3. The conceptual basis of the pan-European criteria and indicators for sustainable forest management

3.1 C&I: genesis and requirements

The development of sustainability indicators as a basis for decision-making processes has been called for by the Agenda 21. These indicators are intended to serve as instruments for measuring progress towards reaching the goal of sustainable development.

Generally spoken, indicators help measure trends, monitor changes, and support assessments. Sustainability indicators in particular should create meaning and give information about the interlinkages between human, economic and environmental systems. Such indicators *"offer an understanding of how human actions affect different dimensions of sustainability (economy, environment, social issues)"* (Rametsteiner et al., 2011). The sustainability dimensions are based on normative principles, which build a reference frame for C&I. Among these are the principles of common but differentiated responsibilities, inter-generational equity, intra-generational equity, justice, participation and gender equality, as well as boundary definitions e.g., of the forest or the forest sector.

Several organizations and governments have issued sets of sustainability indicators by now: for instance the United Nations Commission on Sustainable Development (CSD) presented its first set in 1995; in the context of the European Union a set of sustainable development indicators have been launched in the beginning of 2000 and have been refined in 2007. In the wake of presenting sustainability strategies, some countries have also developed indicator sets – some are detailed, while others are less specific. Sector-specific sustainability indicator sets have also been put forward – for example, for forestry by the Ministerial Conference of the Protection of Forests in Europe (MCPFE), and for the agricultural and transport sectors led by the European Environmental Agency (EEA). More recently, indicators have been employed in a variety of impact assessment tools (Ness et al., 2007). The EU Commission has been fostering the approach of Sustainability Impact Assessment (SIA) to overcome sectoral boundaries by identifying potential impacts of policy actions and support policy and decision-making processes in the context of sustainable development (EC, 2002).

Whatever C&I approach or scheme is followed, in principle C&I for SFM are applied on three different levels: (a) international and national, (b) sub-national/local, (c) forest management unit. Implementation on all three levels is deemed important (Wijewardana, 2008). Furthermore, C&I have been used to a certain extent with different purpose in marked-based certification instruments (Rametsteiner and Simula, 2003). All these levels face heterogeneous expectation and claims. C&I have to achieve a balance between system validity and reducing complexity. They need to condense key information in an understandable and communicable way as a form of constructed knowledge, while maintaining reliable and sound information on ecological, economic, and social aspects, which interact with each other, and can be furthermore related to the goals of sustainable management (Linser, 2001).

Against this background, a lot of demands are put on C&I from the conceptual point of view. From a procedural point of view two main aspects are important: (a) definition of indicators (i.e., which content?), and (b) selection of indicators (i.e., who decides,?) (Rametsteiner et al., 2011).

In terms of *which content?,* the initial definition of indicators, frequently used are the following six aspects (Rametsteiner et al., 2006):

- Relevance for sustainability: in theory, the framework of environmental, economic and societal indicators determines to what extent the system dynamics and behaviours underlying sustainability (and in effect, sustainability impact assessments) can be captured and understood. Sustainability indicator sets are supposed to address those three dimensions.
- Compatibility with existing sets: a range of relevant sustainability indicator sets are already

available, both within scientific and political contexts. Consistency with the relevant existing sustainability indicator sets (sector-specific and general frameworks) with respect to themes and issues could enhance its political relevance and acceptance.
- Relevant measures: indicators are supposed to provide relevant measures reporting towards the goal of sustainability. This relevance may differ depending on the geographical scale on which they are applied.
- Availability of data: indicators shall benefit from adequate data availability within the appropriate spatial scale and they are supposed to be based as far as possible on already existing data so as to be able to use existing competency in maintaining data sources and interpreting indicator values.
- Technical feasibility and scale: indicators are to be selected according to their practical applicability on the various geographical scales.
- Affordable cost of indicator application: the cost of data collection has to be taken into account when selecting indicators to keep costs at feasible levels.

In terms of *who decides?*, the selection of indicators is both a scientific and a normative process (Rametsteiner et al., 2011). Hence the following two factors of analysis for the actual selection of indicators are to be investigated:
- Actors: indicator sets are developed in both a political and scientific context, where policy makers, scientists and the wider public are involved or not involved. This has been discussed in the literature as making choices at the interface of science and policy (McCool and Stankey, 2004). Ideally, there is consensus on the objectives of C&I before their design.
- Decision-making mode: hierarchical or consensus-led decisions are taken during indicator selection. Consensus-led decisions are not easily acceptable for scientists (Rametsteiner et al., 2011) as they are neither facts-oriented nor based on scientific reasoning.

Furthermore the following aspects are relevant (see also Wedeles and Williams, 1999; Duinker, 2001):
- Reference: C&I must be based on a central reference to prove legitimacy and goal compliance to cover the underlying value scheme.
- Validity: C& I should measure what they intend to measure, and do this in a consistent and reproducible manner including terms and definitions, measurement units and measurement procedures. In particular, proxy and surrogate functions need to be clarified and explained a priori.
- Sensitivity: C&I must be able to react to and display changes of systems to properly document and inform on these variations.
- Goal context: C&I only fulfill their full potential when there is a clear goal reference, i.e. to interpret a change of indicator value and the direction thereof. This is precondition for any indicator-based assessment and operational link to policy- and decision-making.
- Communication: C&I should not only be understandable for scientists and expert but entail a broader public for the communication and explanation of SFM issues.
- Prognoses and trends: C&I should be designed to depict trends and to create not only ex-post descriptions, but also ex-ante prognosis to be used as prospective planning and policy-making tools.

The validity of these claims vis-à-vis the pan-European C&I will be tested in this report.

3.2 C&I development

Recently, the process of indicator development itself has been increasingly put into the spotlight (e.g., Rametsteiner et al., 2011). Indeed, the question of indicator development seems to have shifted to a procedural debate when designing indicators (Hezri and Dovers, 2006). A proper development process is crucial for transparency, comprehensibility and acceptance of indicator-based systems. There is a strong notion that information management in sustainability issues is a complex social task rather than a technical, purely scientific process (Spash and Vatn, 2006), and that indicator development should relate to political-social systems in terms of participation and science-stakeholder interaction (McCool and Stankey, 2004). Spangenberg (2008) proclaims an iterative indicator development process incorporating both scientific experts (for scientific input and steering) and stakeholders (for judgments and advices). A particular advantage of such an approach is that user needs and methodological gaps in addressing the SFM problem can be identified and clarified together with stakeholders and decision makers.

In general, a dichotomy can be observed between science-driven and policy-driven indicator processes (Rametsteiner et al., 2011). They can both be driven by bureaucrats involved in a specific area, as well as include policy makers, scientists and citizens. However some indicator sets are more scientifically driven (e.g., Sustainability Impact Assessment) and involve policy makers only on the side; other development processes are more policy-driven and involve scientists mainly in their expert function (e.g., MCPFE, EU-Indicators and EEA). Citizens and stakeholders usually participate only to a very limited extent or are not involved at all. Following the normative aspect underlying the sustainability concept (as outlined above), participation is strongly connected to the idea of democratic practice.

The indicator literature highlights the need to better understand and structure the development process as such (e.g., Niemeijer and Groot, 2008a; Cimorelli and Stahl, 2005; Niemeijer 2002). Some authors have outlined more technical approaches to sustainability indicator development to be followed (e.g., Niemeijer and Groot 2008b; McCool and Stankey, 2004; Failing and Gregory, 2003; Reynolds et al., 2003); others (Pülzl and Rametsteiner, 2009; Rametsteiner et al., 2011) have pointed out that the participation aspect is crucial for the norm creation and knowledge production process that both underlie the development of sustainability indicators. This also implies that there is a shift from developing mainly technically–based indicators towards designing hybrid instruments involving "multi-objectives" and "multi-stakeholder" perspectives (Journel et al., 2003). In terms of decision analysis, decision-making does not only require empirical facts and data but also information about values as well as a proper process for integrating facts and values (Gregory et al., 2006). Besides fulfilling the requirements of proper measurement, validity and significance there is strong demand for an enhancement towards supporting decision-making in an integrated manner. Hezri and Dovers (2006) state that sustainability indicator frameworks often hide their nature that they are also political tools. Hence, a clear definition of the purpose of those sustainability indicators and the roles that scientists and policy makers play in their selection and use is needed (McCool and Stankey, 2004). This incorporates strong emphasis on participation and transparency both within the development process and its implementation (Pülzl and Rametsteiner, 2009).

Approaches and conceptual ideas on how to structure the indicator development process, especially for natural resource use and management indicators have been proposed by several authors (Niemeijer and Groot, 2008a; Wilson et al., 2007; Donnelly et al., 2007; Hezri and Dovers, 2006). In this regard, Rametsteiner et al. (2011) highlight that the decision of "who participates and decides" during the indicator development process is more important than the technical aspects on how to develop them. Both substantive expertise as well as balanced interest representation are essential. They present two conceptual frames that could be followed during the development process. Those two models are either focusing on information and knowledge production or on norm creation during the design process (Table 4).

While the knowledge production frame is driven by the search for scientific, technical objective and sound knowledge, the norm creation frame puts an emphasis on balancing norms, values as well as interests. Scientists from the natural and social sciences as well as experts (e.g., bureaucrats) are involved in the knowledge production framework; citizens or their substitutes (e.g., democratically elected politicians, diplomats or other civil servants) are involved in the norm creation framework. Ideally those scientists and experts identify the best available knowledge, while citizens and politicians opt for the best possible reflection of norms, values and try to find a balance between interests. Ideally, approaches from a range of disciplines guide the science, while on the other hand democratic voting (e.g., by consensus) guides the work of the politicians and citizens. Finally the knowledge production frame puts an emphasis on a 'truthful' representation of human-system and eco-system interactions, while the norm creation frame puts an emphasis on the expression of democratically legitimized preferences on the values of nature as well as on a reconciliation of inter-generational and intra-generational equity.

Both, information/knowledge production and norm creation frames are to be encountered in sustainability indicator development processes.

Table 4. Characteristics of the two main frames for sustainability indicator development processes (Rametsteiner et al., 2011).

	Knowledge production	Norm creation
Background and input	Scientific / technical objective knowledge	Norms, values and interest
Actors	Scientists, experts	Citizens or their substitutes (democratically elected politicians as representatives)
Ideal-type knowledge application	'Best available' reflection of factual knowledge	'Best possible' reflection of societal norms, values and interest
Ideal-type process	Scientific methods of disciplinary, inter-, multi- or trans-disciplinary science	Democratic voting/consensus formation
Outcomes	'Truthful' representation of human system-ecosystem interaction	Democratically legitimized preferences on values of nature, inter- and intra-generational equity

What varies is the degree to which these two are balanced (or not), and how these two interplay with each other. These two ideal-types come in different forms: on the one hand they may be completely separate domains of knowledge production and norm- creation, and on the other hand they may be integrated. in that regard they appear to follow an 'integrationist idea', where knowledge production and norm creation are merged, and the role of different participating actors at times is indistinguishable.

3.3 Indicator systems as logical frameworks

We have seen earlier that C&I are in principal requested to be multi-functional, multi-disciplinary, and analytic.

Accordingly, the shaping of indicators may vary in the type of information they carry (e.g., statistics, modelling results, expert estimations), type of data (quantitative or qualitative), type of aggregation (single aspect vs. composite index) as well as in geographical (global, national, regional, forest management unit) and time scales (state vs. continuous, short-term vs. long-term) (Rametsteiner, 2001). All these arguments imply that there is a conceptual framework underlying the use of any C&I that specifies structure, purpose, and modes of implementation as well as means how to synthesize information carried by indicators to an overall interpretation of SFM.

However, it has been suggested that international C&I schemes generally lack a coherent conceptual framework (Grainger, 2012), which is inter alia due to:

- Difficulties in fully capturing interdisciplinary concepts and design;
- Variation between scientific concepts and negotiation outcomes in political processes;
- Terms and definitions, consistency are better agreed upon on Principle level than on C&I, so Work on C&I is often kept separate from the political process due to terms and definitions designed on general, overarching level;
- C&I sets tend to accumulate parameters in order to satisfy various claims – this leads, however, to huge amounts of parameters and data collection of C&I sets that are not coherent in themselves;
- Consequently, only one-third of indicators may be ready for instrumental use in a narrow understanding of SFM, while symbolic and redundant use is overly abundant.

It comes as no surprise that systemic and analytical features have not been fully developed in most international C&I schemes. For instance, there is missing link from criteria to SFM pillars (economic, ecological, social), and little conceptual understanding on how these criteria interact and can be thematically clustered.

A second example is the missing interaction between quantitative and qualitative policy indicators, which bear the potential to more systematically understand the human-nature interaction in the context of SFM.

Further, while SFM in principle acknowledges that there are potential conflicts among land users, land-use forms, environmental and societal interests, these trade-offs are not explicitly addressed by C&I. Mostly, international agreements remain uniformly vague with regard to preference and trade-off statements towards competing forest functions and interests (Lowe, 1995).

From the structural point of view, increasing experience in assessment and analysis of indicators has shown that listings and hierarchical arrangements of C&I reflect but a partial view on the complex nature of SFM combining ecological and human systems under a common umbrella (Kelly, 1998; Prabhu et al., 2001). Furthermore, an indicator set should be sufficiently balanced to give a reliable picture of a planning problem. It has been observed that indicator sets are often imbalanced and weak in social and cultural aspects (Gough et al., 2008) as well as in issues of vague importance in every-day forestry business such as water protection or nature conservation (Hickey et al., 2005).

Indicators are often arranged in indicator systems in order to enrich problem perspectives and systemic understanding. The building of indicator systems or models means that singular approaches are not sufficient because there is need for the analysis of linkages among indicators, checks for plausibility, and for analysis of changes in the system (Kelly, 1998).

Following this argument, indicators should be designed for considering their potential interactions and feedbacks within a given set. This would help to provide more insight into systemic cause-effect relationships and – by identifying key processes and indicators – help to make data collection and analysis more efficient (Requardt, 2007).

Considering the state-of-the-art, it can be observed that methodological approaches to consider networks of indicators are still scarce in the field of natural resource management. Among few examples, causal networks of environmental/ecological indicators have been highlighted by Niemeijer and de Groot (2008a,b) and Lin et al. (2009). In sustainability issues, network approaches have been demonstrated for forest policy (Requardt, 2007) and local level indicators (Mendoza and Prabhu, 2003; Wolfslehner et al., 2005). Most recently, Wolfslehner and Vacik (2011) demonstrated the methodological implications of arranging the 35 quantitative MCPFE indicators in three different types of indicator models (hierarchical decomposition linkages, relationship linkages, cause–effect linkages) (Figure 2). The analysis showed that the significance of indicators in networks methods is strongly affected by the structuring procedure and depends on how cause–effect relationships are interpreted. A clearer definition of these linkages will reduce 'unwanted noise' in assessments due to redundancies of interactions among indicators and lead to clearer and less ambiguous interpretations of causal relations.

However, Grainger (2012) raised concerns about using given C&I sets for purposes for which they have not been designed. Since the nature of most international C&I schemes is that they are mostly accumulations of forest-related information, the question is whether we can employ them at all in system-analytical and assessment procedures.

3.3.1 Assessment: towards advanced use of C&I

Glück stated already in 1995 that a central problem of the MCPFE SFM process is the absence of thresholds, weights and aggregation rules to make an indicator set applicable and expressive. In fact, there has been little progress to date in employing C&I as assessment tools. Reporting indicator by indicator on collected data renders C&I mainly descriptive, while giving little insight into the overall progress towards SFM. To proceed beyond the formulation and planning phase of SFM initiatives it is of prime importance to develop practical recommendations to evaluate impacts and outcomes of SFM and to transfer SFM implementation from political negotiation to the practical and technical level. There are growing expectations that policy

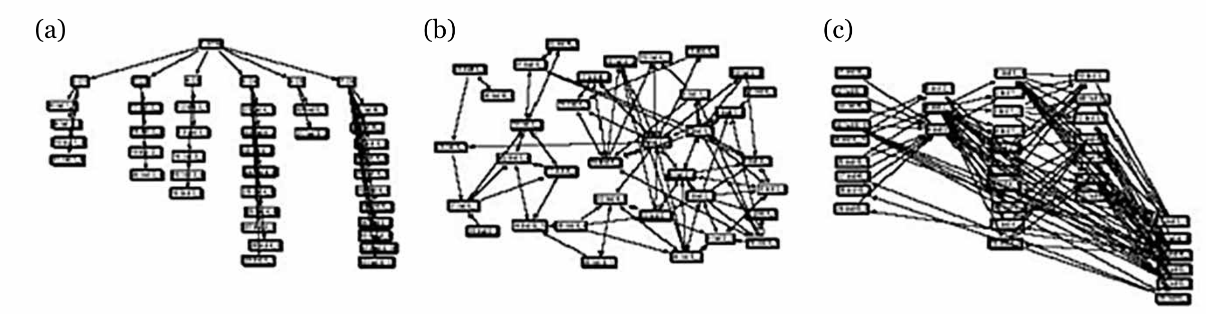

Figure 2. (a) Hierarchical C&I, (b) SFM network, (c) DPSIR (Driving force, Pressure, State, Impact, Response) system of pan-European SFM indicators (Wolfslehner and Vacik, 2011).

makers and forest managers can demonstrate SFM by quantifying progress towards goals and outcomes (Raison et al., 2001).

Conceptually, assigning a new key role to indicators in sustainability assessment puts an extra-burden on them. Whereas (sustainability) assessments have been equivalent to collecting and reporting information only, an integrated assessment means integrating this information into various stages of the decision-making process (Lee, 2006). Linking information to decision-making in a consistent manner is thus deemed a crucial function of sustainability indicators (Searcy et al., 2005).

Hence, a series of processes is needed to prepare both collected and generated data and create knowledge out of data. This entails spatial and temporal scaling of heterogeneous data to common scales, a comparative consistency check, and where appropriate synthesising information from a variety of sources. The latter point may be important to simplify and merge huge amounts of parameters, to eliminate redundancies in the data and to convey comprehensible information. This could also include a unit transfer from technical parameters towards commonly known and understood measures.

When considering indicators as assessment tools they, in addition to the issues discussed in section 3.1, need to be:

- Operational: the decision maker must be able to judge the performance of indicators using meaningful units and corresponding scales.
- Complete and balanced: the whole decision problem has to be depicted by the indicators, not only partial aspects.
- Manageable: the set of indicators should be clearly structured and limited in complexity to support a comprehensible application of assessment tools.
- Non-redundant: indicators should not overlap in reporting the same information.

Against these criteria, we see that data availability is one of the driving forces for indicator selection (Niemeijer, 2002), and has led to the phenomenon of 'data availability bias' (Failing and Gregory, 2003). There is also a tendency to overestimate authoritative forms of scientific knowledge at the cost of more tacit and informal forms of knowledge (Siebenhüner and Barth, 2005). These aspects have to be taken into account to achieve a balanced and legitimate assessment scheme.

A second important issue for employing C&I as assessment tools is the definition of thresholds that define progress towards SFM.

Indeed, the formulation of thresholds and reference values for indicators is a potentially conflict-burdened topic. There are hardly any scientific-based thresholds for aspects of SFM to be applied at the FMU level (Rametsteiner, 2001). Thus, defining thresholds would again require stakeholder value input and supposes that there would be broad consensus (e.g., agreement on measurable goals). It is more likely that forest stakeholders would try to avoid such targets and thresholds because of their intrinsic normative power. Efforts to establish reference values both in political and scientific spheres are conspicuous by their rarity (Reynolds et al., 2003). Nonetheless, generally abandoning thresholds would lead to certain limitations of indicator approaches. From a systemic point of view, as well as the lack of progress towards reaching SFM goals and objectives, there is also a lack of opportunities to evaluate changes in single indicators and in clusters of indicators. Reference values can be of different forms: as real thresholds, benchmarks, modelled reference conditions, desired future states, trends, tipping points, development of standards and norms (USDA, 2002).

3.4 Outcomes and constraints

Over the past 25 years, C&I for SFM have developed as powerful tools and are well-known for playing a central role in the implementation of SFM. Ever since their introduction in sustainability sciences, indicators have been deemed to be more than just simple data carriers. They are intended to draw and moreover communicate a picture of a certain problem by providing a selection of (often simplified and synthesized) key information which – most importantly – refers to the user's information needs. Before addressing the empirical aspects of the use of the pan-European C&I, it is necessary to collect an overview of reported outcomes and shortcomings of C&I so far.

As reported in the literature, the main merits of C&I implementation are (Grainger, 2012; Wijewardana, 2008):

- Supporting a global understanding of what constitutes SFM;
- A vehicle to foster political processes on SFM;
- Find a common symbolic language to overcome historic conflicts (e.g., forestry vs. environmentalists) and hence support consensus-finding;
- Find a common terminology in the global environmental governance;
- Substantial progress in streamlining and structuring forest reporting;
- Support unambiguous communication and learning among stakeholders;
- Serving as a means for education and capacity-building by fostering participatory decision-making and decentralized policy implementation.

Further achievements can be seen in:

- Measuring aspects of SFM at regional and forest management unit level (Mendoza and Prabhu, 2000; Franc et al., 2001; Raison et al., 2001);
- Global convergence in the understanding of C&I (McDonald and Lane, 2004);
- Serve as a reference for regional and local C&I application (e.g., Adam and Kneeshaw, 2008);
- Allow for combined top-down and bottom-up approaches in C&I development (Khadka et al., 2012);
- Support participatory modes of knowledge generation and exchange (Thomson, 2005).

Despite the progress in implementing C&I over a relatively short period, some general shortcoming are evident:

- Little conceptual foundation from which to exploit the full potential of C&I;
- Little instrumental use of C&I, much more symbolic use;
- Unclear reference to political goals as regards SFM, neglecting potential conflicts and trade-offs within the concept of SFM, may lead to confusing signals given by different indicators (Grainger, 2012);
- Uneven implementation of C&I among countries;
- Weak political will to support C&I implementation, little priority to forestry issues in competing claims;
- Little conception of how to present the findings based on C&I beyond description of indicator outcomes;
- Limited operational design and data availability;
- No assessment features providing diagnosis, warning signals, and guidance (Wijewardana, 2008).

Further limitations are reported as:

- Unbalanced indicator sets, which are particular weak in socio-economic indicators (Gough et al., 2008);
- Harmonization, terms and definition on forest information is still imperfect and hampers reliable C&I interpretation (Irland, 2010);
- Monitoring and streamlined reporting are still challenges for policy makers and forest managers (Hickey, 2008);
- C&I are strongly outcome-centred measure but fail in identifying direct links to and evidence on forest management activities and responses (Foster et al., 2010);

- C&I do not consider linkages, interdependencies, and causal chains among indicators (Requardt, 2007), and do not connect quantitative and qualitative policy indicators;
- C&I fail to facilitate more systemic analysis of how SFM is embedded in socio-ecological systems (Wolfslehner and Vacik, 2011).

In the subsequent sections, these findings are referred to as the empirics of pan-European C&I implementation. It is put to test what are the specifics of the European set as compared to the conceptual considerations, and how the state-of-the-art can be updated in 2013.