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Converging global indicators for sustainable forest management

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Abstract

Policy-makers in most countries now recognise the need to conserve biodiversity, forest productivity and the prosperity of forest dependent communities in the long-term. There is wide recognition of the importance of forested watersheds to hydrological regimes and water quality and the significant cultural, social and aesthetic values of forests. Policies are now directed at achieving sustainable forest management (SFM). Criteria and indicators (C&I) define SFM but obtaining agreement on what SFM is has proven to be a difficult task internationally and nationally. International activities including the work of the International Tropical Timber Organisation (ITTO), the European Union (EU) and the Montreal Process (MP) for temperate and boreal forests outside Europe, have, over the past decade refined C&I for SFM to the point now that there is substantial agreement between them. This paper reviews progress towards defining SFM and shows through a synthesis of the ITTO, EU and MP C&I the emergent consistency in defining SFM. The implication is that there are now sufficiently specific and agreed principles, C&I to guide policy-makers towards SFM. While much work remains to be done to operationalise the C&I, the gap between these agreed criteria and current practice for forest management is so wide that progress can be made within the frameworks while refinement continues.

Keywords: Sustainable forestry; Forest management; Criteria and indicators; Montreal Process

1. Introduction

National policy-makers in most countries now recognise the need to conserve biodiversity, forest productivity and the prosperity of forest communities in the long-term. There is also wide recognition of the importance of forested watersheds to hydrological regimes and water quality and of the significant cultural, social and aesthetic values of forests. Those countries that are fortunate enough to have significant areas of natural forest remaining, even old growth forests, have revised their approach to wood extraction from forests, giving greater attention to protection of forest biodiversity and to ecosystem processes. Developing countries with substantial forest resources are adopting more conservative approaches to forest clearing and use, and recognising the long-term importance of forests to the environment and forest dependent com-

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munities. New 'paradigms' of forest management are emerging under the general label of sustainable forest management (SFM) or ecosystem management.

International cooperation has been significant in the search for improved forest management, focusing on the concept of SFM. While concern about SFM did not start at the United Nations Conference on Environment and Development (UNCED) in 1992, UNCED was a decisive event as far as current philosophies, concepts and practices in SFM are concerned. UNCED produced the 'Forest Principles: The non-legally binding authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forests'.[1] These principles did not take the debate very far as to what is SFM and how it could be achieved, but many subsequent activities triggered by UNCED did. These included:

- The continuing efforts of the post-UNCED UN programs including the UN Commission on Sustainable Development and its intergovernmental panel on forests (UNED, 2001),
- The International Tropical Timber Organisation (ITTO) development of SFM policies and manuals for application in developing countries,
- The European nations development of SFM criteria and indicators (C&I) following the 1993 Helsinki (forest) Ministerial Congress, and,
- The Montreal Process (MP), which developed SFM principles for application to the temperate and boreal forests of non-European countries.

Despite the inherent imprecision of the term 'sustainable forest management', it has been given increasing clarity by these post-UNCED activities. These different programs are converging in their operational definitions of SFM. They are consistent in defining that SFM should conserve biological diversity, maintain the health and productive capacity of forest ecosystems and their role in watersheds and the global carbon cycle, and that SFM should maximise the long-term multiple social and economic benefits of forest use. While the process of refining the definition of SFM and operationalising it is still underway, the main outcomes are sets of C&I to determine the general objectives or values that must be maintained in SFM (Kneeshaw, 2000, p. 483).

The aim of this paper is to demonstrate that there is emerging consistency in defining the C&I for SFM. This is done by analysing and comparing the content of the three major sets of C&I which together incorporate most countries.

C&I have also been developed for methods of implementing SFM. Again, there is broad agreement in the major programs listed above on what legislative, institutional, economic and information conditions are necessary to achieve SFM. Countries need to adapt the broad C&I guidelines to suit their particular political, economic, social and cultural conditions and institutions. Most countries will then need to reform their forest management systems, basing their reform agenda on a clear understanding of the strengths and weaknesses of their present system in terms of their ability to achieve the outcomes specified in the C&I.

2. Criteria for sustainable forest management

The global focus of SFM is on the definition of C&I for the goals of SFM and what management processes are necessary. A *Criterion* is a category of conditions or processes by which SFM may be assessed. A criterion has a set of related indicators that are monitored periodically to assess change. An *Indicator* is a quantitative or qualitative measure of an aspect of the criterion to show current performance and trends in performance (Canadian Forest Service, 1997, p. 3).

In all cases, developing C&I entailed a process of technical and scientific input into the complex international standard setting process and the translation of those C&I to national and regional levels.

3. Montreal Process criteria and indicators

Following UNCED, in September 1993, the conference on security and cooperation in Europe sponsored an international seminar in Montreal, Canada on the sustainable management of temper-

[1] The UN system and its UN Forum on Forests (UNFF) has yet to successfully incorporate forestry within the Earth Summit process meeting again at Rio + 10 in 2002 (UNED, 2001).

Table 1
The MP C&I

	MP criteria	No. of indicators
1	Conservation of biological diversity—including the elements of diversity of ecosystems, the diversity between species and genetic diversity in species	9
2	Maintenance of the productive capacity of forest ecosystems—including forest land availability, forest products outputs	5
3	Maintenance of forest ecosystem health and vitality including disturbances such as diseases and pests, pollution and biological components such as seed availability nutrient cycling	3
4	Conservation and maintenance of soil and water resources—including the conservation of soil and water resources and the protective and productive functions of forests	8
5	Maintenance of forest contribution to global carbon cycles	3
6	Maintenance and enhancement of long-term multiple social and economic benefits to meet the needs of societies including the production and consumption of wood products, employment and investment recreation, cultural, social and spiritual needs and values	19
7	Legal, institutional and economic framework for forest conservation and sustainable management	20

Source: Forestry Working Group (1995).

ate and boreal forests.[2] The meeting established a working group that progressively refined the C&I, and by 1995 the seven criteria and 65 indicators known as the MP C&I were accepted and member countries committed to their implementation. (See Forest Working Group, 1997.)

The MP C&I recognise that forests are essential to the long-term well-being of local populations, national economies, and the earth's biosphere as a whole. The approach to forest management reflected in the C&I is the management of forests as ecosystems. They are intended to provide a common understanding of what is meant by SFM and provide a framework for describing, assessing and evaluating a country's progress towards sustainability at the national level. The C&I are shown in Table 1. Because each country is different in terms of the character of forests and economic circumstances, landownership and political organisation, the specific application as well as capacity to do so will vary from country to country.

[2] Countries included in the Montreal Process are Argentina, Australia, Canada, Chile, China, Japan, Korea, Mexico, New Zealand, the Russian federation, USA and Uruguay. These countries represent 90% of the world's temperate and boreal forests in addition to accounting for 45% of the world trade in wood.

The MP Criteria 1–6 define desired outcomes for the use of forests and Criterion 7 defines the types of management system required to achieve them. The C&I do not specifically identify the systems and components of policy and planning as such, or provide guidance on structural attributes—rather the criteria are diagnostic. The Criterion 7 indicators define the need for activities such as periodic forest-related planning and policy reviews, best-practice codes for forest management, public education, awareness and extension programs and the collection of up-to-date data, statistics and other information important to measuring or describing indicators. They also cover desirable attributes of planning systems such as opportunities for participation in public policy and decision-making, public access to information and non-discriminatory trade policies for forest products.

4. European criteria and indicators

In Europe a similar process of C&I development occurred. Meetings of forest ministers from the European Union (EU) were held at Helsinki and Lisbon, which prepared the Helsinki Resolutions H1 and H2 and the Lisbon Resolutions L1 and L2

Table 2
Pan-European C&I for SFM

	Criteria
1	Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles
2	Maintenance of forest ecosystem health and vitality
3	Maintenance and encouragement of productive functions of forests (wood and non-wood)
4	Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems
5	Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)
6	Maintenance of other socio-economic functions and conditions

Source: Anonymous (2000a).

(Anonymous, 1995). The signatories of these resolutions endorsed the new idea of SFM, striving towards the harmonisation of economic, social and ecological interactions in forests across Europe (Gluck, 1999). In the Lisbon Resolution L2, the signatories committed themselves to use the 'Pan-European Criteria and Indicators' as a reference framework and to supplement them according to specific country conditions (Table 2). The implementation of the Helsinki Resolutions and the Lisbon Resolutions was further endorsed by the Forestry Strategy for the EU and specifically by the regulation on rural development (Anonymous, 2000a).

The European C&I provide guidelines for 'sustainable forest management' for forest management planning as well as forests management at the sub-national level. The guidelines can be used as a reference tool for advising forest owners and forest managers in planning forest practices and supervising their implementation.

In contrast to the MP C&I which has a specific Criterion 7 to deal with management issues, the European system systematically imbeds the management and implementation process criteria into each outcome criterion under the following headings:

- Existence of a *legal/regulatory framework*, and the extent to which it provides legal instruments to regulate or limit forest management.
- Existence and capacity of an *institutional framework* to develop and maintain institutional instruments to regulate or limit forest management.
- Existence of *economic policy framework* and financial instruments, and the extent to which they support the preparation of management guidelines for infrastructure and protection of forests.
- Existence of *informational means* to implement the policy framework, and the capacity to conduct research on infrastructure and protection forests in relation to land use practices/forest management.

For each a set of indicators is developed.

5. The ITTO Manual

The ITTO is a commodity organisation of producers and consumers of tropical timber to discuss and exchange information and develop policies on the world tropical timber economy. At its September 2000 ITTO had 56 members, which together represent 95% of world trade in tropical timber and 75% of the world's tropical forests. The International Tropical Timber Agreement (ITTA) first established the ITTO in 1983 under the auspices of United Nations Conference on Trade and Development (UNCTAD). The successor agreement to the ITTA (1983) was negotiated in 1994 giving new emphasis to the policy work of the ITTO. It aimed that by the year 2000 all tropical timber products traded internationally by member states would originate from sustainably managed forests. In 1998 the council approved the preparation of a Manual on C&I for Sustainable Management of Natural Tropical Forests that was prepared to guide this process (Table 3). Well-

Table 3
ITTO C&I for sustainable management of natural tropical forests

	Criteria
1	Enabling conditions for SFM
2	Forest resource security
3	Forest ecosystem health and condition
4	Flow of forest produce
5	Biological diversity
6	Soil and water
7	Economic, social and cultural aspects

Source: Derived from ITTO (1998).

known tropical forest management consultants Duncan Poore (United Kingdom) and Thang Hooi Chiew (Malaysia) prepared a draft of the Manual, which was subsequently considered and finalized by a panel of international experts, comprising representatives from ITTO's tropical timber producing and consuming member countries.

The *Manual* (Part A) provides a clear and detailed description of actions to be taken to measure and describe the 66 national level indicators to help producing countries to assess their own progress towards SFM and to report on the status of their forests in a focused and standardised way (ITTO, 1998).

Criterion 1 addresses the general institutional requirements that are necessary to make SFM possible. Most of the indicators cover the legal and institutional frameworks and are mainly descriptive in nature. Taken together, the information gathered measuring the ITTO C&I indicates the extent of a country's political commitment to SFM.

For the ITTO Criterion 1 enabling conditions for SFM, the indicators are more basic and structural than either the Montreal or European C&I, recognising the less mature systems of public administration in most tropical countries.

The criteria gain meaning and precision in application through the detail provided in the indicators. The ITTO Manual suggests reporting measures and provides template tables as a guide to reporting on the criteria. For Criterion 1.1, a sample matrix is presented as a guideline (Table 4).

The *Manual* provides advice to record the presence or absence of laws that govern each element, the agency responsible for them, tenure coverage, changes, 'if there are significant gaps in the coverage of laws, policies and regulations and how they will be filled within the context of SFM'. This is a pointer in the right direction but does not, and probably should not, give more prescriptive approaches or methodologies for doing this. Similar approaches are taken in other managerial criteria in the ITTO *Manual*.

6. Converging criteria and indicators for sustainable forest management

We can see from the above three major SFM programs and protocols that quite robust sets of C&I have emerged in recent years. While there are differences in detail between the European, Montreal and ITTO guidelines, reflecting the different contexts, there is also substantial conformity between the philosophy and intent, scope and content of the C&I. The need to evaluate forest

Table 4
Evaluation matrix for assessing ITTO C&I on implementation

Framework governing	Laws	Policies	Regulations
Enabling conditions for SFM			
Forest resource security			
Forest ecosystem health and condition			
Flow of forest produce			
Biological diversity			
Soil and water			
Economic, social and cultural aspects			

Source: ITTO (2000), p. 3.

Table 5
Montreal, European and ITTO C&I compared

C&I	MP criteria	European criteria	ITTO criteria
Conservation of biological diversity	1	4	5
Maintenance of the productive capacity of forest ecosystems	2	3	2 and 4
Maintenance of forest ecosystem health	3	2	3
Conservation and maintenance of soil and water resources	4	5	6
Maintenance of forest contribution to global carbon cycles	5	1	Not included
Maintenance and enhancement of long-term multiple social and economic benefits	6	6	7
Legal, institutional and economic framework for forest management	7	Incorporated in 1–6	1

planning system performance is relevant to all three.

The criteria of the three systems are very similar as shown in Table 5. The Montreal and ITTO processes have seven criteria whereas the European C&I set has six because the European system imbeds the implementation criteria inside each of the criteria dealing with SFM outcomes. The C&I are defined and worded only slightly differently, reflecting the differing socio-economic contexts. It is also relevant to note that the ITTO have the Criterion dealing with management at the top of their set as #1 rather than as #7 in the MP case.

Implementation of the C&I is progressing quite differently in each of the three 'realms' reflecting the politics of each case. While each 'realm' consists of multiple nations, the Pan-European C&I were endorsed by the forest ministers of the participating countries, whereas this is not the case for the MP and the ITTO Manual. Implementation in Europe can build on the political foundation of the EU, and forest management C&I adopted as a framework in each country. For the ITTO and MP C&I, implementation has been very patchy. There is much work yet to be done to promote and implement these principles across the very diverse political regimes represented in each group. Extensive implementation of the Montreal principles has occurred in Canada, Australia and New Zealand but less so elsewhere. The US has its own political and technical discourse about forest management, and while the US is a member of the Montreal group and is actively committed to ecosystem management, the Montreal C&I are rarely mentioned in these discourses. In the face of substantial international hostility over forest management issues, the ITTO is making significant progress toward implementing the C&I in member nations through a broad front of programs from emphasising cooperation, capacity building, technical assistance, accreditation and monitoring (ITTO, 2001 ITTO, 2002; Atyi et al., 2002).

7. Discussion

The foregoing analysis demonstrated that there is a welcome global convergence in C&I for SFM. Even after accepting that SFM is a new way of thinking about forest management, it is an understatement to say that implementing SFM is problematical. While it might be agreed that these criteria (and their indicators) need to be taken into account in forest management, optimising management, or even finding an acceptable level of achievement across incommensurate criteria is extraordinarily difficult. Stakeholders in the process hold strong and often conflicting beliefs about the importance of the criteria and much of the required process science is inconclusive. Fig. 1 shows two common conceptions of how to resolve this problem. The first conception is that SFM is a balancing act, requiring ecological values to be carefully balanced or traded off against economic and social values (Elkington, 1997). This balance aims to maximise the triple bottom line account of forest values (social, economic and ecological). The second conception of the problem is that economic activity must operate within the ecological constraints of the forest ecosystem. The nested constraints model implies that forest products cannot be extracted at rates exceeding regeneration rates and that forest ecosystems cannot be dis-

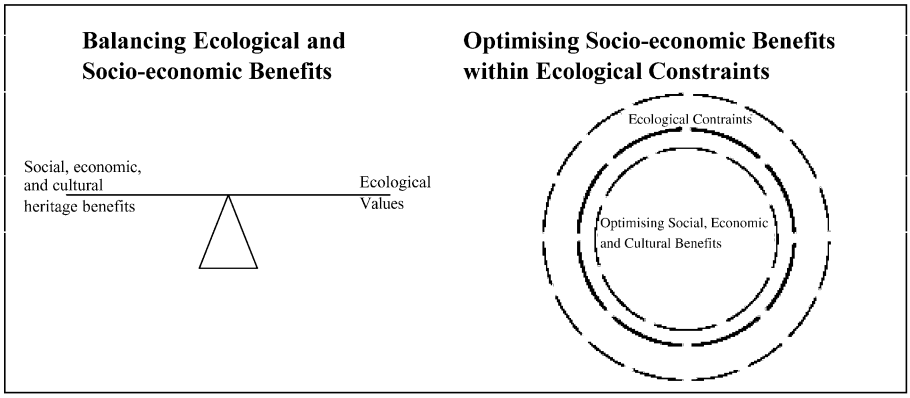

Fig. 1. Alternative modes of ecosystem management.

turbed in a way that exceeds their resilience. This derives from Prugh's model of life support systems and non-declining natural capital (Prugh, 1995). Unfortunately, the ecological integrity of the forest ecosystems in relation to the demands of SFM has yet to be determined. Until this occurs, it is not possible to deliver a reliable answer to questions such as 'how much wood', 'how much clearing' and 'how much biodiversity'. Ecosystem limits are uncertain and management systems must be adaptive and consider the risks involved in using forest resources (Raison et al., 2001). In the final analysis these decisions and trade-offs will be made in the political process of each nation.

Progress in developing C&I such as these has assisted narrow down the concept of SFM, but no simple or precise operational definition of SFM principles exist (or probably ever will). Some of the issues revealed in a recent case study in Southeast Queensland, Australia include

(i) The relative weighting given to the values, and the quantity of each desired will vary locally, and thus must relate to agreed management goals for particular forests. Emphasis will vary from conservation, through multiple uses, to intensive wood production (e.g. plantation forestry).

(ii) Forest values vary in both space (e.g. with environmental conditions) and time (e.g. during forest succession after disturbance and as forests age). This is true for both protected natural forests and those that are managed for timber production. It follows that not all parts of the forest can contribute equally to all forest values, and that any patch might well make different contributions at different points in time. Management plans must reflect these aspects of forest life and address ESFM at appropriate scales. For example, soil and water values need to be protected at the site level by local engineering measures, while others (e.g. home range and population targets of large vertebrates) must be considered at the whole forest scale. Wood production goals will also be set at larger scales, with some patches of forest making no contribution and others making a large contribution. This is effectively a zoning of forest use to meet agreed objectives. Any such initiative should be set in a broader context of strategic planning for ESFM goals that include vegetation structural and other ecological goals.

(iii) It is unrealistic to expect particular patches of forest to provide the same level of all forest values when they are managed for different purposes. The community must decide what levels and mix of environmental, social and economic values provide an acceptable balance for SFM (McDonald and Lane, 2002).

There is a risk that decisions made on the basis of stakeholder consensus may not adequately consider the requirements for maintaining some values (e.g. cultural heritage values, viability of species populations, sustainable wood supply). For example, three key stakeholder issues are

- What are the trade-offs between competing values—are all forest values equal or is there a hierarchy of values.
- Is it possible to have resource security for the timber industry in the face of so much uncertainty—can an 'annual allowable cut' be specified for a 20–40 year period (e.g. 183 000 m^3 per year for 20 years)?
- Biodiversity conservation—how much of the existing biodiversity should be protected?

The outcomes of these assessments have national and state policy significance leading to improvements in legislation, policies, and funding and intergovernmental relations. There may also be trade significance, as responsible importers of forest products require assurances that they have been sourced from sustainably managed forests. Accreditation by a rigorous process may provide the necessary assurances.

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References

Anonymous, 1995. Pan-European Criteria and Indicators for Sustainable Forest Management. Annex 1 of the Resolution 1, Lisbon, Vienna Liaison Unit.

Anonymous, 2000a. General Declarations and Resolutions Adopted at the Ministerial Conferences on the Protection of Forests in Europe, Vienna Liaison Unit.

Atyi, Richard Eba'a, Simula, Markku, 2002. 'Forest Certification: Pending Challenges for Tropical Timber' Background Paper ITTO International Workshop on Comparability and Equivalence of Forest Certification Schemes. Kuala Lumpur, April.

Canadian Forest Service, 1997. The Montreal Process Progress Report. Ottawa.

Elkington, J., 1997. Cannibals with Forks: the Triple-bottomline of 21st Century Business. Oxford, Capston.

Forestry Working Group, 1995. Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. The Montreal Process. Ottawa Canadian Forest Service.

Gluck, P., 1999. National forest programs—Significance of forest policy framework. In: Gluck, P., et al. (Eds.), Formulation and implementation of National Forest programs. EFI Proceedings, 30 (1), 39–52, Joensuu.

ITTO, 1998. Criteria and Indicators for the Sustainable Management of Natural Tropical Forests. ITTO. Yokahama.

ITTO, 2002. Manual for the Application of Criteria and Indicators for the Sustainable Management of Natural Tropical Timber Forests. ITTO. Yokahama..

Kneeshaw, D.D., et al., 2000. Development of integrated ecological standards of sustainable forest management at an operational scale. The Forestry Chronicle 76, 481–500.

McDonald, G.T., Lane, M.B., 2002. Forest management systems evaluation using ISO 14000. J. Environ. Plann. Manage. 45, 633–652.

Prugh, T., 1995. Natural Capital and Human Economic Survival. International Society for Ecological Economics Press, Solomon, USA.

Raison, R.J., Brown, A.G., Flinn, D.W., 2001. Criteria and Indicators for Sustainable Forest Management London, IUFRO Research series Number 7, CABI Publishing.

UNED, 2001. 'Linkages between Summit and the UN Forum on Forests remain undefined.' United Nation Environment and Development Forum, vol. 1, issue IX.