RANKING METHODOLOGIES FOR SUSTAINABLE DEVELOPMENT AND CDM PROJECT CHECKLISTS

1 INTRODUCTION

This paper is the follow up paper to the initial discussion paper "Developing a Methodology to Evaluate CDM Projects according to National Sustainable Development Criteria" (Nov 2000). In this earlier paper, an approach was recommended to assist SUSAC parties develop:

- a national definition of sustainable development in the light of *current* circumstances;
- indicators that can be used to evaluate the national sustainable development of a country and
- a project checklist completed by project developers and information provides the basis for CDM eligibility assessment.

This paper was prepared in response to the request made by SUSAC Parties for a paper that identifies a simple method to enable a government to assess to what extent CDM projects contribute to sustainable development. The methods reviewed in this paper provide examples of different quantifiable approaches to enable countries to identify which sustainable development goals are priorities for their country and how these techniques could be used to score the contribution of different CDM projects to these sustainable goals.

Using a method that quantifies how much a CDM project contribute to national sustainable development is only one option that countries can use when assessing CDM projects contribution to sustainable development. A simpler, but less vigorous and transparent method is to use expert opinion to review project proposals and assess whether a project contributes to sustainable development goals. The methods discussed in this paper are only relevant for countries that are keen to identify to what extent different CDM projects contribute to sustainable development priorities.

The objective of this paper is therefore to answer the following questions:

1. How should sustainable development indicators be prioritised ? How should differences between indicators in terms of their relative importance to other indicators be identified? (e.g. if increasing employment is more important than increasing forests should this be accounted for?)
2. How can the process of checking if a CDM project is compatible with sustainable development indicators be developed so that it is transparent, low cost, valid and objective?
3. How often should indicators be altered over time to ensure they accurately represent national sustainable development priorities? (e.g. water pollution may be more serious than air pollution at first, but if action to mitigate water pollution are successful, air quality issues may become a more significant problem after a period of time.)

The paper first provides a brief summary of ranking approaches considered most suitable for prioritising sustainable development goals and discusses their advantages and disadvantages[1]. (Summaries of methods reviewed but not recommended are included in *Annex A*). Second the

[1] The methods were evaluated in terms of their theoretical validity, data requirements and skill requirements.

paper discusses how these ranking methods can be used to evaluating a CDM projects contribution to national sustainable development. Finally requirements for updating sustainable development indicators are considered.

It is envisioned that for those countries that seek to use a quantified method for assessing CDM project contributions to national sustainable development, the process for developing a ranking system should be in two steps which are presented in the following table and recommendations regarding which actors should be involved in the process are identified.

Step:	(1) Rank sustainable development indicators on a national level applying a proposed method	(2) Rank sustainable development criteria on a CDM project level (based on step 1) and rank various CDM projects according to the degree of compatibility with the criteria checklist
Actor:	National body for SD criteria	CDM secretariat CDM committee
Tasks:	· Develop a list of indicators and criteria, adding comments from other participants (NGOs, scientific & technical staff of CDM secretariats) · Identify a preferred ranking methodology · Rank sustainable indicators and criteria · Submit the list of ranked criteria and indicators to the CDM secretariat · Notify the CDM secretariat if the s sustainable criteria and indicators are altered.	· Apply the ranked checklist of sustainable development indicators to sustainable development criteria on CDM project level · Submit checklist to body responsible for identifying which projects conform the most closely to sustainable development priorities · Reject CDM projects that fall under a certain threshold approved by the government. The threshold defines the minimum contribution of a CDM project to sustainable development.

2 RANKING METHODS

2.1 Introduction: What is Ranking?

Ranking is a systematic tool that allows the qualitative comparison of very different and interrelated policy priorities or preferences. In the case of sustainable development, ranking is useful for assisting policy makers come to a uniform decision on what should be prioritised.

In general ranking allows participants to identify individual preferences that are then added with other participants to assess the importance of the individual indicators. Ranks can be calculated by voting, allocation of economic values or through discussion and consensus. Since the discussion at Den Hague 2000 indicated that government officials and CDM secretariats would have primarily be responsible for developing sustainable development indicators and CDM project checklists, the following discussion reviews only those methods that can be applied to a top down decision process, including Multi-Criteria Analysis and pair-wise ranking techniques. In other words a discussion of assessments that utilise surveys of all stakeholders is not included.

However, a summary of two techniques that do involve a broader spectrum of stakeholders is provided in *Annex A.* These ranking methods discussed can all be applied whether it refers to the aspects of sustainable development, the various indicators and criteria or even the CDM projects to assess which projects have higher priority than others.

2.2 Multi-Criteria Analysis (MCA)

MCA is a tool developed for complex multi-criteria problems that include qualitative and quantitative aspects. All MCA methods involve two stages. First goals and objectives must be clarified, second weights are attached to different objectives. The following MCA methods are summarised and discussed next[2]:

- Preferential ranking
- Normal ranking
- Ordinal ranking
- Rating

2.2.1 Preferential Ranking

This is the simplest approach to ranking, and does not require scoring as such but indicates differences between indicators with '+' and '-' signs to indicate a range. The following table illustrates how this might work in practice:

- -	-	+ -	+	++
Unimportant	Weakly important	Moderately Important	More Important	Extremely Important

Decision makers would be asked to mark each indicator in the range from "- -" to "+ +". The more + that an indicator is awarded the more significant it is. These ranks could be discussed and if necessary some minor alterations to rank position could be made.

Example: A Preferential ranking list could read as indicated below

Criteria	*Preferential ranking*
Improving health condition of inhabitants	+ +
Reducing national debt	+ +
Reducing crime in communities	+
Protecting natural resources	+ -
Transferring / applying state-of the art technology	+-
Empowering women	- +
Built capital stock and productive capacity	- -

2.2.2 Normal Ranking

Normal Ranking and preferential ranking are very closely related, except that in normal ranking the range is indicated with numbers rather than "+" and "-" symbols. Ranks are assigned according to a scale such as follows:

[2] Other MCA techniques rely on computer simulations and require a relatively high mathematical capability e.g. Monte Carlo Analysis. Due to the additional costs in terms of skills and time these techniques were not reviewed.

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

Decision makers then mark indicators according to this scale. Once indicators have been ranked, the totals are calculated and the indicators ranked accordingly to the average score. As with preferential ranking, should there be clear disagreement regarding the final outcome, a majority vote by the experts should be able to alter the final ranking.

Example: The following criteria have been ranked using a normal ranking procedure. The same rank can be given to different criteria.

Rank	**Criteria**
8.5	Ecosystems: extent, diversity and health
8.3	Energy and material resource efficiency and amount of overall use
8.1	Renewable resources: renewal capacity and productivity
8.0	Inter-generation equity
7.7	Current equity
7.3	Non-renewable resources: stocks and productivity
6.8	Extent to which social "services" systems; cultures and institutions meet human needs and wants
6.7	Human capital stock and productive capacity
6.7	Social capital and co-operative capacity
6.7	Capacity for adaptation, innovation and resilience
6.6	Extent to which human activity remains within critical environmental

Source: Extract from Sustainable Development Indicator Mavens Meeting, January 13, 1999, http://198.183.146.250/maven113.htm/

2.2.3 Ordinal Ranking

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.

Most Important	Criterion 1
|	|
Least Important	Criterion x

Example: An ordinal ranking list of sustainable development indicators could be presented as follows. The indicators belong either to the environmental, the social, the economic and the institutional aspect of sustainable development.

	Expert opinion 1	**Expert opinion 2**	**Expert opinion 3**
6	Reducing national dept	Protecting natural resources	Transfer of environmentally sound technology, co-operation and capacity building
5	Women empowerment	Women empowerment	Reducing national dept
4	Transfer of environmentally sound technology, co-operation and capacity building	Avoiding future GHG emissions	Improve health condition of inhabitants
3	Improve health condition of inhabitants	Improve health condition of inhabitants	Avoiding future GHG emissions
2	Protecting natural resources	Reducing national dept	Women empowerment
1	Avoiding future GHG emissions	Transfer of environmentally sound technology, co-operation and capacity building	Protecting natural resources

Once all experts have handed in their ranking sheets the average position for each indicator is calculated. In this example 6 various indicators have been ranked by three experts. To find the average position of each indicator the indicator on the top (that one which is felt most important) gets number 6, that one at the bottom (least important) gets number 1 and the ones in between get number 2 to 5. For each indicator the total number is determined (which results of adding the appropriate numbers for each criterion from all experts) and the indicators will be listed in order of their average importance. In this case reducing national dept would be the indicator with the highest importance and avoiding future emissions that one with the lowest importance in relation to sustainable development.

Reducing national debt	13 points (most important)
Women empowerment	12 points
Transfer of environmentally sound technology, co-operation and capacity building	11 points
Improve health conditions of inhabitants	10 points
Protecting natural resources	9 points
Avoiding future GHG emissions	8 points (least important)

2.2.4 Rating

Rating requires that a decision maker allocates an indicator a score between 1-100. Ideally the total will add up to 100 but this is rarely the case in practice and usually totals will have to be corrected once indicators scored, in order to ensure the total is 100. For example:

Indicators	**Score**	**Modification formulae**	**Rating %**
Indicator 1	30	30 / (110/100)	27

Indicator 2	35	35 / (110/100)	32
Indicator 3	45	45 / (110/100)	41
Total	110	indicator score / (total for indicators /100)	100

Thus, when one indicator has a high score this will automatically lower the scores for other indicators. In the following example, we have presumed that we have only three indicators, although in reality there will be considerably more. One advantage of Rating is that it provides both an Ordinal and Cardinal measure of importance for each Indicator.

- *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.

2.2.5 Summary of MCA ranking methods

In terms of validity, all the methods are internationally recognised methods for decision making. However, all Multi Criteria Analysis methods rely on inputs from experts, therefore the credibility of ranking depends on the knowledge and experience of the decision makers. A disadvantage specific to preferential ranking and normal ranking, is that they allow decision makers to avoid choices by ranking indicators equally both impairing theoretical validity and creating difficulties for decision makers to identify clear priorities. A disadvantage of rating methods is that they attempt to indicate the degree to which one indicator is more or less significant than another, but this may not be valid i.e. an indicator with a score of 50% might not be twice as important as another one with a score of 25%. It is for this reason that some economists prefer to use simpler methods such as preferential ranking. However, this creates difficulties when trying to calculate the differing degrees of significance of responses to questions on a CDM checklist.

Data requirements for MCA method are kept to a minimum since voting and qualitative judgement is used. Data collection is necessary to identify relevant indicators and to ensure that the expert group has a common understanding of the ranking method and the meanings of the indicators. Defining the method and ensuring a common understanding of indicators can be achieved in informal closed workshops prior to the voting. As a result MCA methods are simple and cost effective, however, simplicity comes at the cost of validity and transparency since expert opinion is not transparent.

In terms of repeatability, the methods discussed only require basic mathematical capabilities and are easily repeated.

2.3 Pair-wise Ranking

Pair wise ranking is a technique by which every item in a list is compared to every other item according to a single indicator/criterion. Each sustainable development indicator/criterion is compared with each other species, and one of the two is selected as better for that particular use. At the end the indicators/criteria are ranked according to the number of times they were chosen as the better of the pair. Pair wise ranking therefore indicates the degree to which one indicator/

criterion is considered more important than another. An example of the pair-wise ranking of indicators is shown below.

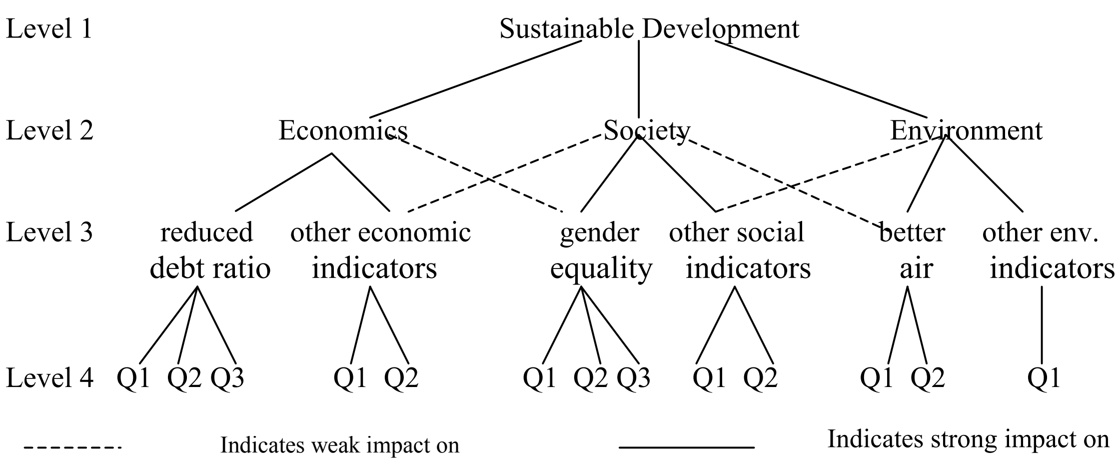
	Indicator 1	**Indicator 2**	**Indicator 3**	**Indicator 4**	→	**Indicator n**
Indicator 1	-	Indicator 2	Indicator 3	Indicator 4		Indicator 1
Indicator 2	Indicator 2	-	Indicator 3	Indicator 4		Indicator n
Indicator 3	Indicator 3	Indicator 3	-	Indicator 4		Indicator n
Indicator 4	Indicator 4	Indicator 4	Indicator 4	-		Indicator n
↓					-	Indicator n
Indicator n	Indicator 1	Indicator n	Indicator n	Indicator n		-

Note: Should read on the x axis first so the matrix shows results for. X is more/less important that Y

The degree of importance for each indicator increases the number of times it appears in the table and should be ranked so that the indicator that appears the most is ranked the highest. For example in the table indicator 1 is equally as important as indicator 2 since they both appear in the pair wise rankings twice. Where as indicator 3 is twice as important as indicators 1 and 2 since it appears four times. The most significant indicator is n since it appears 7 times.

2.4 Decision Hierarchy

Decision Hierarchy is an approach that combines normal ranking and pair-wise ranking with simple vector mathematics. It was developed to assist decision makers select the best criteria when such a choice involved the comparison of dissimilar criteria (e.g. could be a quantifiable criteria such as cost and an qualitative criteria such as social benefit). The framework can be extended to many levels of criteria, each a function of the previous level. For example:



Q n = a question on the CDM checklist (see section 3.3 for more details)

Decision trees are usually developed with a top down approach, by which a group of elements is assigned to one or more elements at a higher level. The next step requires pair wise comparison of all hierarchical elements. In each level ranking will be done always in relation to the element above to which it is related and weights are assigned to each element. If we want to rank the sustainable development aspects of Social, Environment and Economic, the pair-wise ranking method described in paragraph 2.3 can be used. However, rather than simply stating which indicator of the pair is more important than the other, it is possible to rank each indicator in terms of a normal ranking scale. This allows to identify to what extent one indicator is better than the other. The table below illustrates this. More information is provided in *Annex B*.

1/9	1/7	1/5	1/3	1	3	5	7	9
Totally Unimportant	Almost Unimportant	Weakly Important	Less Important	Equally Important	Moderately more Important	More Important	Very much more Important	Absolutely more Important

This scale could be used to formulate the following matrix, which is also referred in literature as *pair wise comparison matrix*. All three sustainable development aspects will be set in comparison to each other and values based on the scale will be assigned to each one of them. It is expected that an expert will assign the values to each aspect of sustainable development, in order to ensure credibility to the ranking method. On the matrix represented below it can be seen that the diagonal always shows the number 1. This is because economic development or any other aspect of development are always equally important to themselves. The part of the matrix below the diagonal always shows values that are reciprocal to the ones in the half above the diagonal.

	Economic development	**Social Development**	**Environmental Development**
Economic Development	1	7	5
Social Development	1/7	1	1/5
Environmental Development	1/5	5	1

Reading the matrix along the x axis we see that economic development is considered to be "very much more important" than social development and "more important" than environmental development. Social development is considered "weakly important" with respect to environmental development. The difference in terms of degrees of significance can be calculated with an easy matrix calculation program (e.g. MORE). It is also possible to calculate the weights with EXCEL.

As pair wise comparison can result in inconsistency of results, a consistency check needs to be done which is performed automatically when using MORE. Once consistency is confirmed, sustainable development indicators (level 3) and sustainable development criteria on CDM checklists (level 4) can be ranked using the same method. Elements will be ranked and weights allocated according to the degree of importance for each thus enabling sustainable development priorities to be clarified.

Once all pair wise comparison matrixes in all levels have been proven consistent, all results (the ranks at each level) will be combined and final weights for the entire hierarchy will be allocated.

Weights can always be expressed as percentages to which each element in the matrix contributes to the key aspect on the top of a hierarchy tree. Our example shows the following result when weights are calculated with the matrix calculation program MORE:

Sustainable Development	***Total***
Economic Development	72%
Social Development	8%
Environmental Development	20%
Total	*100%*

The benefit of this approach is that it is possible to identify the significance of each indicator with respect to each other and to verify how much each indicator contributes to either economic, social or environmental development. The same applies for CDM project checklist questions. These criteria can also be weighted and the degree to which they contribute to the achievement of an indicator also quantified. This shall be discussed in more detail in section 3.3. The main disadvantage is that it requires lots of pair wise ranking to be done and this is time consuming. Since the mathematical program that this method requires is not complex and most mathematicians will be able to develop it the maths is not considered a serious disadvantage.

2.5 Summary of Ranking Approaches

The following table summarises the key advantages and disadvantages of MCA, pair-wise ranking and decision hierarchy is presented in the following table:

Advantages and Disadvantages of MCA Approaches

	Preferential Ranking	**Normal Ranking**	**Ordinal Ranking**	**Rating**	**Pair-wise Ranking**	**Decision Hierarchy**
Advantages	Allows for ties i.e. the list can have two elements with the same order of importance Is the simplest ranking method.	Allows for ties i.e. the list can have two elements with the same order of importance. The decision maker can apply grades of importance.	Simple, no ambiguity in terms of order of importance. Discriminating in terms of degree of importance.	Provides both an Ordinal and Cardinal measure of importance. Discriminates in terms of degree of importance	Simple to implement Allows for ties amongst two elements. Gives indication of differing degrees of importance	Accuracy and theoretical validity Mathematical simplicity Repeatability and transparency Includes qualitative aspects

	Preferential	**Normal**	**Ordinal**	**Rating**	**Pair-wise**	**Decision**

	Ranking	Ranking	Ranking		Ranking	Hierarchy
Disadvantages	May not be discriminating enough i.e. the decision maker might opt out by giving equal assessments Relies on experts, so credibility depends on knowledge of experts. Degree of importance between indicators is not quantifiable.	May not be discriminating enough i.e. the decision maker might opt out by giving equal assessments. Relies on experts, so credibility depends on knowledge of experts. Degree of importance between indicators is not quantifiable.	No ties i.e some indicators may be considered equal but this can not be shown with this technique. Relies on experts, credibility depends on knowledge of experts. No grades of importance Indicator differences may not reflect reality	More complex than ranking and therefore more time consuming. Relies on experts, so credibility depends on knowledge of experts. Indicator differences may not reflect reality	There is duplication of evaluation of indicators. Relies on expert opinion.	Requires purchase or development of simple computer program to do the consistency test. Requires the decision makers to do a lot of pair wise ranking which is time consuming. Relies on expert opinion.

3 Connecting Sustainable Development Ranking with CDM Project Checklist

As discussed in the SUSAC discussion paper on sustainable development methodologies, CDM project checklists are forms to be submitted by a project developer in order to apply for CDM project status. These forms are used to verify that a project proposal satisfies the Kyoto Protocol requirement that CDM projects will be compatible with national sustainable development objectives. Therefore, there needs to be a connection between the criteria on the CDM project checklist and the sustainable development indicators in order to identify differences between projects, since a project that conforms better than another with national sustainable development priorities, must then be considered the better CDM project. The following describes how the project checklist relates to the sustainable development priorities.

3.1 Developing the CDM Project Checklists

It is anticipated that checklists will be standardised for different industrial sectors (e.g. renewable projects, coal efficiency projects, forestry projects etc) to reduce the administrative work load of creating checklists for individual projects. However, in the early phase of CDM project implementation, individual checklists could be developed for each project and then standardised checklists once practical experience has been gained.

It is recommended, that CDM project checklist questions are based on relevant sustainable development indicators. Only sustainable development indicators that are likely to be impacted by the project should be selected. Such a selection is best made by specialists who are familiar with different industrial sector or project specific manufacturing processes, emissions, environmental, social and economic impacts, in order to ensure that no relevant indicators are overlooked for sectors or specific projects. As an example of how to develop criteria, we can consider two imaginary indicators and generate two CDM project checklist criteria. First let's take a possible sustainable development indicator of – 'the creation of new employment opportunities' as one example and 'using new renewable energy technologies' as another.

The indicators can be translated into questions to be included on the CDM project checklist. For example, the indicator 'the creation of new employment opportunities' can be translated into: Does the project create employment? Is new training provided that creates new skills? Our second indicator refers to the use of new renewable energy technology. Possible questions on the checklist could be: Does the project result in enhancing the use of wind, solar, biomass resources? Will the project result in transferring state-of-the-art renewable energy technology? Once the checklist questions have been approved the checklists must be sent to project developers to be completed with other CDM project forms.

3.2 Completing (filling in) the Checklists

It is recommended that project developers mark compliance with the criteria using one of the ranking methods discussed above rather than yes/no responses since this will increase the validity and transparency of the approval process, unless the CDM secretariat contains insufficient staff members to process anything more complex than yes/no responses. If yes/no answers are used it is more difficult to compare projects, since it will not be possible to evaluate the extent to which a project contributes to sustainable development, so the validity of the approach could be questioned. Alternatively project developers could indicate a precise number or a range in their response, for example by identifying exactly how many jobs will be created by a project. However, this will make the review of the checklists more complex and therefore increase the processing time (see section 3.3. on review process). However in situations where few people are employed within a CDM secretariat, then the simple yes/no response is possibly the most practical in terms of ease of processing, although it compromises accuracy and validity of the approval process.

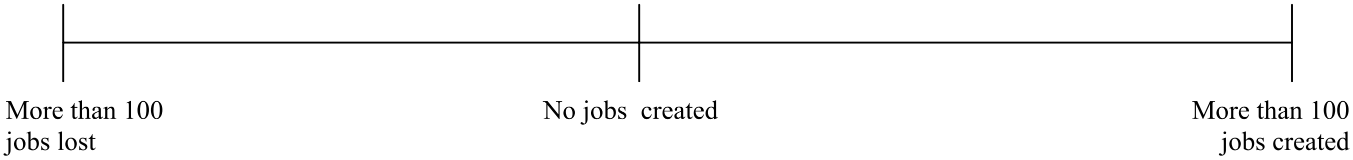
Alternatively, project developers could be asked to indicate a range of an indicator in response to the question on the checklist. The checklist questions could be answered by marking responses in a given range. In our example, first we must indicate how many new jobs and/or new training opportunities will be created and secondly how probable it is to transfer renewable energy technology and to which extent? The first method indicates specified ranges using normal ranking and the second unrestricted ranges. Once the checklists have been completed they are submitted to the CDM committee who are responsible for identifying which projects conform the most closely to sustainable development priorities.

Restricted ranges

-3	-1	0	1	3
Loss of more than 50 jobs	Reduction of 1-50 jobs	No change	1-50 jobs	Over 50 jobs

Continuous range

-9 *1*
+9



3.3 Evaluating the Checklists and the Eligibility of a Proposed CDM Project

The projects submitted by developers must be reviewed and assessed in terms of compatibility with national sustainable development priorities. This could be done by establishing an expert group to review the responses on the checklist and make a qualitative assessment regarding conformity with sustainable development criteria. This approach is not transparent, and objectivity and repeatability are questionable because of the reliance on expert opinion.

Alternatively project checklist scores can be weighted, since the questions are based on different indicators that have different degrees of importance. The rating, pair-wise ranking and decision hierarchy methods used to rank sustainable development criteria produced scores that were relative to each other in the sense that the difference in magnitude between each score is quantified. In order to identify the difference between the importance of the answers to different questions on the checklist, weights could be attached to different questions. These weights can be calculated from the ratios identified in the process of rating, or in the final outcome of the rating or pair-wise ranking exercise or by extending the decision hierarchy to level 4 to include the questions (see diagram in section 2.4). How to make these calculations is discussed next.

Rating - lets imagine that our indicator examples were rated as shown in the tables below, then the weighting factor for “are jobs created” would be 27 and the weighting for, ‘Are renewable energy technologies used?’, would be 32. Since the questions developed from the indicator job creation includes two questions these will both have a weighting value of 27. In reality, there should be a difference between these two questions in terms of the significance, but this can not be accounted for using rating.

Sustainable Development Indicators	Score	Modification formulae	Rating %
Indicator 1 Are jobs created?	30	30 / (110/100)	27
Indicator 2 Are renewable energy technologies used?	35	35 / (110/100)	32
Indicator 3 ………	45	45 / (110/100)	41
Total	110	indicator score / (total for indicators /100)	100

When the answer to the question is no, then 0 will be scored and if there is a reduction in jobs or decrease in using renewable energy technology then the score should be indicated with a -.

Imagine that a project developer is told to answer questions on a CDM checklist using the following scores for answers to our example questions (see table below).

Scores	-3	-1	0	1	3
Is use of renewable energy technology increasing?	Large decrease in using renewable energy technology	Some decrease in using renewable energy technology	No change	Some increase in using renewable energy technology	Large increase in using renewable energy technology
Is training provided?	Training totally reduced	Training slightly reduced	No training	Minimal increase	Intensive training
Are jobs created?	Loss of more than 50 jobs	Reduction of 1-50 jobs	No change	1-50 jobs	Over 50 jobs

The questions will be scored as shown below. The scores for each question can be adjusted using weights from sustainable development criteria to generate the final score. Even though it is clear that training is not as significant as job creation in terms of generating increase in employment, the weighting is the same. This reduces the validity of the scores for project selection.

	Does the Project generate new jobs	**Does the project create new training opportunities**	**Does the project result in increased use of renewable energy technology**	**Weighted Total Score for project**
Score	1	1	3	(1x27) + (1x27) + (3 x 32) = **150**

Pair-wise ranking similarly identifies the degree of difference between indicators. These factors of significance can be used in a similar way as indicated for rating to weight differences between different questions on a checklist. Pair-wise ranking, like rating is unable to weight differences between different questions and this impairs the validity of the project scores and therefore the decision whether a project is eligible for CDM support is also questionable.

Decision Hierarchy – can weight questions and therefore is a more valid method for assessing project conformity with sustainable development goals. In order to weight the different questions on the question list, it is necessary to first rank them by using the pair-wise matrix with a normal ranking score system. The weights are identified by converting the difference between the ranks into percentages. Answers to CDM project questions are scored using a score card (see example above) and then weighted to reflect the different significance of each question. Projects with the highest scores should qualify as CDM projects.

4 PROJECT SELECTION

Once all the scores for the projects have been calculated then it is necessary to identify which projects will be selected as CDM projects. Those projects which contribute most to sustainable development will be selected. Therefore those projects with the highest scores (accounting for weighting of different questions and indicators) will be chosen. The method for making this selection depends on how the ‘cut off mark’ below which projects fail to be accredited is calculated. Defining this cut off point will dictate how stringent a country wishes to make the requirement that CDM projects conform to sustainable development criteria and must therefore be set by the countries themselves. It is recommended that countries specify a range within which projects are considered eligible for CDM financial support but with different priorities. Projects that do not score enough to fall into the range should be discarded. Where the parameters are set will remain a national policy decision for governments to decide.

5 EVALUATING PERFORMANCE OVER TIME

As mentioned in the introduction, another issue for consideration is that sustainable development indicators must be dynamic, in other words they must be altered over time because priorities will change over time. If sustainable development indicators are updated, then the compatibility of CDM projects with sustainable development priorities will also change over time. It is recommended that a review of sustainable development indicators is implemented once every 5-10 years, in parallel with national long term plan reviews. However, in circumstances where the local environment changes rapidly, for example, energy markets are liberalised, a review might be necessary at an earlier stage.

6 References

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7 DEFINITION OF TERMS

Aspect of sustainable development:	elements that address sustainable development, these are mainly Environment, Social, Economic
Indicators of sustainable development:	each indicator belongs to one of the outlined aspects (e.g. "using new renewable energy technology" would refer to the environmental aspect of sustainable development)
Criteria of sustainable development:	describe how an indicator can be addressed in respect to CDM (e.g. enhancing state-of-the-art renewable energy technology would be one of a few possibilities to address the indicator "using new renewable energy technology").

ANNEX A : DETAILS OF RANKING APPROACH SUMMARIES THAT WERE REVIEWED BUT ARE NOT RECOMMENDED

8 COST BENEFIT ANALYSIS

Seeks to compare the *monetary value* of benefits with the monetary value of costs. A benefit is defined as anything that increases human well being and a cost as anything that decreases human well-being. In turn, human well being is determined by what people prefer. Preferences are revealed through choices and market behaviour, or stated via questionnaires. Measurement of a preference is obtained by finding out the individual's willingness to pay for a benefit or for the avoidance of a cost, or their willingness to accept compensation for tolerating a cost or giving up a benefit. The aim of maximising benefits minus costs, or of requiring benefits to exceed costs is fundamental to the concept of *economic efficiency* which has the overall goal of maximising the sum of human well being in a given economy.

8.1 Cost Benefit Analysis

The techniques to estimate willingness to pay/accept and opportunity cost vary with the market situation. In competitive markets, prices are direct measures of benefit and cost and so can be observed and then used as values. Competitive markets rarely exist for all environmental, and social goods and services. In their absence, willingness to pay/accept and opportunity costs for sustainable development criteria must be derived from other kinds of data. These other data provide the opportunities to apply the techniques of valuation, as the following table shows.

Market situation	Data used	Approach	Techniques
1. Observable market data available to calculate prices or values.	Price cost of environmental or social resource.	*Market valuation** (a value is derived from comparisons of costs and revenues)	1. Change in Income 2. Replacement Cost 3. Change in Productivity
2. No observable market data for price or cost available	Responses to questions in a survey which simulates a market	*Simulated market* approaches (the value is derived from hypothetical questions)	1. Contingent Valuation 2. Trade off Game

What follows is a brief introduction to each of the techniques which is followed by a summary of the advantages and disadvantages of using economic cost benefit analysis to rank sustainable development priorities.

8.1.1 Change in Income

Income can be lost due to loss of work from ill health, premature illness or death. Each of these problems can be caused by environmental effects such as pollution, stress from social changes such as sudden unemployment, or economic deprivation. Income can be gained due to improvements in health, postponed illness and fewer deaths. If the changes in health are due to changes in society, the environment or the economy, the loss in health is a sustainable development cost and the gain is an benefit. When the relationships between the environmental effect, health and income can be established, the effect can be valued as a change in income. The differences in these values will therefore reflect a value for each of the indicators. For example the increase in wages due to increased pollution control was calculated for each country from the predicted increase in working days. The benefits of pollution control were identified as the increase in wages.

8.1.2 Replacement Cost

The technique identifies the expenditure necessary to replace an environmental resource or a human made good, service or asset. Expenditure actually incurred on replacement is a measure of the minimum willingness to pay to continue to receive a particular benefit. It gives only a minimum estimate because more may have been spent had it been seen to be necessary to do so. The higher the value for a good, service or asset the more important it is, and this should be reflected within the ranking.

8.1.3 Change in Productivity

Market prices can often be used to value the output from a productive process and environmental conditions often affect such processes. In these circumstances, values for a change in the environment can be derived from the associated change in productivity. An increase in output due to the change is a measure of an increase in benefit, and a decrease in output is a measure of an increase in cost.   For example this technique could be used to calculate the costs of imposing strict regulations on GHG emissions for the energy sector.

8.1.4 Contingent Valuation

This technique asks respondents in a survey, 'How much they are willing to pay for a particular sustainable development effect or how much are you willing to accept in compensation for a reduction in sustainable development? Provided the respondent understands the question and answers truthfully the benefit of a particular indicator can be estimated. For example, this technique can value environmental quality, clean air, preservation of natural habitats, cultural facilities, recreation, and research.

8.1.5 Trade off Game

In any decision there are benefits to be gained and costs to be incurred and a trade-off is the act of weighing benefits and costs. In the trade-off game, respondents are offered two alternatives and are asked to choose between them. The alternatives are defined in terms of their outcomes, they differ in the level of one or more outcomes and one of the outcomes will be monetary. The differences in values for an outcome from a sustainable development indicator will identify a value in relation to the others and then the indicators can be ranked. The following example illustrates how to apply this technique in practice.

First a respondent is shown two scenarios (see table)

Outcomes	**Alternatives**	
	Existing Situation	**New Situation**
	A	B
Money Payments	$0	$X
Level of Service or Amenity	Level A	Level B

The respondent is then asked: 'What is the value of the payment $X at which you are indifferent between A and B?'. The sum $X is the willingness to pay for the given improvement in the level of the service, or amenity. The trade-off can often be expressed as a simple question instead of a formal table. Questions can be posed to decision makers just as easily as to individuals in the community.

8.1.6 Summary

In general Economic Cost Benefit analysis can be seen to provide a method for establishing sustainable development priorities, however each of the methods reviewed are time consuming and may also require establishing questionnaires that are expensive. For these reasons it is not recommended that Economic cost benefit analysis techniques be used for establishing sustainable development priorities. The following table identifies the advantages and disadvantages of each technique discussed above.

8.1.6.1 Summary of Differences between Economic Cost Benefit Techniques

Technique	Advantages	Disadvantages
Change in Income	Straightforward to apply Established procedures and actual data form the basis of the technique. Actual damage is valued	The link between pollution and health (the dose-response relationship) and between health and income must be identified for each application.
Replacement Costs	Are simple to calculate	The replacement goods and services must be identical to, or at least good substitutes for, the original goods and services. The method assumes that the benefit of the replacement exceeds the cost otherwise the cost would not be incurred. The replacement cost therefore provides only a minimum estimate of the benefit.
Change in Productivity	It relies on observed market prices It relies on observed output levels	It is difficult to define the physical flows of output over time. Required data will need to collected and therefore it is time consuming.
Contingent Valuation	The technique is theoretically valid, since the question 'how much do you value X` can be easily formed and can be answered.	It is difficult to ensure that questions do not influence the respondents answer. Respondents answers are hypothetical and may not reflect behaviour in real situation.

		It is time consuming and an expensive approach.
Trade Off Game	Is a valid technique.	Requires detailed explanation of scenarios to players and is time consuming. Interviewer may bias respondents answers

8.2 Distance to Goal Techniques

In distance to goal approaches, weights are derived from the extent to which actual environmental performance deviates from the environmental indicator. E.g. if the ambient concentration of a pollutant is 1.1 mg/m3 and the goal or standard is 1 mg/m3 then the weight to be attached to this impact is 10% since the ambient concentration is 10% away from the goal.

Advantages	Disadvantages
Easy to understand	Existing standards do not exist for all environmental sustainable development indicators and do not exist for economic and social indicators.
Most environmental impacts can be included and considered under this approach.	This approach implicitly assumes all standards are equally important. Below the target level affects are assumed to be unworthy of consideration.

Due to the limited opportunity for use with all sustainable development criteria, this approach is not recommended.

8.3 Damage Costs

Weights or ranks are given according to the damage of not achieving the goal. For example if the cost of clean up for pollutant A is twice that of pollutant B, therefore ensuring that pollutant A does not damage the environment is twice as important as B.

Advantages	Disadvantages
Most sustainable development impacts can be included and considered under this approach.	Only considers the costs of avoided damage which does not necessarily reflect the real value of the indicator. Needs data for cost estimates for environmental, social and economic damage, which currently is uncommon and would be costly to calculate.

Due to anticipated damage cost data limitations in Africa this technique is not recommended.

ANNEX B : WORKED EXAMPLE FOR DECISION HIERARCHY METHOD (EXTRACT FROM MORE A COMPUTER PROGRAMME)

The Hierarchy method prioritises alternatives with criterion by using a method of pair-wise comparisons and eigenvector (i.e vectors that satisfy the equation that ensure the vector is perpendicular to the plane) calculations

All of decision making is the selection of alternatives based upon specific criteria. This framework can be extended to many levels of criteria, each a function of the previous level. For instance, an individual wishes to select a car to purchase. He is interested in two alternatives, a Mercedes and a Volvo. He has two primary criteria, performance and cost. This hierarchy with levels of objectives, criteria and alternatives can be described as follows:

```
Level 1        Select_a_car       Objective (1)

Level 2       Cost  Performance   Criteria (2)
               |  \     / |
               |    \/    |
               |   /  \   |
Level 3     Mercedes   Volvo      Alternatives (2)
```

The analysis could be extended to four levels by recognising that cost can be characterised into initial cost and operating/maintenance costs and that performance can be characterised by power and handling. This hierarchy appears as:

```
(1)                Select a Car
                    /         \
                  /             \
(2)       Performance          Cost
             / \                / \
            /   \              /   \
           /     \            /     \
          /       \          /       \
(3)  Power   Handling  Initial Cost   Op & Maint
          | \   | \      /    \         /|
          |   \ |    \  /      \       /  |
          |     |\     /\       \  /     |
          |     |   \ /    \    /\       |
          |     |    / \     /\   \      |
          \     |   /     \/    \  \    /
           |    |  /    /    \    \ \  |
(4)          Mercedes          Volvo
```

Standard Definitions used or describing the hierarchy:

```
Level 1 -       Buy a Car             1 Objective    -+
                    / \
Level 2 -      Cost   Performance     2 Criteria        5 Elements
                  | \ / |
                  | / \ |
Level 3 -     Volvo   Mercedes        2 Alternatives -+
```

OBJECTIVE - The goal of the session, such as "Buy_a_Car"

CRITERION - A factor, or attribute, used as a standard for ranking

ALTERNATIVE - An element to be ranked, found on the lowest level

ELEMENT - A member of the set of objectives, criteria and alternatives
Element also refers to an individual entry in a matrix

LEVEL - A partition of a hierarchy

In this technique, the CRITERIA or ALTERNATIVES at one level are related to CRITERIA (or OBJECTIVES) at the upper level by making pairwise comparisons. In this example, a pairwise comparison must be made for Volvo and Mercedes with respect to cost, and a second comparison with respect to performance.

```
     Buy_a_Car

        / \
    Cost  Performance
      | \ / |
      | / \ |
  Volvo   Mercedes
```

Comparison Number	Element Compared (1)	Element Compared (2)	With respect to
1	Volvo	Mercedes	Cost
2	Volvo	Mercedes	Performance
3	Cost	Performance	Buy a Car

If weighting factors exist for the CRITERIA, the pairwise comparison can be considered to be the relative weighting of each CRITERIA, i.e. W1/W2 where W1 is the weighting for Mercedes relative to cost and W2 for weighting for Volvo relative to cost.

A common problem in multi-objective analysis is comparing two CRITERIA that do not have similiar metrics for measurement, for instance, how does one compare the importance of performance and cost in the selection of an automobile. A normal ranking scale can be used to make such comparisons.

Scale	Contribution to the Overall Goal
1	Two elements are of equal importance
3	Element 1 is slightly MORE important than element 2
5	Element 1 has been judged MORE important than element 2
7	Element 1 has demonstrated MORE importance than element 2
9	Element 1 is absolutely MORE important than element 2

Even numbers are used to interpolate between the levels (for example)
4 Element 1 is (slightly - judged) MORE important than element 2

Reciprocals indicate the opposite relationship (for example)
1/9 Element 1 is absolutely LESS important than element 2

A pairwise comparison matrix is constructed for each CRITERION:

```
                  A1     A2     A3    ...   An
           A1  w1/w1  w1/w2  w1/w3       w1/wn      Where wn is the
           A2  w2/w1  w2/w2  w2/w3       w2/wn      relative importance
   A   =    .                                       for ALTERNATIVE (An)
            .                                       as defined in
           An  wn/w1  wn/w2  wn/w3       wn/wn      matrix A
```

When the first row is completed, the first column can be generated by using the reciprocals of the row entries. The second row can then be completed and used to complete the second column, etc. When objective data are available, the weights can be computed on a scale of one to ten. When objective data are unavailable, the weights must be based upon subjective judgement.

When completing the matrix, the input is the ratio or relative weight or value of the pairs, not the weight itself. CONSISTENCY in the ratios is not required, as it will be determined in this methodology

The eigenvector of the pairwise comparison matrix normalised to unity is the most appropriate vector of weights for the criteria. The maximum positive eigenvalue of the matrix is equal to the number of criteria (the rank of the matrix) if the ratios are consistent. The difference of the largest eigenvalue and the rank of the matrix reflects the INCONSISTENCY of the matrix elements.

The next step is to construct a matrix comparing the pairwise value or weights of the CRITERIA to satisfy the overall goal. The scale used forcomparing CRITERIA is the same as for comparing ALTERNATIVES (using CRITERION pairs rather than ALTERNATIVE pairs).

The elements in each criterion matrix have a vector of weights with respect to each criterion in the next higher level derived from the PAIRWISE COMPARISONS.

The weight vectors at any one level are combined as the columns of a matrix for that level. The weight matrix of a level is multiplied on the right by the weight matrix of the next higher level. If the highest level of the hierarchy consists of a single objective, then these multiplications will result in a single vector of weights, which will indicate the relative priority of the entities of the lowest level for accomplishing the highest objective of the hierarchy.

It is possible to construct or purchase a simple computer programme that can perform the following procedures:

STRUCTURE: definition and storage of the hierarchies.

ANALYSIS: standard matrix manipulation routines to compute the eigenvectors (ranks), eigenvalues (inconsistency statistics), and finally the simple matrix manipulations. Matrices and results are saved if desired.