Guidelines for Applying Multi-Criteria Analysis to the Assessment of Criteria and Indicators

9 The Criteria & Indicators Toolbox Series

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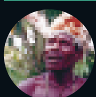

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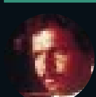

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1 Background

1.1 – TARGET AUDIENCE

This manual is written for an audience that needs a clear, easy to follow manual for implementing Multi-Criteria Analysis (MCA) in the field. While a background in mathematics is desirable, it is not a necessary condition for the application of the techniques described.

We hope that this manual will be useful to those interested in using MCA as a decision-making tool for the assessment, evaluation and selection of Criteria and Indicators (C&I). Users might include:

- *Certification bodies* assessing timber management for certification purposes;
- *Government officials* designing more sustainable policies pertaining to forestry and other related sectors;
- *Funding agencies* evaluating the sustainability of the activities undertaken by various natural resource management projects;
- *Forest managers* improving the sustainability of their management at the forest management level; and
- *Project managers* planning, implementing and evaluating conservation and development projects.

1.2 – STRUCTURE OF MANUAL

This Manual may or may not be read in a linear fashion. The information is structured so that the reader is first introduced to the general concepts involved before delving into the more specific applications of MCA. We expect that the way this manual is used will depend on the amount of knowledge and background information the reader already possesses. To assist the reader in finding the pertinent information a brief synopsis of each section is presented below.

Section 2 reviews the conceptual framework of C&I and introduces the theory behind MCA, specifically the Analytic Hierarchy Process (AHP). The methods specific to MCA and a justification for the use of MCA with C&I is included.

Section 3 is a detailed account of how MCA can be applied to C&I in a Forest Certification context. It includes the following sub-sections:

Section 3.1 is an explanation of the difference between a top-down and bottom-up approach to selecting and evaluating C&I with MCA. For the purpose of this manual, Forest Certification is considered a top-down approach.

Section 3.2 recognises that as MCA is a decision-making tool it involves the active participation of decision-makers. Thus, for MCA to be a useful tool it needs to be clearly presented to the decision-makers, and adapted to suit their particular needs. This part, then, introduces some of the issues to consider when working with different groups, and suggests general ways to structure the process based on the experience gained from field testing these methods.

Section 3.3 explains the entire process of incorporating MCA into C&I analysis (as a decision-making tool) using the simple tools of Ranking and Rating. The Ranking and Rating analyses are introduced in a step by step, 'cookbook' manner. The focus is on using these techniques as a way to streamline a generic set of C&I so that they reflect the conditions in a hypothetical Forest Management Unit (FMU)[1].

Section 4 explains how to use the Pairwise Comparison technique and (In)consistency Index (C.I.) to improve the sensitivity of the analysis and help facilitate the decision-making process. This section will explain in detail the steps to take in applying these analysis techniques to the examples used in Section 3.3.

Section 5 looks at how to use MCA in a bottom-up analysis situation. Fieldwork on the effectiveness of this particular use of MCA is still ongoing, thus it is difficult to provide an effective 'formula' for carrying out this kind of analysis in the field. Still, the theory behind the bottom-up approach might be useful in certain assessment situations, and for this reason it is included in this manual.

Annexes. The annexes contain:

1. Glossary
2. Sample Data Collection Forms
3. The CIFOR Generic Template of Criteria and Indicators for Sustainable Management

Nuts and Bolts

Information concerning the structure of this Manual can be found in the Nuts & Bolts boxes in the relevant sections.

1 An FMU is defined as a clearly demarcated area of land covered predominantly by forests, managed to a set of explicit objectives and according to a long-term management plan (Prabhu *et al.* 1996)

1.3 – THE PURPOSE OF THIS MANUAL

Global forests are being depleted at an alarming rate. In recognition of this, intense pressure on forest resources widespread attention has been focussed on devising ways to define and assess the sustainability of forest use worldwide. One concept that has been developed to guide the management of these remaining forests is Sustainable Forest Management (see box).

In order to implement Sustainable Forest Management successfully, it requires the development of site specific and field verifiable measures that reflect the condition of forests. To this end, the Center for International Forestry Research (CIFOR) has been engaged in a program of collaborative research to further the development and testing of Criteria and Indicators (C&I). C&I are tools that can be used to collect and organise information in a manner that is useful in conceptualising, evaluating, implementing and communicating sustainable forest management. Other work on C&I has also been carried out by different organisations, such as the Forest Stewardship Council (1994), SGS Forestry (1994), Scientific Certification Systems (1994) and the Tropenbos Foundation (1997).

Sustainable Forest Management (SFM)

For the purposes of this manual, we use a definition proposed by Prabhu *et al.* (1999):

'A set of objectives, activities and outcomes consistent with maintaining or improving the forest's ecological integrity and contributing to people's well-being both now and in the future'.

One objective of this process is a set of internationally recognised Principles, Criteria, Indicators and Verifiers[2], that, with adaptation to fit local conditions, can be used by anyone wishing to evaluate either, or both, the performance and sustainability of forestry operations.

2 Definitions of Principles, Criteria, Indicators and Verifiers can be found in Section 2.1.1.

Adapting a set of C&I to local conditions is a complex process. It is important that the decision-making process used to choose or modify C&I be able to handle multiple variables, be consistent and be transparent. One such decision-making process that fulfils these requirements is Multi Criteria Analysis (MCA).

2 The Concepts Involved: C&I and MCA

2.1 – REVIEW OF CONCEPTUAL FRAMEWORK FOR CRITERIA AND INDICATORS

This Manual is prepared in conjunction with the *Guidelines for Developing, Testing and Selecting Criteria and Indicators for Sustainable Forest Management* (Prabhu *et al*. 1999). For the benefit of users of this Manual who are not familiar with these Guidelines, a brief overview of the conceptual framework of C&I is described in the next sections. This review is abstracted from Prabhu *et al*. (1999). Readers are referred to this original document for a more complete description of the framework.

2.1.1 UNDERSTANDING PRINCIPLES, CRITERIA AND INDICATORS

In this section, we define the three main conceptual tools constituting the important components of the C&I framework, namely: Principles, Criteria and Indicators. In addition, we also define the concept of verifiers.

The following definitions are used for each of the elements above:

Principle: A fundamental truth or law as the basis of reasoning or action. Principles in the context of sustainable forest management are seen as providing the primary framework for managing forests in a sustainable fashion. They provide the justification for Criteria, Indicators and Verifiers. Examples of Principles are:

- For sustainable forest management to take place 'ecosystem integrity is maintained or enhanced', or
- For sustainable forest management to take place 'human well-being is assured'.

Criterion: A principle or standard that a thing is judged by. A Criterion can, therefore, be seen as a 'second order' Principle, one that adds meaning and operationality to a principle without itself being a direct measure of performance. Criteria are the intermediate points to which the information provided by indicators can be integrated and where an interpretable assessment crystallises. Principles form the final point of integration. Examples of Criteria when applied under the first Principle given above are:

- For ecosystem integrity to be maintained or enhanced, 'principal functions and processes of the forest ecosystem are also maintained'; or
- For ecosystem integrity to be maintained or enhanced, 'processes that sustain or enhance genetic variation are perpetuated'.

Indicator: An indicator is any variable or component of the forest ecosystem or management system used to infer the status of a particular Criterion. Indicators should convey a 'single meaningful message'. This 'single message' is termed information. It represents an aggregate of one or more data elements with certain established relationships. Examples of Indicators when applied to the above Criterion are:

- To ensure that processes that sustain or enhance genetic variation are perpetuated we can examine the 'directional change in allele or genotype frequencies'.

Verifier: Data or information that enhance the specificity or the ease of assessment of an indicator. They provide the special details that indicate or reflect a desired condition of an indicator. As the fourth level of specificity, Verifiers provide specific details that would indicate or reflect a desired condition of an Indicator. They add meaning and precision to an Indicator. They can be considered as subindicators. An example of a Verifier when applied to the above Indicator:

- The directional change in allele or genotype frequencies can be determined via periodic measures of the 'number of alleles in the population'.

2.1.2 THE C&I HIERARCHY:

The definitions of the three major conceptual tools, including the Verifiers as described above make it possible to structure the C&I conceptual framework into a hierarchy of elements. Prabhu *et al*. (1999) describes this C&I hierarchy in the following manner:

Figure 1. **Hierarchical Structure of C&I**

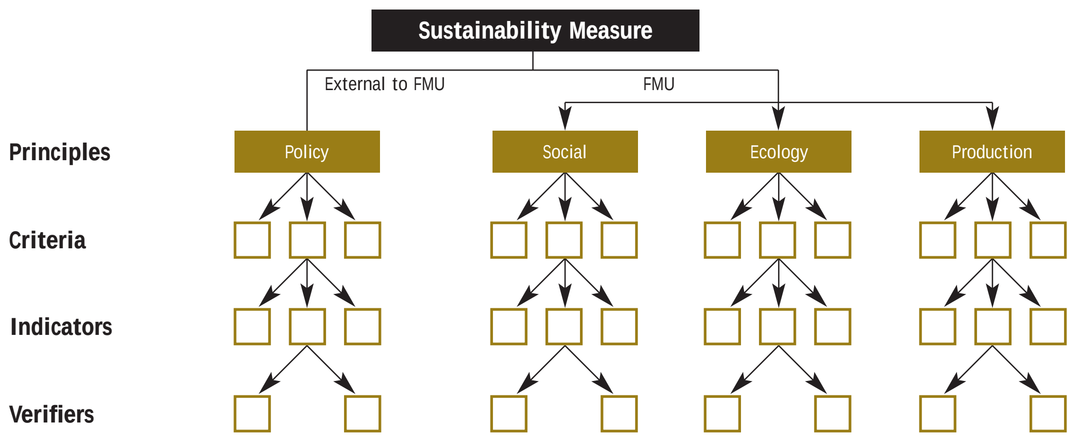
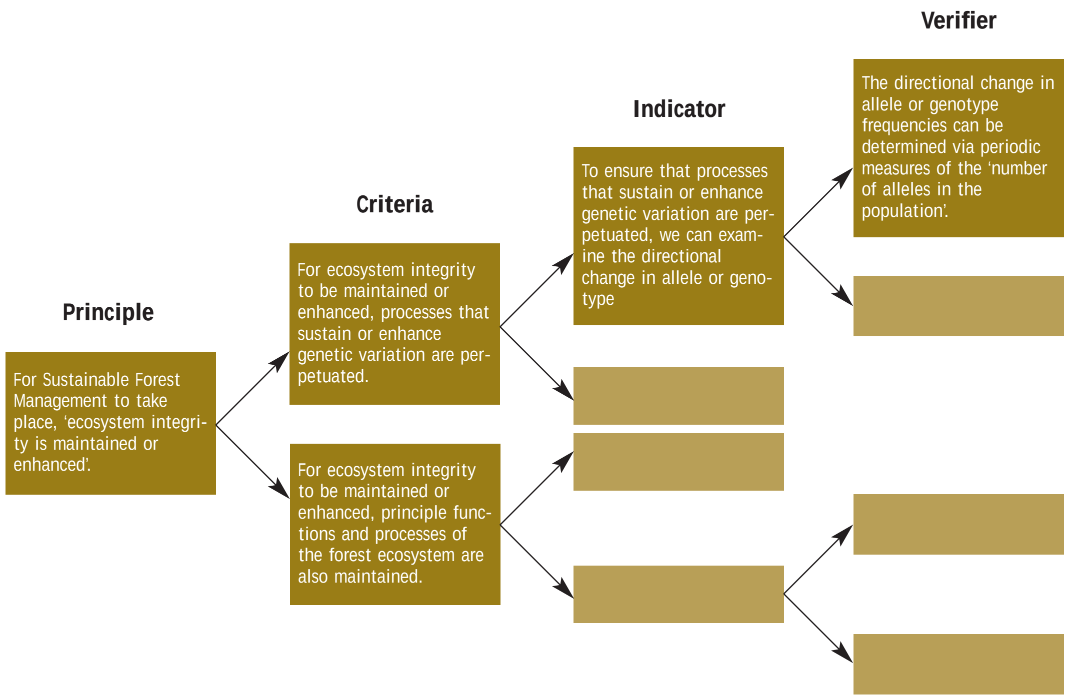


Figure 2. **Example of Information Links in C&I Hierarchy**



2.2 – INTRODUCTION TO MULTI-CRITERIA ANALYSIS

DEFINITION

Multi-Criteria Analysis is a decision-making tool developed for complex multi-criteria problems that include qualitative and/or quantitative aspects of the problem in the decision-making process.

WHY IS A DECISION-MAKING TOOL NEEDED?

In a situation where multiple criteria are involved, confusion can arise if a logical well-structured decision-making process is not followed. Consider the following simple example:

Two thirsty people are trying to decide whether to buy a can of Cola or a bottle of Orange Juice

- The two Criteria being used to make this decision are the *cost* and *health benefit* of each drink.
- The first person is concerned by the small amount of money they have and wants to buy the Cola as it is cheaper.
- The second person is more concerned with living a long healthy life and is willing to pay for the more expensive, but healthier Orange Juice.

To arrive at a preferred option in this situation the importance of each Criterion (i.e. cost and health benefit) relative to the decision being made must be evaluated and included in the decision-making process. Thus, if cost were deemed to have more relative importance than health benefit the can of Cola would be the most desirable option. Obviously reaching agreement on the relative importance of different Criteria can be a complex and difficult task. MCA is a tool that can help evaluate the relative importance of all Criteria involved, and reflect their importance in the final decision-making process.

Another difficulty in decision making is that reaching a general consensus in a multidisciplinary team can be very difficult to achieve. By using MCA the members don't have to agree on the relative importance of the Criteria or the rankings of the alternatives. Each member enters his or her own judgements, and makes a distinct, identifiable contribution to a jointly reached conclusion.

Nuts and Bolts

- 2.2.1 and 2.2.2 contain a brief overview of the techniques used in MCA: Ranking; Rating; Pairwise Comparison. All these techniques are explained in detail in later sections.
- In defining these techniques the term decision elements is used. This term refers to the different elements that need to be analysed in order to make complex decisions. In the context of analysing C&I these elements could be Principles, Criteria or Indicators.

2.2.1 RANKING AND RATING

The two simplest MCA methodologies that can be used in a C&I assessment are Ranking and Rating.

Ranking involves assigning each decision element a rank that reflects its perceived degree of importance relative to the decision being made. The decision elements can then be ordered according to their rank (first, second etc.)

Rating is similar to ranking, except that the decision elements are assigned 'scores' between 0 and 100. The scores for all elements being compared must add up to 100. Thus, to score one element high means that a different element must be scored lower.

2.2.2 ANALYTIC HIERARCHY PROCESS (AHP) AND PAIRWISE COMPARISONS

The Analytic Hierarchy Process (AHP) approaches decision making by arranging the important components of a problem into a hierarchical structure similar to a family tree. In the context of C&I assessment, the AHP method is a useful decision-making tool because it is a good fit with the existing hierarchy of Principles, Criteria, Indicators and Verifiers (Section 2.1.2).

The AHP method reduces complex decisions into a series of simple comparisons, called Pairwise Comparisons, between elements of the decision hierarchy. By synthesising the results of these comparisons, AHP can help you arrive at the best decision and provide a clear rationale for the choice you made.

For more information on the AHP method, refer to Mendoza (1997a,b), Saaty (1995), Golden *et al*. (1989) and Vargas and Zahedi (1993).

Pairwise Comparisons, in a nutshell, distil the complex C&I decision problem into a series of one-on-one judgements regarding the significance of each Indicator relative to the Criterion that it describes. Each Indicator under a Criterion, then, is compared with every other Indicator under that Criterion to assess its relative importance.

2.3 – WHY USE MCA IN C&I ASSESSMENT?

Some of the challenges involved in using C&I to assess the sustainability of forest areas are:

1. The C&I used must cover the full range of diverse goods and services provided by the forest.
2. The information used to assess sustainability includes both qualitative and quantitative data.
3. The assessment of sustainability must involve the participation of multiple interest groups, stakeholders and experts.
4. Decision-making requires consensual agreement amongst the various interest groups, which may be difficult to achieve.
5. Analysis must be interactive and assessments should be informed.

A more detailed account of these challenges is presented on the following box.

Given the complexity of the decision process involved one might expect that the challenge of arriving at an objective decision cannot be met by using 'seat of the pants' or 'ad hoc' procedures. Some of the dangers associated with using 'ad hoc' procedures in this type of decision-making process are:

- There is a heightened risk or probability of generating the wrong decision.
- An ad hoc procedure can exacerbate a wrong decision because there is no 'track record' to help explain the rational or logic behind the decision.

- There is a lack of transparency of the decision-making process which could hinder the adoption of C&I, or at worst, result in failure to gain public acceptance of the results of the C&I assessments.

Multiple Criteria Analysis provides an appropriate tool for addressing some of these challenges involved in C&I assessment; specific useful attributes of MCA are outlined below.

1. Capability to accommodate multiple criteria in the analysis.
2. MCA can work with mixed data and the analysis need not be data intensive. It allows for the incorporation of both qualitative and quantitative information.
3. It allows the direct involvement of multiple experts, interest groups and stakeholders.
4. Analysis is transparent to participants.
5. MCA includes mechanisms for feedback concerning the consistency of the judgements made.

Specific ways MCA can be applied to C&I assessment are:

- As a way to facilitate the decisions of each individual/participant regarding the importance of each Criterion/Indicator.
- As a way to assess the relative importance of each Criterion/Indicator in order to select a set deemed most significant.
- As a way to 'aggregate' all the evaluations made by participants/experts to arrive at a 'consensus' or group-based evaluation of all Criteria/Indicators.

Finally, in many decision situations the ability to communicate and explain the decisions and how they were reached is as important as the decisions themselves. MCA's ability to separate the decision elements and track down the decision-making process make it ideally suited to communicate the basis of all decisions. Such a tool is needed to reach informed and reasoned collective decisions with regard to C&I assessment.

Issues in C&I Assessment

1. The C&I used must cover the full range of diverse goods and services provided by the forest.

   Forests must be managed in a way that accommodates the socio-economic, biological, ecological, physical and environmental dimensions of each ecosystem. Such complexity, inherent in forest systems, means that any measurement system must be able to deal with this complex and multi- dimensional reality.

2. Information used to assess sustainability includes both qualitative and quantitative data.

   Quantitative data is 'hard' data that can be collected, analysed and synthesised. In general, hard data is difficult to obtain in an assessment situation, and can only be included as a 'proxy' variable, or in some qualitative fashion. *Qualitative data*, on the other hand, is for the most part conceptual. Examples are social and environmental factors. The assessment methods used must, therefore, be able to accommodate both qualitative and quantitative data.

3. Assessment of forest sustainability must involve the participation of multiple interest groups, stakeholders and experts.

   As a result, the methods used to assess sustainability should be highly transparent to all participants and stakeholders.

4. Decision-making requires consensual agreement amongst the various interest groups, which may be difficult to achieve.

   While there is widespread agreement in terms of the need to measure sustainability, there is hardly any consensus in terms of:

   1. How to measure sustainability.
   2. What should be included in the assessment.

5. Analysis must be interactive and assessments should be informed.

   The analysis should be able to convert information into insights which are useful to participants in arriving at more informed choices/evaluations.

3 Applying MCA to C&I Assessment

3.1 – INTRODUCTION TO TOP-DOWN AND BOTTOM-UP APPROACHES

Two different approaches to applying MCA are covered in this manual, a top-down and a bottom-up approach. The objective of the top-down process is to ensure that the right conceptual information is retained; the objective of the bottom-up process is to ensure that information, especially from the field, is not lost (Prabhu *et al*. 1996). The choice of one approach over the other will depend ultimately on the goal of the assessment and the conditions at the site in question.

While this Manual treats these two approaches separately, they are not mutually exclusive. Many situations exist where a combination of these two approaches would yield the most beneficial results. Some discussion regarding this combined approach is found in Section 5.

Nuts and Bolts

- The example used in this manual to illustrate the different MCA methods uses a top-down model and is taken from a quasi-certification field test in Central Kalimantan.
- The top-down model lends itself more easily to the ‘cookbook’ approach intended for this manual. Using a team of experts who are already familiar with the conceptual basis of C&I and working from a Generic Template means that the top-down approach theoretically deals with fewer variables. Thus, it is a better candidate for a ‘cookbook’ style of presentation.
- Information on the bottom-up approach is presented in Section 5. The information is presented as a guide to implementing a bottom-up or 'mixed' approach but is not meant to be a ‘cookbook’ style guide. Rather the methods and problems encountered during a CIFOR attempt to test a bottom-up approach are presented.

Top-down Approach: Example, Forest Certification

The top-down approach is the most appropriate for assessing the performance of a Forest Management Unit; one specific application is Forest Certification. Following are some of the specifics of a top-down assessment approach.

- In this approach, a previously generated set of C&I (CIFOR Generic Template) is used as an initial set and the basis for selecting the final set of C&I.
- The Assessment Team consists of professionals or experts representing the different disciplines included in the C&I set.
- The focus of the team is on,
  1. adapting and modifying the initial set of C&I to a local situation; and
  2. estimating the relative importance of each element in the set of C&I with regard to selected Criteria. Some of these Criteria could include auditability, applicability and cost-effectiveness.

In general, the top-down approach can be used both before and after going into the field. It can be used before to streamline the C&I that will be evaluated in the field, and it can be used after as a way to make decisions based on the data collected. The text box on the next page contains a synopsis of how a top-down approach can be applied to C&I assessment. It might be useful to refer to these steps for a framework as you work through this manual.

The Bottom-up Approach: Example, Forest Management

The bottom-up approach is purposely organised in a way that accommodates the direct involvement and participation of various stakeholders within the Forest

Forest Management Scenario • Top-down Approach	
Step 1	Establish an initial (base) set of C&I (e.g. CIFOR Generic Template).
Step 2	Expert Team examines the initial set. Modify the initial set if necessary.
Step 3	Team gives individual judgements on each of the Principles. Individual judgements are solicited using Response Form 1A.
Step 4	Team gives individual judgement on the Criteria under each Principle. Individual judgements are solicited using Response Form 1B.
Step 5	Based on the results obtained from steps 3 and 4, prioritise the Principles and Criteria according to their Relative Weights.
Step 6	If possible, eliminate those Principles and Criteria that are rated significantly lower than the others.
Step 7	Of the remaining Principles and Criteria that are judged significant examine the Indicators under each Criteria. Individual judgements are solicited using Response Form 2A and 2B.
Step 8	Calculate the Relative Weights of each Indicator. Prioritise the Indicators according to their Relative Weights. Eliminate those Indicators that are deemed significantly less important.
Step 9	Show final list to the Team. If the Team is satisfied, the Final List of C&I is identified. If the Team is not satisfied then the process can be repeated from Step 2.

Management Unit (FMU). In this Manual, we look at the bottom-up approach from the context of Forest Management, as opposed to Forest Certification.

The bottom-up approach does not lend itself as easily to a 'cookbook' method of description as the top-down approach. Furthermore, the methods for using MCA in this approach have not been as thoroughly field-tested. However, a bottom-up approach to decision making that includes local stakeholders is vitally important in any process that aims to have a lasting impact on the long-term management of a FMU.

3.2 – ORGANISATIONAL CONCERNS

MCA relies heavily on input from experts and stakeholders. These inputs are solicited and synthesised to arrive at a collective decision, or choice, regarding the selection of a weighted set of C&I. Some relevant questions are:

- What kind of team do you want to select?
- How will you structure the voting process so that it is successful in obtaining relevant information from the experts?
- How will you collect and analyse the information you receive?
- Which MCA methodologies are best suited to the goals of the analysis?

3.2.1 THE EXPERT TEAM

The relevance and strength of MCA depends ultimately on the knowledge and experience of the Expert Team assembled. The Expert Team needs to understand the C&I hierarchy, and have a broad knowledge base relevant to the FMU in question.

The CIFOR Generic C&I Template hinges on six general Principles under four general categories, namely: Social, Policy, Ecological Integrity and Production (see Annex 7.4 for more information). We suggest that the Expert Team consist of at least six experts/team members representing expertise in each of the Principles. This expertise can be gathered through many different combinations of experts. As a guide, an example Expert Team is illustrated below.

Example of a Local Team

Context: Forest Certification of a forest concession in Central Kalimantan

1. *Social Scientist* specialising in social forestry and community development.
2. *Resource Economist* with expertise in production and forest economies.
3. *Ecologist* familiar with the ecology of dipterocarp forests in Kalimantan.
4. *Forest Management Scientist* with knowledge of forest policies and history of forest management in Indonesia.
5. *Forest Management Scientist* with expertise in South East Asian forests.
6. *Professional Assessor* with advanced forestry degrees who has worked extensively on forest certification.

Effort should be made to recruit the best expertise available, both with respect to the discipline and site concerned. As far as possible, gender diversity should be ensured. It is also important to include different perspectives on the teams (e.g. academics, consultants, NGOs, government officials). The teams should not represent an 'insider' group, overly familiar with each other and holding very similar views. Such a situation detracts from the range of views and the quality of discussions. A mix of National and International team members will help bring diverse perspectives to the process.

3.2.2 GUIDELINES FOR COLLECTING THE DATA

In order to implement a successful MCA analysis, careful consideration must be given to the structure of the voting process used by the Expert Team, and the way the data will be collected and analysed.

3.2.2.1 VOTING

Before voting takes place, there must be a forum for an *open discussion* provided. During this discussion, it is desirable that team members refrain from explicitly expressing their judgement in terms of how they score, rank or rate each of the elements in the C&I hierarchy. This will help ensure the independence of each member's judgement, free from undue influence by other more vocal members of the team.

While discussions are open, voting should be done individually. Voting is done by filling-out Response Forms for each MCA approach, stage and level of analysis, and decision element within the C&I hierarchy. Sample forms can be found in Section 3 and in Annex 7.2.

In general, it works best to have the group discuss and vote on one Principle, Criteria or Indicator at a time. For example, if dealing with Criteria 1 under Principle 2 the group would

1. discuss its importance; and
2. vote individually using the Response Forms.

After voting they would move on to Criteria 2 under Principle 2.

Effective interdisciplinary communication is absolutely essential for the pre-voting discussions to be successful. Four attitudes that are important in improving communication are:

- a willingness to make reasonable compromises to accommodate the needs of other team members;
- a sincere interest in learning about other fields;
- genuine respect for your team members and acknowledgement of the relevance of their expertise; and
- significant agreement among team members about goals.

3.2.2.2 DATA COLLECTION AND ANALYSIS

The examples used in this Manual focus on a small data set for illustrative purposes. In the context of a ‘real' MCA process, the data set will be much larger and difficult to analyse by hand.

We suggest that, before beginning the analysis, an Excel Spreadsheet is set up that incorporates all the data points you intend to collect. The examples in Section 3.3 can provide information about titles and labels for the tables relevant to the analysis you choose.

A number of computer programs have also been developed to help collect and analyse the results of different Multi-Criteria Analyses. Two examples are,

- CIMAT

  This is a computer tool CIFOR is developing for the modification and adaptation of C&I to suit local situations. Currently, CIMAT does not include a decision support tool, but it does have information on MCA. For more information, see No. 3 in the C&I Toolbox Series.

- Other Software Applications

  Expert Choice Inc. have developed computer software tools for decision support. More information on their different products can be found at the following Web site: *www.expertchoice.com*

3.2.3 CHOOSING THE APPROPRIATE ANALYSIS METHODS

SEQUENCING THE ANALYSIS

Before the expert group begins their analysis, it is worthwhile to think about the sequence of the analysis; in what order the Principles, Criteria and Indicators will be examined.

In a top-down scenario like a certification exercise, the Expert Team should be able to begin the analysis at the more conceptual Principle level, due to their prior knowledge of the C&I hierarchy. However, it is not essential to start at the top of the hierarchy.

In many situations, it might be more useful to start the analysis at the Criteria or even Indicator level. These lower levels are less conceptual and based more on concrete measurements and observations. Thus, by analysing the Criteria and Indicators first the Expert Group can build a knowledge base that helps them better analyse at the Principle level. This is especially relevant in a bottom-up assessment situation where the expert group should represent a wide range of experience and educational backgrounds (see Section 5).

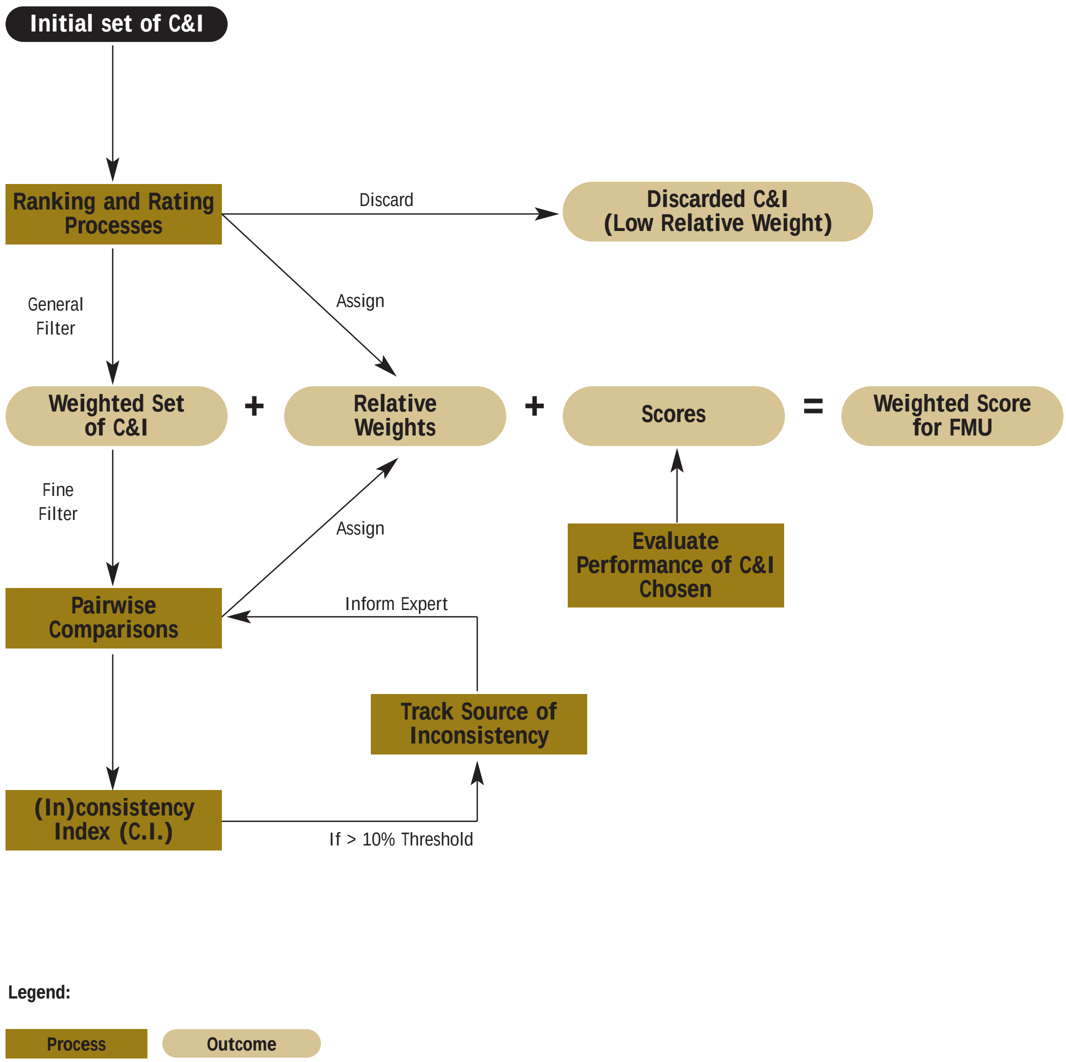
The sequence in which the different MCA methodologies are applied is also important to consider.

- In light of field testing experiences, it is recommended that *Ranking* and *Rating* be used as initial screening tools as they provide a quick way to filter out C&I elements that are not sufficiently significant.
- *Pairwise Comparison*, on the other hand, is best suited as a fine filter that can be used in deciding further which C&I elements are least significant and may be recommended for omission. Or, it could be used to determine more accurate relative weights of indicators.

Nuts and Bolts

The flow chart on the next page visually depicts some of the ways Ranking, Rating and the Pairwise Comparison methods can fit into C&I analysis. It might be useful to refer back to it as you read through the next sections.

Figure 3. **Application of MCA Techniques to the Selection and Scoring of C&I**



3.3 – PROCEDURAL DETAILS

There are three general steps in C&I assessment. MCA has specific application as a decision-making tool in steps 1 and 3.

1. The identification and selection of Criteria and Indicators.
2. The scoring of indicators based on the selected set.
3. The assessment of the FMU in terms of its overall performance at all levels of the C&I hierarchy.

This section outlines all three steps in 'cookbook' fashion.

Nuts and Bolts

In the following examples, a short form has been used to refer to specific Criteria and Indicators. For example,

- C2.1 = Criterion (under Principle 2).(Criterion 1)
- I2.1.1 = Indicator (under Principle 2).(under Criterion 1).(Indicator 1)

3.3.1 SELECTION OF C&I SET: THE FIRST STEP

Two simple techniques that MCA utilises to identify and select relevant C&I are Ranking and Rating. In this section, these techniques are defined and examples of how to use them are provided.

3.3.1.1 RANKING

There are two different ways to rank a set of decision elements, Regular Ranking and Ordinal Ranking.

1. Regular Ranking

Definition: Regular Ranking assigns each element relevant to the decision process a 'rank' depending on its perceived importance. Ranks are assigned according to the following 9 point scale.

1	3	5	7	9
Weakly Important	Less Important	Moderately Important	More Important	Extremely Important

Example: Consider the *Policy Principle*, which has 6 Criteria (C1.1 to C1.6). The expert group is asked to judge the importance of each Criterion relative to the *Policy Principle* in particular, and to overall forest sustainability in general. Using regular ranking one expert might respond as follows:

Criterion	Rank	Meaning
C1.1	6	Moderately Important
C1.2	5	Moderately Important
C1.3	5	Moderately Important
C1.4	3	Less Important
C1.5	4	Less to Moderately Important
C1.6	2	Weak to Moderately Important

Policy Principle 1

Policy, planning and institutional framework are conducive to sustainable forest management.

Criteria

C1.1 There is sustained and adequate funding for the management of the forest.

C1.2 Precautionary economic policy in place.

C1.3 Non-forestry policies do not distort forest management.

C1.4 The existence of a functional buffer zone.

C1.5 Legal framework protects forest resources and access.

C1.6 Demonstrated reinvestment in forest-use options.

2. Ordinal Ranking

Definition: Ordinal Ranking is a technique where each expert is asked to put the list of decision elements in order of importance. Unlike regular ranking where different decision elements can be given the same ranking, ordinal ranking forces the experts to put the elements in a hierarchy of importance; each element is deemed more or less important relative to the other elements involved.

Example: For the same *Policy Principle*, illustrated above one expert might order the list of Criteria as follows:

Most important	C1.1
	C1.2
	C1.3
	C1.4
	C1.5
Least important	C1.6

Notice that in this case the expert has been forced to decide that Criterion 1.2 is more important than Criteria 1.3. Using the Regular Ranking method they were both given equal ranking.

When deciding which type of Ranking to use, the following list of advantages and disadvantages might be useful:

Regular Ranking

Advantages

1. Allows for 'ties'.
2. Decision-Maker can specify the 'grades' (i.e. 1–9) of importance.

Disadvantages

1. May not be discriminating enough. The decision-maker might 'opt out' by giving equal assessments.

Ordinal Ranking:

Advantages

1. Simple, no ambiguity in terms of 'order' of importance.
2. Discriminating in terms of 'degree' of importance.

Disadvantages

1. No 'ties'. The list cannot have two elements with the same order of importance. The decision-maker might be forced to make an ordered judgement when they believe the group of decision elements is of 'about the same degree of importance'.
2. There are no 'grades' of importance (i.e. 1–9).

Ordinal Ranking may be best suited for a 'rough' initial cut from a set. For example, if the decision maker is trying to select 50 elements from an initial set of 200.

3.3.1.2 RATING

Definition: Rating is a technique where each expert is asked to give each decision element a rating, or percentage score, between 0 and 100. The scores for all the elements being compared must add up to 100.

Example: For the same *Policy Principle* used in the examples above, one expert might give the Criteria the following ratings.

Criterion	Rating
C1.1	25
C1.2	20
C1.3	20
C1.4	12
C1.5	15
C1.6	8
Total	100

One advantage of Rating is that it provides both an Ordinal and Cardinal measure of importance for each Indicator (see box). Ranking, on the other hand, only provides a measure of Ordinal importance.

To be able to give each Indicator an accurate measure of Cardinal importance requires that the Expert team have access to large amounts of relevant information. During a C&I assessment this is not usually the case.

Ordinal Importance

This refers to the order of importance of the list of elements involved. For example, which one comes first, second, etc.

Cardinal Importance

This refers to the difference in magnitude between the importance of two elements. For example, one element might be three times more important than another one.

SAMPLE FORM FOR COLLECTING RANKING AND RATING DATA FROM THE EXPERT TEAM

Response Form 1B

(Please refer to CIFOR Generic Template for detailed information about the Criteria and Indicators)

Description: Response Form 1B is designed for Level 2 analysis of Stage 1. Level 2 elicits responses from respondents about their opinions on the importance of each Criterion relative to the Principle, in particular, and overall forest sustainability, in general.

Purpose of Form: The purpose of Form 1B is to estimate the relative importance or weight of each Criterion under each Principle.

Coding of Criteria: Ci.j ; *i* refers to Principle index number; *j* refers to criteria index number

Principle 1 Criterion	Ranking	Rating	Relative Weights/Priorities (To be filled by Analyst)			Remarks
			Ranking (Priority)	Rating (Priority)	Overall (Priority)	
C1.1						
C1.2						
C1.3						
C1.4						
C1.5						
C1.6						
		Total = 100				

Principle 1 Criterion	Ranking	Rating	Relative Weights/Priorities (To be filled by Analyst)			Remarks
			Ranking (Priority)	Rating (Priority)	Overall (Priority)	
C2.1						
C2.2						
C2.3						
		Total = 100				

3.3.1.3 CALCULATING RELATIVE WEIGHT

Once the experts on the team have assigned a rank and rating to each decision element, their responses need to be analysed. The goal of this analysis is to calculate the relative weight, or importance, of each decision element based on a synthesis of the different responses provided.

Step 1: After the Expert Team has filled out their forms, the data can be entered into a spreadsheet, or a table similar to Table 1. This table contains field data from an expert group asked to Rank (using Regular Ranking) and Rate the four Criteria relevant to Principle 2 (Maintenance of Ecosystem Integrity) of the CIFOR Generic C&I Template.

Table 1. **Ranks and Ratings of Criteria Relevant to Principle 2**

Criteria	Expert 1		Expert 2		Expert 3	
	Rank	Rating	Rank	Rating	Rank	Rating
C2.1	5	20	5	20	8	20
C2.2	8	40	7	35	8	30
C2.3	6	30	6	30	7	25
C2.4	4	10	4	15	6	15

Step 2: For both Ranking and Rating, calculate the sum of the expert's votes for each Criterion. This will show the total weight allocated to each Criterion by these two different techniques. Calculate the total of all votes for both Ranking and Rating.

Table 2. **Sum of Votes for Each Criterion**

Criteria	Sum of Ranking Votes		Sum of Rating Votes	
	Calculation	Ranking	Calculation	Rating
C2.1	5 + 5 + 8	18	20 + 20 + 20	60
C2.2	8 + 7 + 8	23	40 + 35 + 30	105
C2.3	6 + 6 + 7	19	30 + 30 + 25	85
C2.4	4 + 4 + 6	14	10 + 15 + 15	40
Total		**74**		**290**

Step 3: In order to combine the results of the Ranking and Rating techniques in Step 2, the relative weight of each Criterion needs to be calculated for both techniques.

The relative weight of each Criterion can be calculated for each technique by dividing its actual weight by the total of all actual weights and multiplying by 100.

Table 3. **Calculated Relative Weights for Ranking and Rating Techniques**

Criteria	Relative Weight		Relative Weight	
	Calculation	Ranking	Calculation	Rating
C2.1	18 ÷ 74 × 100	24	60 ÷ 290 × 100	21
C2.2	23 ÷ 74 × 100	31	105 ÷ 290 × 100	36
C2.3	19 ÷ 74 × 100	26	85 ÷ 290 × 100	29
C2.4	14 ÷ 74 × 100	19	40 ÷ 290 × 100	14
Total		**100**		**100**

Once the relative weights have been calculated for both the Ranking and Rating results the two can be compared. In this case, the two techniques show similar results.

Step 4: To calculate a final combined weight for each Criterion, the relative weights calculated for both the Ranking and Rating techniques can be averaged.

Table 4. **Calculating the Combined Weight for Each Criterion**

Criteria	Calculation	Combined Weight
C2.1	(24 + 21) ÷ 2	22
C2.2	(31 + 36) ÷ 2	34
C2.3	(26 + 29) ÷ 2	28
C2.4	(19 + 14) ÷ 2	16
Total		**100**

The calculation of the Combined Weights of each Criterion shows that the Criteria C2.1, C2.2 and C2.3 are deemed relatively more important than Criterion C2.4. Hence, it may be instructive to examine Criterion C2.4 to see if it can be omitted from further consideration in the analysis.

Following the assessment of each Criterion, the Indicators can also be assessed. This assessment is done by Ranking or Rating the Indicators according to their perceived importance relative to the Criteria they come under.

3.3.2 SCORING: THE SECOND STEP

A scoring system that adequately reflects the performance of a FMU being assessed is the key to any evaluation system. MCA methods can be used prior to scoring in order to streamline the set of C&I being evaluated. Streamlining can ensure that time and money are spent on scoring only relevant C&I.

While the process of scoring the different sets of C&I is outside the scope of this manual, a dynamic and informative scoring system that works well with MCA is suggested below.

Score	General Description
*	Impossible to score at a time of assessment; possibly due to lack of information or unavailability of field samples. To be scored at a later date.
0	Not an applicable Criteria or Indicator.
1	Extremely weak performance; strongly unfavourable.
2	Poor performance; unfavourable; may be the norm for the region, but major improvement needed.
3	Acceptable; at or above the norm for good operations in the region.
4	Very favourable performance; well above the norm for the region, but still needing improvement to be state of the art.
5	'State of the art' in region; clearly outstanding performance which is way above the norm for the region.

3.3.3 ASSESSMENT OF THE FOREST MANAGEMENT UNIT: THE THIRD STEP

This is the final step in a C&I assessment. The goal of this step is to estimate the overall performance of the FMU and express it as a score. The calculation of a score, or scores, that adequately reflect the performance of the

FMU allow it to be compared with other FMUs. Generally, this assessment is the most accessible if done at the Criteria level because it is still specific enough to allow for variation, but general enough to allow for comparison.

The final score for each Criterion can be calculated by averaging the 'weighted' scores given to all its Indicators. These 'weighted' scores can be calculated by combining the relative weights of each Indicator (The First Step, section 3.3.1) with the actual scores assigned to each Indicator (The Second Step, section 3.3.2). By combining these two steps, a score is reached that reflects the relative importance of each Indicator in relation to the Criterion it helps measure.

In Table 5 below, the Expert Team has given all the Indicators under Criterion C2.1 a score using the Regular Ranking method. The Relative Weight of each score has been calculated, and these Relative Weights have been averaged; this is a similar series of calculations as is described in Section 3.3.1 'Selection of C&I Set: The First Step'. These Average Weights have been combined with the Scores given to each Indicator to get 'weighted' scores. The sum of these 'weighted scores' is the final score that reflects the performance of the FMU in relation to Criterion C2.1.

Criterion C2.1

Clear evidence of long-term forest use rights to the land (e.g. land title, customary rights, or lease agreements) shall be demonstrated.

Table 5. **Calculating the Combined Weight for Each Criterion**

Indicator 2.1	Rank			Relative Weights			Avg. Weight (w)	Score (s)	Final Score (w × s)
	Expert 1	Expert 2	Expert 3	Expert 1	Expert 2	Expert 3			
I2.1.1	7	9	7	27	27	26	27	3	80
I2.1.2	7	8	6	27	24	22	24	3	73
I2.1.3	6	8	8	23	24	30	26	2	51
I2.1.4	6	8	6	23	24	22	23	2	46
Total	26	33	27	100	100 *	100			**251**

The Average Weight column shows very little variability between the scores assigned to each Indicator. As a result, *all* these Indicators are important and must be used in the final assessment of the FMU. A final score for the FMU can be calculated by taking the sum of the Final Scores and dividing it by 100. Therefore, the final score for Criterion C2.1, based on the expert team's judgements, is (251 ÷ 100) = 2.51.

This performance measure of 2.51 implies that the FMU is performing a little below what is considered good operational regional standard in terms of Criterion C2.1. In other words, evidence of long-term forest use rights to the land has not been acceptably demonstrated. According to the scoring guide on section 3.3.2, a score of 3 or better is *Acceptable: at or above the norm for good operations in the region*.

4 More Specific Application of AHP: Pairwise Comparisons

4.1 THE PAIRWISE COMPARISON

Definition: The Pairwise Comparison (PC) method involves one-on-one comparisons between each of the Indicators. The Expert Team is asked to make comparative judgements on the relative importance of each pair of Indicators in terms of the Criterion they measure. These judgements are used to assign Relative Weights to the Indicators. This method is based at the Indicator level because it is at this level that the Principles and Criteria are the most measurable and observable.

Advantages: The Pairwise Comparison method provides a much finer analysis of the responses provided by the Expert Team. The analysis is finer because:

a. Like Rating, the Pairwise Comparison method measures both ordinal and cardinal importance of the different Indicators;

b. The responses of the Expert Team should be more specific as they have to consider each Indicator's importance in relation to all the other Indicators; and

c. The Pairwise Comparison method can be analysed for consistency. This Consistency Index can indicate *when* there is a great inconsistency among the responses, and help to pin point *where* the inconsistencies have occurred. This can help make the analysis more reliable and accurate.

4.1.1 COLLECTING THE DATA

Example: To calculate the Relative Weight of the four Indicators under Criterion C2.1 using the Pairwise Comparison method, the Expert Team is given *Response Form 2A* (see Annex 7.2). In this form they are asked to compare each Indicator to the other three Indicators relevant to

Criterion C2.1. To facilitate this they are asked to use the following numerical scale.

Numerical Scale for Comparative Judgement of Indicators	
Scale	**Meaning/Interpretation**
1	Equal Importance
3	Moderately More Important
5	Strongly Important
7	Very Strongly Important
9	Extremely More Important

One Expert might fill in *Response Form 2A* as follows,

Indicator A									Criterion C2.1									Indicator B
I2.1.1	9	8	7	6	5	4	3	2	1	2	3	4	5	**6**	7	8	9	I2.1.2
I2.1.1	9	8	7	6	5	4	3	2	1	**2**	3	4	5	6	7	8	9	I2.1.3
I2.1.1	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	I2.1.4
I2.1.2	9	8	7	6	5	4	3	2	1	**2**	3	4	5	6	7	8	9	I2.1.3
I1.1.2	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	I2.1.4
I1.1.3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I2.1.4

The shaded squares are the ones chosen by the expert to represent the relationship between the 2 indicators being compared.

For this Pairwise Comparison, one can generate a comparison matrix as follows:

	I2.1.1	I2.1.2	I2.1.3	I2.1.4
I2.1.1	1	⅙	½	2
I2.1.2	6	1	1	½
I2.1.3	2	1	1	3
I2.1.4	½	2	⅓	1

This matrix is a way of displaying the data gathered using *Response Form 2A*. By displaying this data comparing Indicators I2.1.1 to I2.1.4 in matrix form it is possible to calculate the Relative Weight of Criterion 2.1. The data in the matrix can be explained using the first row as an example.

- The first element is 1 because the Indicator I2.1.1 is being compared to itself.
- The second element is ⅙ because the Expert considers I2.1.2 to be strongly more important (value 6) than I2.1.1. Hence, a value of ⅙ was placed on the intersection of *row* I2.1.1 and *column* I2.1.2, and a value of 6 (the reciprocal) was placed on the intersection of *row* I2.1.2 and *column* I2.1.1 (see dark shaded squares).
- The third element in the row has a value of ½ because in comparing I2.1.1 with I2.1.3, the expert considers I2.1.3 to be weakly more important than I2.1.1. Hence, a value of 2 (reciprocal of ½) was placed at the intersection of *row* I2.1.3 and *column* I2.1.1 (see light shaded squares).
- The fourth element of the matrix is 2 because in comparing

I2.1.1. with I2.1.4, the expert considers I2.1.1 to be weakly more important than I2.1.4. Hence the value of ½ (reciprocal of 2) was placed at the intersection of *row* I2.1.4 and *column* I2.1.1.

4.1.2 CALCULATING RELATIVE WEIGHT

Saaty (1995) describes four different approaches to calculating Relative Weights based on the Pairwise Comparison matrix. In this manual, we will only describe the one of these methods we consider the most useful in the context of C&I assessment. For information on the other methods, refer to Saaty (1995).

To calculate the Relative Weights of the Indicators in the matrix on the previous page, three steps are necessary.

Step 1: Calculate the sum of each column.

	I2.1.1	I2.1.2	I2.1.3	I2.1.4
I2.1.1	1	⅙	½	2
I2.1.2	6	1	1	½
I2.1.3	2	1	1	3
I2.1.4	½	2	⅓	1
Total	**9.5**	**4.2**	**2.8**	**6.5**

Step 2: Normalise[3] the elements in each column by dividing by the column sum (calculated in Step 1.) Add the normalised elements of each row.

	I2.1.1	I2.1.2	I2.1.3	I2.1.4	Total
I2.1.1	0.105 (1/9.5)	0.040	0.176	0.308	**0.629**
I2.1.2	0.632 (6/9.5)	0.240	0.353	0.077	**1.301**
I2.1.3	0.211 (2/9.5)	0.240	0.353	0.462	**1.265**
I2.1.4	0.053 (0.5/9.5)	0.480	0.118	0.154	**0.804**

Nuts and Bolts

The numbers in parenthesis show the calculation used to derive the value displayed in the box. For example, 1 divided (/) by 9.5 (column total) = 0.105

Step 3: Divide the row totals in Step 2 by the number of Indicators compared. In this case 4 Indicators were compared.

Relative weight of I2.1.1	0.629 ÷ 4 =	**0.1574**
Relative weight of I2.1.2:	1.301 ÷ 4 =	**0.3254**
Relative weight of I2.1.3:	1.265 ÷ 4 =	**0.3163**
Relative weight of I2.1.4:	0.804 ÷ 4 =	**0.2010**

3 The elements need to be normalised so they can be compared and assimilated.

Step 4: Calculate Relative Weights for the Indicators based on input from other experts.

The shaded scores calculated above represent the Relative Weights for each Indicator based on the Pairwise Comparisons from one expert. Next, the comparisons from the other experts in the team need to be put in matrix form and converted to a Relative Weight value.

In the Central Kalimantan Field Test, the Relative Weights calculated for the other experts were:

Table 6. **Relative Weights Calculated Using Pairwise Comparisons for All 4 Experts**

Indicator	Pairwise Comparison				Average Relative Weight (Total ÷ 4)
	Expert 1	Expert 2	Expert 3	Expert 4	
I2.1.1	16	52	7	11	**21**
I2.1.2	33	9	14	30	**22**
I2.1.3	32	13	54	51	**38**
I2.1.4	20	26	25	8	**20**

Notice that all these scores have been multiplied by 100. For example, the score given to I2.1.1 by expert 1 in the calculation above is 0.1574, and in Table 6 it has been rounded up and multiplied by 100 to get the score 16. This has been done to make the numbers easier to work with. As long as *all* the numbers are multiplied by 100, the relationship between them will not change.

Step 5: Calculate a final score for Criterion C2.1.

Indicator	Average Relative Weight (w)	Score (s)	Final Score (w × s)
I2.1.1	21	3	63
I2.1.2	22	3	66
I2.1.3	38	2	76
I2.1.4	20	2	40
Total			245

As with the Ranking and Rating approaches, the Average Relative Weight calculated for each Indicator can be combined with the score given each Indicator to come up with a weighted score for each Indicator. The sum of these weighted scores for the Indicators provides a final weighted score for the Criterion in question (C2.1).

Final Calculated Scores for C2.1

The final score using Pairwise Comparisons is (245 ÷ 100) = **2.45**.

The final score using the Ranking method was **2.51**.

The text box above displays the final score calculated for the FMU in question using the Pairwise Comparison approach and the simpler Ranking approach. In this case the scores are very similar and thus the main advantage of using the Pairwise Comparison is its facility for analysing the consistency of the judgements made by each expert. How to calculate this (In)consistency Index is described in the next section.

4.2 – CALCULATING THE (IN)CONSISTENCY INDEX (C.I.)[4]

The (In)consistency Index (C.I.) is a measure of how logically consistent the judgements of the expert/participant are. The following Scenario gives an example of inconsistency of judgement.

Pairwise Comparison Scenario

Purpose: to give an example of judgement inconsistency.

Scenario: An expert is asked to do a Pairwise Comparison of 3 Indicators called *a*, *b* and *c*. She decides that Indicator *a* is more important than Indicator *b* by a value of 3; Indicator *b* is more important than Indicator *c* by a value of 3; Indicator *c* and Indicator *a* have equal importance.

Analysis: In this scenario the expert's decision to give Indicator *a* and *b* equal importance is inconsistent. Given her previous comparisons, a logically consistent judgement would be to decide that Indicator *a* is more important than Indicator *c* by a value of 6. Any number of reasons could account for this inconsistency, for example individual interpretation of the Indicators, tiredness and the repetitive nature of the methodology.

In this scenario, then, it is useful for the analyst to have a way of measuring the consistency of the judgements being given. In general, a higher consistency of judgements implies better judgements and, therefore, will result in more reliable estimates of the relative weights.

The (In)consistency Index provides a means of measuring the consistency of an Expert Team's judgements when they are using the Pairwise Comparison method. It can provide information on consistency in terms of both the ordinal and cardinal importance of the two elements compared. In general, a tolerance consistency index of 10% is set for comparisons involving no more than 9 elements. As there are rarely more than 9 Indicators under any Criterion, this is the

4 The Inconsistency Index is commonly referred to as the Consistency Index; hence the acronym C.I. However, in the context of this manual, when the term C.I. is used it refers to a measurement of inconsistency.

tolerance level most applicable to C&I analysis. Higher inconsistency levels may be tolerable for comparisons involving more than 9 elements.

Using the set of Indicators under Criterion C2.1, we can calculate the (In)consistency Index as follows:

Step 1: Multiply the column totals for each Indicator (see section 4.1.2 *Calculating Relative Weight*: Step 1.) by the calculated Relative weights for each Indicator (see section 4.1.2 *Calculating Relative Weight*: Step 3), and add the results.

Using the Indicators for Criterion C2.1 the result would be,

$(9.5 \times 0.1574) + (4.17 \times 0.3254) + (2.83 \times 0.3163) + (6.50 \times 0.2010) = \mathbf{5.054}$

Step 2: Subtract the number of elements (Indicators compared) from the result of Step 1.

$5.054 - 4 = \mathbf{1.054}$

Step 3: Divide the result of Step 2 by the number of Indicators less one.

$1.054 \div (4 - 1) \cong \mathbf{0.35}$

Therefore, the Consistency Index for this matrix is 0.35 or 35%. As this is above the tolerance Consistency Index of 10% it implies a high degree of inconsistency amongst the judgements of the expert who provided the responses. In the context of the analysis, then, these responses might not give a very reliable estimate of the relative weights of the Indicators.

4.3 – IMPROVING THE CONSISTENCY OF JUDGEMENTS (FOR EACH EXPERT)

While it is important for the analyst to be able to measure the degree of inconsistency related to the judgements of the individuals in the Expert Team, this measurement by itself won't help to improve the consistency of these judgements. One of the advantages of using the Pairwise Comparison method is that it makes it possible to pinpoint the decisions that contribute to inconsistency in the judgements made by each expert. With information about the degree of inconsistency in regard to their judgements, and information on the specific areas of inconsistency, the Expert Team has the tools to re-evaluate the first set of responses made, and modify them with the intent of being more consistent.

For the Indicators under Criterion C2.1, the comparison matrix representing the responses of expert 1 looks like this (for a detailed explanation of how the Relative Weight was calculated see *Calculating Relative Weight*):

	I2.1.1	I2.1.2	I2.1.3	I2.1.4	Relative Weight
I2.1.1	1	⅙	½	2	**0.1574**
I2.1.2	6	1	1	½	**0.3254**
I2.1.3	2	1	1	3	**0.3163**
I2.1.4	½	2	⅓	1	**0.2010**

The Consistency Index for this matrix was calculated in the previous Section to be ≅ 35%. The next step is to try and pinpoint the sources of this high inconsistency. In order to do this, the consistency of each comparison made needs to be calculated. In the matrix above, this means that each of the shaded values should be analysed. Only half the matrix needs to be analysed because the values in the shaded half are the inverse of the values in the unshaded half. In other words, the values in the shaded half and the unshaded half represent the same comparisons, just in different ways.

For each comparison a value that reflects the (in)consistency of the judgement can be calculated by multiplying the value assigned to the comparison by the ratio of relative weights ($^{w1}/_{w2}$) of the two Indicators being compared.

For example, the value assigned to the relationship between I2.1.1 and I2.1.2 is ⅙. To calculate an (in)consistency value for this comparison, ⅙ must be multiplied by the ratio of relative weights for I2.1.1 (0.1574) and I2.1.2 (0.3254). The calculation looks like this,

⅙ × (0.1574 ÷ 0.3254) = **0.08**

Using this calculation the following matrix can be constructed. The shaded areas show how each (in)consistency value was calculated.

	I2.1.1	I2.1.2	I2.1.3	I2.1.4
I2.1.1	1	**0.08** ⅙ (0.157 ÷ 0.325)	0.25 ½ (0.157 ÷ 0.316)	1.57 2 (0.157 ÷ 0.201)
I2.1.2		1	1.03 1 (0.325 ÷ 0.316)	0.81 ½ (0.325 ÷ 0.201)
I2.1.3			1	4.72 3 (0.316 ÷ 0.201)
I2.1.4				1

The comparison with the lowest calculated value is the most inconsistent.

Interpretation: In the matrix above, the comparison with the lowest calculated value is the comparison between I2.1.1 and I2.1.2 (0.08). Therefore, this is the most inconsistent of the comparisons made by *expert 1*.

To improve the consistency of the judgements made by this expert, the Pairwise Comparison of I2.1.1 and I2.1.2 should be changed in the direction of the ratio of Relative Weights ($w1/w2$). Remember that $1/6$ means *expert 1* regards I2.1.2 to be 6 times more important than I2.1.1. In this case, the ratio of Relative Weights ($w1/w2$) is ($0.157/0.325$). In order to interpret this, ratio in a useful way it needs to be converted to the format $1/x$. Since,

0.325 ÷ 0.157 = **2.07**

the ratio $0.157/0.325$ can be expressed as approximately $1/2$. Therefore, to reduce the inconsistency of *expert 1*'s judgements the value $1/6$ needs to be moved closer to the value $1/2$. In other words, I2.1.2 should be judged as more important than I2.1.1 by a value of 2, not 6.

Indicator A								Criterion C2.1										Indicator B
I2.1.1	9	8	7	6	5	4	3	**2**	1	2	3	4	5	**6**	7	8	9	I2.1.2

Changing this value will change the Relative Weights of the Indicators and the (In)consistency Index for *expert 1* will fall to 0.38. This process can be repeated until the C.I. is within the 10% tolerance level. The goal is not to totally eliminate inconsistency, rather to bring it within tolerable limits.

5 The Bottom-Up Approach and Forest Management

The 'bottom-up' approach to C&I selection differs from the 'top-down' approach in the following ways:

- The 'bottom-up' approach can be used to select a set of C&I without the benefit of a Generic Template. In this case, the set of C&I chosen come from the ideas and recommendations of the Selection Team.
- There is less of a focus on the assessment of C&I from the perspective of forest certification. Instead, the emphasis is on the assessment of C&I as management tools within the general context of Sustainable Forest Management.
- The approach is purposely organised in a way that accommodates the direct involvement and active participation of various stakeholders within a Forest Management Unit.

A theoretical application of the 'bottom-up' approach is described in the following box.

Forest Management Scenario • Bottom-up Approach

Step 1: Open brainstorming session. Each Team member is entitled to suggest appropriate list of C&I.

Step 2: A complete list of all suggested C&I is compiled.

Step 3: Each Team Member is asked to pick a fixed number (n) of Criteria or Indicators from the list. This number can vary depending on the resources or variability within the FMU in question.

Step 4: The Team Members are asked to rank the Criteria or Indicators in their list according to perceived degree of importance (i.e. 1,2, … n).

Step 5: From the ranked list generated by each Team member in Step 4, determine the relative weights of each Criteria or Indicator.

Step 6: Prioritise and select the set of C&I based on their relative weights. C&I which are rated significantly lower are discarded.

Step 7: If the list is satisfactory to all Team members, an acceptable list is identified. If not, the process may be repeated by increasing (n), or by considering other C&I from the complete list which were not previously included.

5.1 – CASE STUDY: CENTRAL KALIMANTAN

Nuts and Bolts

Information on the 'bottom-up' approach is presented in this section in a Case Study format. The key points covered in the study are outlined in a text box at the end of the Section.

In order to illustrate an application of the bottom-up approach, a Case Study done in Central Kalimantan (Mendoza and Prabhu 1998b) is outlined below. The study was not a 'pure' 'bottom-up' approach in that the CIFOR Generic Template was used as a guide. The Assessment Team was free to add/delete or create new C&I, but they were not starting from 'scratch'. Their goal was to create a set of C&I suitable as a guide to Forest Management in the FMU being studied. In many ways, this is a good example of a '*mixed*' approach that incorporates aspects of the 'top-down' and 'bottom-up' approaches. However, in this Section the Case Study is used to illustrate the advantages and difficulties of using MCA in a bottom-up situation.

Assessment Team Assembled

- 4 employees; full time staff of the FMU
- 2 villagers coming from 2 villages under the FMU's community forestry program
- 1 academic lecturer
- 1 government employee
- 1 social scientist
- 1 CIFOR employee stationed at the site

The C&I assessment was carried out in an FMU of about 125 000 hectares that started operating in 1973. The 1997 annual report of the company showed that it harvested about 94 800 cubic meters and 2200 hectares from the concession. All log production was allocated to the company's wood processing mills, mainly the plywood mill. There are five villages and resettlement area, and three transmigration areas located within the concession.

An Assessment Team that would adequately represent the various stakeholders in the FMU was assembled. The process of identifying stakeholders and involving them in the decision-making process is a complex and difficult task. Further references on stakeholder identification are included at the end of this Section.

Recognising the discrepancy in expertise, educational background and technical capabilities of the team members, it was necessary to have discussions and presentations on C&I and MCA prior to the voting taking place. A half day was set aside for these discussions/presentations; the following procedure was used:

- The Generic C&I were translated into the local language.
- Discussions, questions and interactions were all done in the local language.
- The Response forms were prepared and translated in advance.
- Briefing documents briefly explaining C&I in general, and MCA in particular were also prepared and translated in advance.
- General instructions on filling in the forms were thoroughly explained.

THE VOTING PROCESS

In order to facilitate the voting process, the 10 team members were divided into two subgroups. Group 1 consisted of members whose expertise was related to the Policy and Social Principles; Group 2 consisted of members whose expertise related to the Ecology and Production Principles.

Before voting began, the MCA facilitator explained the following:

- The C&I element (i.e., Principle, Criteria, Indicator) being evaluated.
- The hierarchical relationship between the elements being evaluated.
- The role of MCA techniques.
- The type of input required from the team members depending on the MCA technique used.
- Instructions for filling out the response forms.

The Chronology of the analysis proceeded as follows:

1. The Criteria level analysis was done first. In this way, the team members were introduced to the analysis where the degree of detail is of sufficient depth and breadth that it is easily within the grasp and comprehension of all team members;
2. The Indicator level analysis followed the Criteria assessment. At this stage, it is likely that each team member had gained a better understanding of the process and C&I. More importantly, this is the level where the team members would probably feel the most comfortable as Indicators are less conceptual and more detailed than Principles and Criteria; and
3. The Assessment at the Principle level was done after the Criteria and Indicator level analyses. It was expected that by analysing the Principle level last the team members would be fully cognisant of the C&I and MCA process, and would be better prepared to do the broad assessment required at the Principle level. At the Principle level, the team was not divided into subgroups.

As in the ‘top-down’ approach, the voting was structured so that each Criteria or Indicator was discussed as a group, but everyone voted individually. As well each sub-group chose one of its members to facilitate the discussion.

The Ranking and Rating approaches were used as initial screening tools. They provided a quick way to filter out C&I elements that were not sufficiently significant. The Pairwise Comparison was used as a fine filter to decide further which C&I elements were least significant and might be recommended for omission. The team seemed most comfortable with the Ranking and Rating approaches and least comfortable with the Pairwise Comparisons, mainly because of the number of one on one judgements that needed to be made. This might have been because the Pairwise Comparisons were carried out at the end of the assessment when the assessment team was tired and less focussed.

Key Points

A number of key points can be extrapolated from the experiences in Central Kalimantan and applied to 'Bottom-up' or 'Mixed' approaches to C&I assessment.

1. Assembling a Selection Team with appropriate representation from the different stakeholders in the FMU is essential. The nature of the Selection Team will strongly influence the applicability and the general acceptance of the decisions made.
2. Adequate time must be allocated for preparation. This might include translating all relevant documents into the local language, as well as discussions and workshops to familiarise the Selection Team with C&I and MCA.
3. The MCA techniques used must be relevant to the goals of the analysis.
4. Adequate time must be allocated for the process. Ideally, there would be time for the Selection Team to take a break from the process between the Ranking/Rating analysis and the Pairwise Comparisons.
5. Having a facilitator in each sub-group would help ensure that all the team members are involved in the discussion process.

References on Stakeholder Identification

Borrini-Feyerabend, G. (ed.). 1997. Beyond Fences: Seeking Social Sustainability in Conservation, Volume 1 and 2. IUCN, Gland, Switzerland.

Colfer, C.J.P., Brocklesby, M.A., Diaw, C., Etuge, P., Günter, M., Harwell, E., McDougall, C., Porro, N.M., Porro, R., Prabhu, R., Salim, A., Sardjono, M.A., Tchikangwa, B., Tiani, A.M., Wadley, R.L., Woelfel, J. and Wollenberg, E. 1999. The BAG (Basic assessment guide for human well-being). Criteria & Indicators Toolbox Series No. 5. CIFOR, Bogor, Indonesia.

6 Literature and Further Reading

Forest Stewardship Council (FSC). 1994. Forestry Stewardship principles and criteria for natural forest management. Oaxaca, Mexico.

Golden, B., Harker, P. and Wasil, E. 1989. The Analytic hierarchy process: Applications and studies. Springer Verlag, the Netherlands.

International Timber Trade Organization (ITTO). 1992. Criteria for the measurement of sustainable tropical forest management. ITTO, Yokohama, Japan.

Landres, P.B. 1992. Ecological indicators: Panacea or liability? *In:* McKenzie, D.H., Hyatt, D.E. and McDonald, J.E. (eds.) Ecological Indicators, Volume 2, pp. 1295–1319. Elsevier Applied Science, London.

Mendoza, G.A. 1997a. Introduction to the analytic hierarchy process: Theory and application to natural resources management. Proceedings: Joint Annual Meeting of the American Congress on Surveying and Mapping (ACSM); American Association of Photogrammetry and Remote Sensing (ASPRS), and Resources Technology Institute (RTI). April 5–10. Seattle, WA.

Mendoza, G.A. 1997b. A GIS-based multicriteria approaches to land suitability assessment and allocation. Proceedings: Seventh International Symposium on Systems Analysis in Forest Resources. May 28–31. Traverse City Michigan.

Mendoza, G.A. and Prabhu, R. 1998a. Multiple criteria decision making approaches to assessing forest sustainability using criteria and indicators: A case study — Part I. CIFOR, Bogor, Indonesia.

Mendoza, G.A. and Prabhu, R. 1998b. Multiple criteria analysis for assessing criteria and indicators in sustainable forest management: A case study on participatory decision making — Part II. CIFOR, Bogor, Indonesia.

Oxford Dictionary of Current English. 1987. Oxford University Press, New York.

Prabhu, R., Colfer, C.J.P., Venkateswarlu, P., Tan, L.C., Soekmadi, R. and Wollenberg, E. 1996. Testing criteria and indicators for the sustainable management of forests. Phase I. Final Report. CIFOR Special Publication. CIFOR, Bogor, Indonesia.

Prabhu, R., Colfer, C.J.P. and Dudley, R.G. 1999. Guidelines for developing, testing and selecting criteria and indicators for sustainable forest management. Criteria and Indicators Toolbox Series No. 1. CIFOR, Bogor, Indonesia.

Saaty, T. 1995. Decision making for leaders: The analytic hierarchy process in a complex world. RWS Publications, Pittsburgh, PA.

Scientific Certification Systems (SCS). 1994. The forest conservation program: Programme description and operations manual. SCS, California.

SGS Forestry. 1994. Assessors handbook, policy document and procedures manual. SGS Forestry, Oxford, UK.

Tropenbos Foundation. 1997. Hierarchical framework for the formulation of sustainable forest management standards. Tropenbos, the Netherlands.

Vargas, L. and Zahedi, F. 1993. Special issue. Analytic hierarchy process and its applications. Mathematical and Computer Modeling Vol. 17.

7 Annexes

7.1 – GLOSSARY

Analytic Hierarchy Process (AHP)

The AHP method reduces complex decisions into a series of simple comparisons, called Pairwise Comparisons, between elements of the decision hierarchy. By synthesising the results of these comparisons, AHP can help you arrive at the best decision and provide a clear rational for the choice you made.

Criterion

Criteria are the intermediate points to which the information provided by indicators can be integrated and where an interpretable assessment crystallises (Prabhu *et al.* 1999)

(In)consistency Index (C.I.)

A means of measuring the consistency of an Expert Team's judgements when they are using the Pairwise Comparison method. It can provide information on consistency in terms of both the ordinal and cardinal importance of the two elements compared.

Cardinal Importance

This refers to the difference in magnitude between the importance of two elements. For example, one element might be three times more important than another one.

Decision Element

This term refers to the different elements that need to be analysed in order to make complex decisions.

Indicator

Any variable or component of the forest ecosystem or the relevant management system used to infer attributes of the sustainability of the resources and its utilisation's (Landres 1992; Prabhu *et al.* 1996).

Forest Management Unit (FMU)

A clearly demarcated area of land covered predominantly by forests, managed to a set of explicit objectives and according to a long-term management plan.

Pairwise Comparison

Making one-on-one comparisons between each of the decision elements (i.e., Indicators).

Principle

A fundamental truth or law as the basis of reasoning or action. (*Oxford Dictionary of Current English* 1987; Prabhu *et al.* 1999).

Rating

The decision elements are assigned 'scores' between 0 and 100. The scores for all elements being compared must add up to 100.

Sustainable Forest Management (SFM)

A way of dealing with the forest that maintains or enhances ecological functions and human well-being.

Multi-Criteria Analysis (MCA)

A decision-making tool developed for complex multi-criteria problems that might include qualitative and quantitative aspects of the problem in the decision-making process.

Ordinal Importance

This refers to the order of importance of the list of elements involved. For example, which one comes first, second etc.

Ranking

Each decision element is assigned a rank that reflects its perceived degree of importance relative to the decision being made. The decision elements can then be ordered according to their rank (first, second etc.)

Stakeholder

Person or group with an interest in the forest.

Verifier

Data or information that enhances the specificity or the ease of assessment of an indicator (Prabhu *et al.* 1996).

Weighting

A value that reflects the relative importance of a decision element (i.e. Indicator) with respect to other decision elements.

7.2 – SAMPLE DATA COLLECTION FORMS

Response Form 1A

(Please refer to CIFOR Generic Template for detailed information about the Principles)

Description: Response Form 1A is designed for Level 1 Analysis of Stage 1. Stage 1 is aimed at generating a prioritised list of Criteria based on the CIFOR Generic C&I Template. Level 1 analysis elicits responses from respondents based on their perceived importance of the six Principles.

Purpose of Form: The purpose of Form 1A is to estimate the relative importance or weight for each Principle in the overall assessment of forest sustainability.

Principle	Ranking	Rating	Relative Weights/Priorities (To be filled by Analyst)			Remarks
			Ranking (Priority)	Rating (Priority)	Overall (Priority)	
Principle 1						
Principle 2						
Principle 3						
Principle 4						
Principle 5						
Principle 6						
		Total = 100				

Response Form 1B

(Please refer to CIFOR Generic Template for detailed information about the Criteria and Indicators)

Description: Response Form 1B is designed for Level 2 analysis of Stage 1. Level 2 elicits responses from respondents about their opinions on the importance of each Criterion relative to the Principle, in particular, and overall forest sustainability, in general.

Purpose of Form: The purpose of Form 1B is to estimate the relative importance or weight of each Criterion under each Principle.

Coding of Criteria: Ci.j ; *i* refers to Principle index number; *j* refers to criteria index number

Principle 1 Criterion	Ranking	Rating	Relative Weights/Priorities (To be filled by Analyst)			Remarks
			Ranking (Priority)	Rating (Priority)	Overall (Priority)	
C1.1						
C1.2						
C1.3						
C1.4						
C1.5						
C1.6						
		Total = 100				

Principle 1 Criterion	Ranking	Rating	Relative Weights/Priorities (To be filled by Analyst)			Remarks
			Ranking (Priority)	Rating (Priority)	Overall (Priority)	
C2.1						
C2.2						
C2.3						
		Total = 100				

Response Form 2A: Pairwise Comparisons

(Please refer to CIFOR Generic C&I Template for detailed information about the Criteria and Indicators)

Description: Response Form 2A is designed for Stage 2 of the Analysis. Stage 2 is aimed at generating a Prioritised list of Indicators for each Criterion.

Purpose of Form: The purpose of the Form is to estimate the relative importance or weight of each Indicator under each Criterion using the Pairwise Comparison method.

Indicator A	Criterion C1.1																	Indicator B
I1.1.1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.2
I1.1.1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.3
I1.1.1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.4
I1.1.1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.5
I1.1.2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.3
I1.1.2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.4
I1.1.2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.5
I1.1.3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.4
I1.1.3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.5
I1.1.4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	I1.1.5

7.3 – THE CIFOR GENERIC TEMPLATE OF CRITERIA AND INDICATORS*
(WITHOUT VERIFIERS)

P	C	I	Description
1			**Policy, planning and institutional framework are conducive to sustainable forest management**
	1.1		**There is sustained and adequate funding for the management of forests**
		1.1.1	Policy and planning are based on recent and accurate information
		1.1.2	Effective instruments for inter-sectoral coordination on land-use and land management exist
		1.1.3	A Permanent Forest Estate (PFE), which includes both protection and production forests and is the basis for sustainable management, exists and is protected by law
		1.1.4	There is a regional land use plan (or PFE) which reflects the different forested land uses, and give attention to such factors as population, agriculture, conservation, environmental, economic and cultural values
		1.1.5	Institutions responsible for forest management and research are adequately funded and staffed
	1.2		**Precautionary economic policies exist**
		1.2.1	Reserve funds for potential damages are available (performance bond)
		1.2.2	Anti-corruption provisions have been implemented
	1.3		**Non forestry policies do not distort forest management**
		1.3.1	Absence of agricultural sector incentives for production expansion
		1.3.2	Absence of price controls on domestic food production
		1.3.3	Absence of price controls on fuel oils
		1.3.4	Absence of distorting resettlement policies
		1.3.5	Absence of distorting exchange rate over or under-valuation
	1.4		**A functioning buffer zone exists**
		1.4.1	Low level of conflict at forest management unit (FMU) boundary
		1.4.2	Local respect for FMU boundary
		1.4.3	Forest management (e.g., company, concession) has demonstrated attempts to protect FMU boundaries
	1.5		**Legal framework protects access to forest and forest resources**
		1.5.1	Security of tenure is clear and documented
		1.5.2	Existence of non-confiscatory land use policy
		1.5.3	Existence of property rights for exploited non-timber forest products (NTFPs) (e.g. fuel wood)
		1.5.4	Land tenurial prerequisite policy does not discriminate against forestry
		1.5.5	Efficient equivalence log price/export log price
		1.5.6	Transparent system of concession allocation
	1.6		**Demonstrated reinvestment in forest-use options**
		1.6.1	Absence of excessive capital mobility (promoting 'cut and run')
2			**Maintenance of ecosystem integrity**
	2.1		**The processes that maintain biodiversity in managed forests (FMUs) are conserved**
		2.1.1	Landscape pattern is maintained
		2.1.2	Change in diversity of habitat as a result of human interventions are maintained within critical limits as defined by natural variation and/or regional conservation objectives
		2.1.3	Community guild structures do not show significant changes in the representation of especially sensitive guilds, pollinator and disperser guilds

* Excerpted from Criteria & Indicators Toolbox Series No. 2.

P	C	I	Description
		2.1.4	The richness/diversity of selected groups show no significant change
		2.1.5	Population sizes and demographic structures of selected species do not show significant change, and demographically and ecologically critical life-cycle stages continue to be presented.
		2.1.6	The status of decomposition and nutrient cycling shows no significant change
		2.1.7	There is no significant change in the quality and quantity of water from the catchment
	2.2		**Ecosystem function is maintained**
		2.2.1	No chemical contamination to food chains and ecosystem
		2.2.2	Ecologically sensitive areas, especially buffer zones along watercourses, are protected
		2.2.3	Representative areas, especially sites of ecological importance, are protected and appropriately managed
		2.2.4	Rare or endangered species are protected
		2.2.5	Erosion and other forms of soil degradation are minimised
	2.3		**Conservation of the processes that maintain genetic variation**
		2.3.1	Level of genetic diversity are maintained within critical limits
		2.3.2	There is no directional change in genotypic frequencies
		2.3.3	There are no changes in gene flow/migration
		2.3.4	There are no changes in the mating system
3			**Forest management maintains or enhances fair intergenerational access to resources and economic benefits**
	3.1		**Local management is effective in controlling maintenance of, and access to, the resource**
		3.1.1	Ownership and use rights to resources (inter- and intragenerational) are clear and respect preexisting claims
		3.1.2	Rules and norms of resource use are monitored and successfully enforced
		3.1.3	Means of conflict resolution function without violence
		3.1.4	Access to forest resources is perceived locally to be fair
		3.1.5	Local people feel secure about access to resources
	3.2		**Forest actors have a reasonable share in the economic benefits derived from forest use**
		3.2.1	Mechanisms for sharing benefits are seen as fair by local communities
		3.2.2	Opportunities exist for local and forest-dependent people to receive employment and training from forest companies
		3.2.3	Wages and other benefits conform to national and/or International Labour Organisation (ILO) standards
		3.2.4	Damages are compensated in a fair manner
		3.2.5	The various forest products are used in an optimal and equitable way
	3.3		**People link their and their children's future with management of forest resources**
		3.3.1	People invest in their surroundings (i.e., time, effort, and money)
		3.3.2	Out-migration levels are low
		3.3.3	People recognise the need to balance number of people with natural resource use
		3.3.4	Children are educated (formally and informally) about natural resource management
		3.3.5	Destruction of natural resources by local communities is rare
		3.3.6	People maintain spiritual or emotional links to the land

P	C	I	Description
4			**Concerned stakeholders have acknowledged rights and means to manage forests cooperatively and equitably**
	4.1		**Effective mechanisms exist for two-way communication related to forest management among stakeholders**
		4.1.1	> 50% of timber company personnel and forestry officials speak one or more local language, or > 50% local women speak the national language used by the timber company in local interactions
		4.1.2	Local stakeholders meet with satisfactory frequency, representation of local diversity, and quality of interaction
		4.1.3	Contributions made by all stakeholders are mutually respected and valued at a generally satisfactory level
	4.2		**Local stakeholders have detailed, reciprocal knowledge pertaining to forest resource use (including user groups and gender roles), as well as forest management plans prior to implementation**
		4.2.1	Plans/maps showing integration of uses by different stakeholders exist
		4.2.2	Updated plans, baseline studies and maps are widely available, outlining logging details such as cutting areas and road construction, and include temporal aspects
		4.2.3	Baseline studies of local human systems are available and consulted
		4.2.4	Management staff recognises the legitimate interests and rights of other stakeholders
		4.2.5	Management of NTFP reflects the interests and rights of local stakeholders
	4.3		**Agreement exists on rights and responsibilities of relevant stakeholders**
		4.3.1	Level of conflict is acceptable to stakeholders
5			**The health of the forest actors, cultures and the forest is acceptable to all stakeholders**
	5.1		**There is a recognisable balance between human activities and environmental conditions**
		5.1.1	Environmental conditions effected by human uses are stable or improving
		5.1.2	In-migration and/or natural population increases are in harmony with maintaining the forest
	5.2		**The relationship between forest management and human health is recognised**
		5.2.1	Forest managers cooperate with public health authorities regarding illnesses related to forest management
		5.2.2	Nutritional status is adequate among local populations
		5.2.3	Forest employers follow ILO work and safety regulations and take responsibility for the forest-related health risks of workers
	5.3		**The relationship between forest maintenance and human culture is acknowledged as important**
		5.3.1	Forest managers can explain links between relevant human cultures and the local forest
		5.3.2	Forest management plans reflect care in handling human cultural issues
		5.3.3	There is no significant increase in signs of cultural disintegration
6			**Yield and quality of forest goods and services are sustainable**
	6.1		**Forest management unit is implemented on the basis of legal title on the land, recognised customary rights, or clear lease agreements**
		6.1.1	Documentary evidence of the agreements with local communities under which management is entitled to manage the forest exists

P	C	I	Description
		6.1.2	Information on the identity, location and population of all indigenous and traditional peoples living in the vicinity of the management area or claiming customary rights to the management area exists
		6.1.3	Evidence or statements from the representative organisations of local indigenous or traditional communities defining the extend of their territories exist, and include maps
	6.2		**Management objectives are clearly and precisely described and documented**
		6.2.1	Objectives are clearly stated in terms of the major functions of the forests, with due respect to their spatial distribution
	6.3		**Forest management plan is comprehensive**
		6.3.1	A comprehensive forest management plan exists
		6.3.2	Management take place with appropriate involvement of the stakeholders and takes into account all the components and functions of the forest, such as timber production, NTFP, ecology and well-being of local populations
		6.3.3	Yield regulation by area and/or volume prescribed
		6.3.4	Silvicultural systems prescribed and appropriate to forest type and produce grown
		6.3.5	Harvesting systems and equipment are prescribed to match forest conditions in order to reduce impact
		6.3.6	Management plan is periodically submitted to revision
	6.4		**Implementation of the management plan is effective**
		6.4.1	The forest unit is zoned into areas to be managed for various objectives
		6.4.2	Boundaries are marked in the field
		6.4.3	Inventory of all forest uses and products are available
		6.4.4	Workers and staff have adequate training to implement management
		6.4.5	Infrastructure is laid out prior to harvesting and in accordance with prescriptions
		6.4.6	Low residual stand damage
		6.4.7	Rehabilitation of degraded and impacted forest is undertaken in accordance with a code of practice
		6.4.8	Absence of significant off-site impacts such as on down stream water quality/quantity, infrastructure etc.
		6.4.9	Systems for production and transformation of forest products are efficient
	6.5		**An effective monitoring and control system audit's management's conformity with planning**
		6.5.1	Continuous Forest Inventory (CFI) plots are established and measured regularly
		6.5.2	Documentation and record of all forest management and forest activities are kept in forms that enable monitoring
		6.5.3	Worked coupes are protected (e.g. from fire, encroachment and premature re-entry)
		6.5.4	Tree marking of seed stock and potential crop trees is practised
		6.5.5	Results derived from monitoring and research, as well as any additional scientific and technical information, are incorporated into the implementation and revision of the management plan
	6.6		**Equitable distribution and presence of economic rent**
		6.6.1	Estimated government rent capture
		6.6.2	Estimated operator (manager) rent capture
		6.6.3	Estimated forest local dwellers rent capture

Multi-Criteria Analysis (MCA) is a decision-making tool developed for complex problems. In a situation where multiple criteria are involved, confusion can arise if a logical, well-structured decision-making process is not followed. Another difficulty in decision making is that reaching a general consensus in a multidisciplinary team can be very difficult to achieve. By using MCA, the members don't have to agree on the relative importance of the Criteria or the rankings of the alternatives. Each member enters his or her own judgements, and makes a distinct, identifiable contribution to a jointly reached conclusion.

This manual is written for an audience that needs a clear, easy to follow manual that can be used in the field to implement MCA. The information is structured so that the reader is first introduced to the general concepts involved before delving into the more specific applications of Multi Criteria Analysis. The manual reviews the conceptual framework of C&I and introduces the theoretical basis of MCA, and methods such as ranking, rating and pairwise comparisons in the Analytic Hierarchy Process (AHP). It provides an example of how MCA can be applied to C&I in a Forest Certification context both from a 'top-down' perspective as well as in a more 'bottom-up' context.

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