organization
OECD	Organization for Economic Co-operation and Development
SDG	Sustainable Development Goal
SFM	Sustainable Forest Management
TP	Tehran Process
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNCCD	United Nations Convention to Combat Desertification
UNFF	United Nations Forum on Forests
WWF	World Wide Fund for Nature

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