CDM Projects under the Kyoto Protocol of the UNFCCC: A Methodology for Sustainable Development Assessment and an Application in South Africa

Diploma Thesis of Renat Heuberger
In cooperation with Christoph Sutter
Received by Prof. Dieter Imboden

Institute of Environmental Physics, Energy & Climate
Swiss Federal Institute of Technology (ETH)

Zurich, January 2003
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Renat Heuberger, Zurich, January 2003
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Abbreviations

ACP  African, Caribbean and Pacific (countries)
AHP  Analytic Hierarchy Process
CDM  Clean Development Mechanism
CER  Certified Emission Reduction
DEAT  Department of Environmental Affairs & Tourism
DNA  Designated National Authority
DOE  Designated Operational Entity
EDRC  Energy & Development Research Center (University of Cape Town)
EIA  Environmental Impact Assessment
GCC  Government Committee on Climate Change
GGP  Gross Geographical Product
GHG  Greenhouse Gases
KP  Kyoto Protocol
LCA  Life Cycle Assessment
LNG  Liquified Natural Gas
LFG  Landfill Gas
LULUCF  Land use, land use change, and forestry (type of CDM projects)
MAUT  Multi-Attributive Utility Theory
MCDA  Multi-Criteria Decision Analysis
NCCC  National Committee on Climate Change (forum in South Africa)
NEDLAC  National Economic Development and Labour Council
NSS  National Strategy Study (on the Clean Development Mechanism)
SA  South Africa
SD  Sustainable Development
SSN  Southsouthnorth
UCT  University of Cape Town
UP  University of Pretoria
UNFCCC  United Nations Framework Convention on Climate Change
WSSD  World Summit on Sustainable Development
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Summary

Under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) industrialized countries, the so-called Annex-1 countries, have made commitments to reduce their greenhouse gases (GHG) emissions to a defined target. The Clean Development Mechanism (CDM) is one of the options to achieve this target: Annex-1 countries can finance project activities, which result in emission reductions in developing countries. The Kyoto Protocol states that “Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments…” In the same article, the Kyoto Protocol declares that "the purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development…“

What is Sustainable Development – and how can a CDM host country determine whether a project does assist in achieving this target?

The methodology: MAUT for sustainability assessment of CDM projects

Sustainable Development stands for a very broad concept. If a CDM project shall be assessed regarding its sustainability effects, there is no way around putting the concept on an operative level. The challenge is to find measurable parameters of a project that map the concerned stakeholders’ interpretation of sustainable development as appropriate as possible.

If the project assessment shall be done in a quantitative way, we suggest that the elements of a multi-criteria decision analysis MCDA are required:

1. A comprehensive set of criteria, which are the “sub-targets” of the overall goal of a “contribution to a sustainable development.”
2. Indicators and scales that measure the performance of a CDM project in terms of each criterion.
3. A procedure to determine the relative weight of each criterion (not all aspects are equally important in the context of a host country.)
4. An option to aggregate the criteria to a final score.

From the review of existing literature, we found that several approaches to assess CDM projects have been proposed. The combination of measurable sustainability indicators with a weighting procedure to identify the relative importance of the respective criteria has so far not been performed.

In the first part of this paper, we propose a methodology to assess potential CDM projects quantitatively in terms of their impacts on sustainable development. The proposed methodology is derived from the Multi Attributive Utility Theory (MAUT). MAUT lets the evaluator assign a quantitative “utility” to each alternative. In our case, the CDM project proposals stand for the “alternatives”.

The methodology aims at assisting decision makers in performing a sustainability assessment, which is transparent (no arbitrary judgments, clear process), robust (clear and replicable in application), simple to apply (data availability, financial / time constraints), comprehensive (all major SD aspects included) and fair (equal conditions for all CDM projects).

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1 Kyoto Protocol, Art.12
Application of the Methodology in South Africa

In the second part of this paper, this methodology is applied in South Africa. 32 persons from different professional sectors have weighted the sustainability criteria. As well, they have given their inputs on the proposed methodology. We have applied the sustainability criteria on three potential CDM projects, which included energy efficiency in a chrome plant, methane recovery in a landfill site as well as methane recovery in a waste water treatment plant.

Finally, we discuss the methodology in the context of the specific political, geographical and social circumstances of South Africa. From the application we concluded that the methodology can be a reasonable compromise between comprehensiveness and simplicity in application. We found that a sustainability assessment does provide valuable information about chances and risks of planned CDM projects. To be applicable in a host country, decision-makers and stakeholders must discuss and further develop the methodology and adjust it for the country’s specific circumstances.

If the uncertainties are carefully and transparently declared, the challenge of assessing projects regarding their impacts on the sustainable development of host countries should be accepted. The CDM mechanism will bring a new type of projects, which for the first time legally require an approval regarding sustainable development – the chance to break a beautiful though abstract concept down to an applicable level must not be missed!

Introduction

The Kyoto Protocol states that “the purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development…”

What is Sustainable Development, and how can a host country determine whether a project under the Clean Development Mechanism (CDM) does assist in achieving it?

Sustainable Development stands for a very broad concept. Its most frequently quoted definition originates from Gro Harlem Brundtland (WCED, 1987): “Meeting the needs of the present generation without compromising the ability of future generations to meet their needs.”

If a CDM project shall be assessed regarding its sustainability effects, there is no way around putting the concept on an operative level. However, sustainability is not only a concept that allows many interpretations. It is even an inherent part of the nature of sustainable development that people with different backgrounds will assign different concrete targets to the same concept. The challenge is to find measurable parameters of a project that map the concerned stakeholders’ interpretation of sustainable development as appropriate as possible.

The host country has to give a final approval for each CDM project through its Designated National Authority (DNA). The definition of criteria that lead to an approval or a rejection of a project proposal lays fully in the responsibility of the host countries. The Marrakech Accords state: .... it is the host Party’s prerogative to confirm whether a clean development mechanism project activity assists it in achieving sustainable development.”

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2 Kyoto Protocol, Art.12
3 FCCC/CP/2001/13/Add.2 Decision 17/CP.7
Requirements for Sustainability Assessments

The definition of the sustainability assessment for CDM projects lays in the full responsibility of the host country. In many countries that participate in the Kyoto Process, investigations to find an appropriate way to perform the assessment are underway now. To judge the performance of project assessment procedures, we listed essential requirements that—in our view—any chosen approach should fulfil. The procedure should be

- transparent: Judgments are not taken arbitrary; the process is clear and predictable. If an approach defines stringent criteria, it is crucial that they are as well applied strictly. Otherwise the investors and the concerned public lose confidence in the system.
- robust: The criteria are formulated clearly enough to be replicable in their application.
- simple to apply: The required data are available with reasonable financial effort and time expenditure. There is no point in deriving yet another set of sustainability indicator that in practice is not applicable.
- comprehensive: The approach includes all major aspects of sustainable development.
- fair: The approach should set equal conditions for all project developers, for all project locations, as well as for all project types that are eligible for CDM regardless of their size.

Of course some of these requirements are trade-offs: When deriving a methodology to measure sustainable development, we encounter the dilemma between effectiveness and efficiency. The more detailed and comprehensive our results should be, the more data intensive our approach becomes. Our ultimate aim is therefore to find a methodology that is reasonably applicable by politicians and project developers, while still guaranteeing a sufficient quality of the results. Or, with the words of Albert Einstein: “Everything should be as simple as possible, but not simpler.”

Three Concepts of Sustainability Criteria

There are several approaches to measure the sustainability implications of a projects in general and CDM projects in particular. All of them have in common that they try to break the concept of sustainable development down to a set of criteria. However, the way how these criteria are applied on the projects differ widely. From the discussion in South Africa we can distinguish three application concepts. Different stakeholders’ opinions in this particular discussion will be presented in part II. Combinations of the three concepts are in reality conceivable as well.

Guidelines: Sustainability criteria are not applied on projects according to a pre-defined procedure. They serve as guidelines to be followed by the DNA, which has to come up with an overall approval or rejection decision for each project.

The main disadvantage of guidelines is that they do not provide replicable project assessments as their application depends on the interpretation of the evaluator. A danger exists that a lobby group might influence the evaluator’s judgments regarding a specific project proposal.

Thresholds: Sustainability criteria are formulated as thresholds, which ask a “yes/no”-question. Example: “Does the project lead to a direct loss of jobs?”
Thresholds are powerful tools to set strict levels that each project has to meet. However, they do provide only qualitative project assessments; ranking of project regarding their contribution to sustainable development is impossible.

**Multi-Criteria concepts**\(^4\): Sustainability criteria are applied on projects with pre-defined scales. Criteria can be weighted. Trade-offs are allowed.

If the project assessment shall be done in a *quantitative* way, we propose that the elements of a multi-criteria decision analysis MCDA are required:

1. A comprehensive set of sustainability criteria, which are a division of the overall goal of a “contribution to a sustainable development.”
2. Indicators and scales to estimate the performance of a CDM project in terms of each criterion.
3. A procedure to determine the relative weight of each criterion (not all aspects are equally important in the context of a host country.)
4. An option to aggregate the criteria to a final score.

In this thesis, we investigate an option to assess CDM project proposals *quantitatively* with a multi-criteria decision analysis (MCDA) tool. As described later, the main disadvantage of MCDA approaches is that they demand a rather high amount and quality of data. Special caution has to be given to the question of uncertainty. Any results of *quantitative* assessments must always be published together with their range of uncertainty.

In the following section, we identify existing sets and concepts of sustainable development indicators on a national and on a project level.

### Existing Sustainable Development Indicators

#### Indicators on a National Level

Since the term ‘Sustainable Development’ was invented, several approaches have been taken to put the generic concept of Sustainable Development into more concrete terms. Much work has been done worldwide to derive sustainability indicators on a *global*, *national* or *regional* level. These systems assess the performance of a geographical area as a whole, and they allow for annual comparisons. For our purpose, however, we need a way to measure sustainable development on a CDM *project* level. Unfortunately, far less work exists to estimate the contribution of a single project to a national sustainability strategy.

It is generally impossible to simply translate national indicators to a project level, as the requirements, under which they have been established, as well as their purposes are very different. However, these national sets of indicators frequently serve as a basis to develop indicators on a project level. Therefore we first present examples of existing indicator sets on a national or global level.

An approach to derive sustainability indicator has been proposed by Donella Meadows. (Meadows, 1998). In her framework, she proposes the “Daly Triangle”, which relates natural capital to ultimate human purpose through technology, economy, politics, and ethics. Natural capital is the ultimate mean; human well-being the ultimate end. The latter is achieved through the intermediates of built- / human- and social capital. For these categories, sets of indicators are proposed. Sustainable development is the

\(^4\) In this broad definition, “multi-criteria concepts” include more than the actual multi-criteria decision analysis methodologies.
“sufficiency, with which ultimate ends are realized for all people, the efficiency, with which ultimate means are translated into ultimate ends and the sustainability of use of ultimate means.”

Bossel understands sustainable development as “the essential aspects of system viability” (Bossel, 1999). To be viable, any system must fulfill a number of requirements. These so-called “orientors” are the dimensions of sustainable developments, for which indicators should be developed. Environment-determined basic orientors of systems are: Existence, Effectiveness, Freedom of Action, Security, Adaptability and Coexistence.

Sets of indicators, which are used to measure the state of a nation or a region, have been developed by several institutions. These usually refer to the classical division of sustainable development: They divide the ultimate goal of sustainable development into social, environmental and economic development. Some examples of comprehensive sets of indicators are listed below:

IISD: The International Institute for Sustainable Development aims at developing “robust sets of indicators for public- and private-sector decision-makers to measure progress toward sustainable development and to build an international consensus to promote their use.”

UNDP: The UNDP’s Human Development Index is a widely recognized tool to measure the economic and social well-being of nations and regions.

World Bank: The “World Development Indicators (WDI)” is the World Bank’s premier annual compilation of data about development.

OECD: The Development Assistance Committee (DAC), the principal body through which the OECD deals with issues related to co-operation with developing countries, has established “Indicators of development progress.” The indicators give an integrated world view of human well-being in its economic, social and environmental aspects.

UNESCAP: The United Nations Economic and Social Commission for Asia and the Pacific has developed an indicator chart for sustainable development.

### Indicators on a Project Level

#### Existing Approaches to assess CDM projects

In the following section, we list several existing approaches that have been developed to assess sustainability impacts of CDM projects. All of these approaches have already been applied on a CDM project level. Our methodology incorporates elements of some of these approaches. In appendix 2 we present the criteria and indicators of the listed approaches in detail.

1. **SSN sustainable development tool**

   **Background:**
   SouthSouthNorth (SSN) is a joint project sponsored by NGOs from South Africa, Brazil, Bangladesh and Indonesia. Its mission is the design and development of CDM projects.

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8. [http://www1.oecd.org/dac/Indicators/htm/list.htm](http://www1.oecd.org/dac/Indicators/htm/list.htm)
projects, including the approval, validation, registration and transaction of these projects. SSN is a worldwide leader in developing standards for environmentally, socially and economically sound CDM projects.

Approach:

SSN has established a Sustainable Development Tool, which consists of eligibility screens, additionality filters, sustainable development indicators and operationality indicators (Thorne et al., 2001). SSN requires that sustainable development indicators must all be positive to make a project eligible.

Indicators: With a few exceptions, SSN proposes qualitative indicators. Whereas the eligibility tests provide “yes” or “no” answers, the SD indicators perform a rating of how the projects score against the particular index. The appraisal provides a rating between −3 and +3, with +3 being a very positive contribution, 0 being no change in the index, and −3 very negative.

The SSN Sustainable Development Tool is a very comprehensive approach and has been applied on several CDM project proposals worldwide. Many of the criteria have been used for the methodology presented here, too. However, the scales of the indicators are derived arbitrarily, and the criteria are not weighted. Therefore, an aggregation of the criteria and a comparison of project is difficult to perform.

2. Johannesburg Climate Legacy (JCL)

Background:
The World Summit on Sustainable Development (WSSD) was held in Johannesburg, South Africa, in 2002, hosting over 40’000 participants. The Climate Legacy measured the total carbon dioxide (CO₂) emissions of the Summit. The mission of JCL was to offset these emissions through investments in carbon-reducing projects across South Africa. JCL was supported by a number of partners, including Southsouthnorth, the WBCSD, Future Forests, IUCN, GEF and UNDP. JCL finally elected 16 projects for its project pipeline and assessed those regarding their contribution to Sustainable Development. ¹¹

Approach:

In line with the SSN methodology, JCL has established six quantitative and qualitative indicators linked to specific scales. Five experts assessed the 16 JCL projects according to these indicators. The opinions of the experts were averaged, and the resulting values of the criteria were added to a final score for each project.

The JCL methodology is closely linked to the SSN Sustainable Development Tool. Therefore the same comments apply.

3. Factor + Dasag: Sustainability Indicators for Small-Scale CDM Projects

Background:

Factor Consulting and Dasag Energy Engineering Ltd. have conducted a study on the opportunities and obstacles of small-scale CDM projects as a mandate from the Swiss Agency for Development and Cooperation (Factor + Dasag, 2001). The authors estimated the attractiveness of these projects for investors as well as their benefits from a sustainability perspective. They assessed several types of energy generation projects in India.

¹⁰ http://www.southsouthnorth.org
¹¹ http://www.climatelegacy.org
Approach:
The authors propose six quantitative criteria that cover social, environmental and economic aspects. As they are all quantitative, the study provides an objective comparison of the considered projects. Four of those indicators have been used in the methodology presented here, too.

The indicators are quantitative, and therefore the performance of different projects can be compared regarding a single criterion. However, as the indicators are not normalized, they cannot be aggregated to a final score. As well, the approach does not contain a weighting procedure.

4. PCFPlus
The Prototype Carbon Fund (PCF) is a trust fund of the World Bank, launched in January 2000 to provide financing for projects reducing emissions of greenhouse gases. In November 2000 the PCF created the PCFPlus program to support outreach, training and research activities related to CDM, JI and PCF projects. One of its research areas is specifically aimed at looking at sustainable development issues related to the CDM. Projects submitted to PCF must describe their expected impacts on sustainable development.

Several project proposals of the PCFPlus have been assessed regarding their impacts on sustainable development (Huq, 2002). Instead of proposing a methodology or a set of criteria, possible indicators have been derived from actual project proposals. Huq proposes to count the number of “sustainability categories” (social, environmental, economic) in which the project has a significant benefit.

The approach provides a quick and easily understandable sustainability check. The results must however not be used for project ranking or quantitative assessment.

5. SUSAC Ranking Methodologies
Background:
CDM Susac12 (Start-up CDM in ACP countries) is funded by the Directorate General Development of the European Commission, and co-funded by the UK’s Foreign and Commonwealth Office (FCO) under its Climate Change Challenge Fund (CCCF).

The IER (Institute for Energy Economics and the Rational Use of Energy) in Stuttgart, Germany, described a set of ranking methods to assess the contribution of CDM projects to Sustainable Development (Thomas et al., 2001.)

Approach:
The authors present 4 methods to rank the criteria (preferential ranking, normal ranking, ordinal ranking as well as ranking using pair-wise comparison) and 2 methods to weight the criteria (rating and decision hierarchy). In fact, the latter methods are as well the basis of the approach discussed here.

SUSAC has applied their evaluation tools in several countries; one of them in Zambia (SUSAC-Zambia). The criteria that have been used for that study are presented in Appendix 2.

The authors present a comprehensive overview on multi-criteria approaches to determine the relative importance of the criteria. The paper does not show measurable indicators and respective scales, which would be applicable on project proposals.

12 http://cdmsusac.energyprojects.net/
6. Country Study South Africa

Background:
At the ERDC, University of Cape Town, a methodology has been outlined to evaluate alternative mitigation projects and to prioritise them for inclusion in a national mitigation scenario (Spalding-Fetcher et al, 2002). These methodological studies were part of the South African Country Study on Climate Change (1997-2000).

Approach:
The authors propose a set of SD criteria with quantitative and qualitative indicators. According to the authors, it was originally intended to introduce a weighting system, too. The approach would be well compatible with other existing sets like the SSN Sustainable Development Tool. The indicators are not elaborated yet, and the weighting system is yet to be established.

7. The Sustainability of the Zafarana Project

In a working paper for the UNEP, a methodological approach on sustainable energy development has been proposed (Villavicencio, 2002). In this paper, sustainable development indicators are integrated into a broad systems concept following the “basic orientors of systems” (Bossel, 1999)13. He has developed sustainability indicators (orientors) to assess the Zafarana wind project in Egypt. His indicators are aggregated in two dimensions: The “viability of the project within the Egyptian technological context” on the one hand and “the contribution of the project to the sustainability of the economic and energy systems” on the other hand.

Of those considered, this is the only approach that explicitly abandons the commonly agreed concept of dividing sustainable development into social, environmental and economic goals. The author even warns that this classical division often leads to reciting “age old problems” only, without actually comprehending the complex concept of sustainable development. While the approach presents a very modern interpretation of sustainable development, it remains to be seen whether the approach bears a feasible solution for countries, where the understanding of sustainable development is still emerging.

8. Gold Standard

Background:
In their document to the “Gold Standard” WWF mentions the risks to the CDM, if the host countries fail to set clear standards and to apply them strictly (WWF, 2002). The Gold Standard is therefore intended to set a quality benchmark for CDM projects.

Approach:
At the time of writing, WWF had not yet published the final standards. In terms of Sustainable Development, the Gold Standard states the following:

1. Insistence on best practice environmental impact assessment, triggered by local stakeholders, rather than just project developers and host governments.
2. Explicit public participation procedures.
3. A ‘Sustainability Matrix’ that breaks the subject down into a series of environmental, social and economic/technological categories and simply

13 The concept is briefly explained above under ‘Indicators on a National Level’
assesses the project’s performance on each. Projects have to show net positive benefits in each of these categories in order to meet the Gold Standard. At the time of writing, the Gold Standard had not been finalised yet.

The Goal of this Paper

From the review of existing literature, we could identify a number of approaches to perform quantitative assessments of CDM project proposals regarding their contribution to sustainable development. At the same time, no approach has so far combined the definition of measurable sustainability indicators with a weighting procedure to identify the relative importance of the considered criteria.

In the first part of this paper, we propose a methodology to assess potential CDM projects in terms of their impacts on sustainable development. The methodology builds on the concept of the Multi Attributive Utility Theory (MAUT). MAUT aims at assigning a quantitative “utility” to each alternative. Several elements from existing approaches have been incorporated in the design of this methodology. The methodology presented here aims at giving inputs to the question, how decision-makers can map sustainability preferences in their country. In the first place it shall provide DNAs, which are establishing sustainability criteria for CDM projects, with respective guidelines. It must be noted that this methodology still gives room for interpretation. To be applicable in a host country, decision-makers and stakeholders must discuss and further develop the methodology and adjust it for the country’s specific circumstances.

In the second part of this paper, we show an application of the methodology in South Africa. The aim of that case study is twofold: On the one hand, we want to gain experience with the different components of the methodology. In particular, we perform the weighting process to identify relative importance of the sustainability criteria, and we apply them on three potential CDM project proposals. On the other hand, we discuss this methodology as an option in the current political context of South Africa in terms of CDM project approval.
Part I: The Proposed Methodology – Multi-Attributive Utility Theory for Sustainability Assessment of CDM Projects

Do you understand the Clean Development Mechanism (CDM) of the Kyoto Protocol?
- Actively involved in making it happening in South Africa
- Thinking about participating or submitting a project
- Someone else in my organization will take care of it

Capacity Development - Direct Weights

Goal: Contribution to Sustainability

Social Development (L.:8)
- Stakeholder Participation
- Improved Service Availability
- Equal Distribution of Benefits
- Capacity Development (L.:327)

Environmental Development (L.:304)
- Min./Env. Resources (L.:166)
- Air Quality (L.:252)
- Water Quality (L.:380)
- Land Resource (L.:192)

Economic Development (L.:329)
- Regional Economy (L.:216)
- Microecon. Efficiency (L.:311)
- Employment Generation (L.:422)
- Sust. Technology Transfer (L.:231)
Part I: The Proposed Methodology – Multi-Attributive Utility Theory for Sustainability Assessment of CDM Projects

The methodology in brief

The proposed methodology is based on the Multi-Attributive Utility Theory (MAUT). Thereby, a set of sustainability criteria is pre-defined and applied on CDM project proposals. A crucial element of our approach is the idea that the given set of sustainability criteria can be weighted in order to account for the specific context of each host country.

In brief, the approach consists of five steps:

1. Criteria: The overall target of a “contribution to sustainable development in the host country” is divided into a hierarchical set of criteria (sub-targets).
2. Indicators: The criteria are associated with indicators, which can be applied on a project level. The scales of these indicators are determined.
3. Weighting: The criteria are weighted in order to determine their relative importance.
4. Assessment of CDM projects: The criteria are applied on CDM project proposals. The respective scorings of the projects can be displayed in a matrix.
5. Aggregation of the results: From this matrix, an aggregation yields the final value for each project.

Multi-Attributive Utility Theory

The approach selected for our methodology is based on the multi-attributive utility theory (MAUT). MAUT stands for a set of methods to analyse situations and perform an evaluation process. MAUT has frequently been used in economics as a tool for decision-making.
support. In the past years, the method has for example been applied in the Case Studies that are performed yearly at the Natural and Social Science Interface of the Swiss Federal Institute of Technology (ETH-UNS).\textsuperscript{14} MAUT is for example documented in the corresponding book “embedded case study methods” (Scholz et al., 2002).

As the name hints, MAUT measures the attractiveness (utility), of each option within a set of alternatives. In decision support applications, MAUT is often used to determine, which alternative performs best. In our case, the alternatives are the CDM project proposals. Our aim is to assign a relative utility to each alternative, in order to determine each project’s utility in terms of a contribution to sustainable development of the host country.

The utility $U$ of an alternative $A_i$ can be formulated as follows:

$$U(A_i) = \sum_{j=1}^{m} w_j f_j(c_j(A_i))$$

where:
- $c = (c_1, \ldots, c_m)$ the set of attributes
- $f = (f_1, \ldots, f_m)$ the set of utility functions
- $w = (w_1, \ldots, w_m)$ the set of weights (relative importance)
- $A = (A_1, \ldots, A_n)$ the set of alternatives

In the following section, each of these components will be discussed separately. For our purpose, we will henceforth use the following terminology:

<table>
<thead>
<tr>
<th>MAUT</th>
<th>SD assessment of CDM projects</th>
<th>described in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attributes $c_j$</td>
<td>SD Criteria with (quantitative or qualitative) indicators</td>
<td>Step 1, Step 2</td>
</tr>
<tr>
<td>Utility functions $f_j$</td>
<td>Scales of the indicators</td>
<td>Step 2</td>
</tr>
<tr>
<td>Weights $w_i$</td>
<td>Weights\textsuperscript{15}</td>
<td>Step 3</td>
</tr>
<tr>
<td>Alternatives $A$</td>
<td>CDM Projects</td>
<td>Step 4</td>
</tr>
</tbody>
</table>

There are two options to perform a Multi-Criteria Decision Analysis (Saaty, 1986). The first requires weighting on two levels: Stakeholders weight the criteria to determine their relative importance. Stakeholders then weight the different alternatives in terms of the degree to which they achieve the inherent goal of a criteria (e.g. the degree to which they are useful for employment generation).

The second requires weighting only for the criteria. The relative utility of the alternatives (here: projects) with respect to the criteria is identified through pre-defined quantitative or qualitative standards (here: indicators) with a respective scale.

It is shown that the first type can result in rank reversal of the alternatives, if a new one is introduced. Rank preservation, which is what we need for our application, is guaranteed with the second type. MAUT follows this second type, too. The main challenge, as we will describe later in Step 2, is the fact that these standards are not defined yet.

\textsuperscript{14} http://www.fallstudie.ethz.ch/

\textsuperscript{15} Weights
Step 1 – The Set of Sustainability Criteria

1.1 About criteria and indicators

As practiced in many approaches, the level of sustainability can be “measured” by considering at the same time very different - sometimes even contradictory - criteria. It is important to note that the “universal” set of criteria would mean an infinite list of aspects. Every set is ultimately a compromise between completeness and applicability. Much caution has to be given to the selection of the initial set of criteria: even if - like in our approach - the stakeholders have the possibility to weight their preferences, omitting one crucial aspect can lead to totally irrelevant results. The initial set of criteria must therefore be simple enough, while at the same time covering a maximum range of sustainability aspects.

Two ways of formulating criteria can be distinguished:
A criterion can be formulated as a premise. Example: “The CDM project shall lead to a gain of jobs.” The compliancy of a project with the eligibility criteria is expressed with “yes” or “no”.
A criterion can be formulated as a target. Example: “Number of jobs gained per unit of investment.” The degree to which a project complies with this target is to be measured with a scale.

The criteria we present here are formulated as targets that are grouped in an objective-tree. At the top level of the objective tree stands the main target: A CDM project shall assist in achieving sustainable development. The positive impact on the sustainable development of the host country is therefore to be defined as the main target.

For our approach we use the following definitions:
SD Criteria are the sub-targets that are parts of the main target of a positive impact of a CDM project on the sustainable development of the host country. The SD criteria are hierarchically grouped in a target-tree. The relative importance of each criterion can be weighted.
Indicators measure, to what extent a concrete CDM project meets the SD criteria (sub-targets). Indicators are applied on the criteria of the lowest hierarchical level of the target-tree.

1.2 Procedure to derive the pre-defined set of SD criteria

As sustainability is a very generic concept, much experience exists worldwide with criteria that measure the sustainability performance of a whole country or a region. To a lesser extent, criteria to assess the sustainability effects on a project level have been established. For a sample of existing approaches, see the section “Sustainable Development Indicators on a Project Level” in the introduction.

How many criteria should be selected?
The number of criteria to be assessed depends on several considerations. On the one hand, the more criteria one selects, the more relevant and important gets the weighting process, as the stakeholders who fill out the questionnaires can express their preferences in more detail. On the other hand, the amount of work to fill in and to evaluate the surveys thereby increases. The decision on the number of criteria might well become a trade-off between the number of people, who can be involved, and the quality of the information the evaluator can get from the questionnaires. In other words,
the smaller the number of criteria, the higher is the already pre-defined level of aggregation, before the people can actually weight. In case of environmental criteria, for example, one could either let people weight only one highly aggregated criterion against social and economic criteria. One could as well let people weight a whole array of environmental issues first. The number of criteria should also match the expected degree of knowledge of the participants.

**Deriving the present set of sustainability criteria**

To derive the tentative set of criteria for the purpose of CDM assessment, we included relevant publications, consulted various experts active in the field of sustainability assessment, and asked for inputs on several mailing lists.

In addition, we organised an “e-conference on sustainability assessment of CDM projects”. This discussion was held on the internet platform CDM-Connect\(^{16}\). From July 15\(^{th}\) to August 2\(^{nd}\), 2002, more than 100 members joined the discussion forum, where the pre-defined set of criteria was presented. (See Appendix 3 for a summary of session 1 of the e-discussion, as well as the answers resulting from an input on the mailing list Climate-L\(^{17}\))

**1.3 Sustainability Criteria: The Objective Tree**

We propose a hierarchical set of sustainability criteria as shown in figure 1.

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**Fig 1: The hierarchical tree of criteria**


\(^{17}\) CLIMATE-L: A moderated mailing list with information on the climate change policy process and the UNFCCC. Hosted by IISD, Canada.
Why no Macroeconomic Criteria?
In the first version of the set, two macroeconomic criteria were discussed: “Positive Effects on Public Budget (Contribution to stability of national economy)” and “Positive Effects on the Trade Balance”. The e-discussion on CDM-Connect showed that both criteria are not applicable: In an interlinked economy, an indicator to measure impacts on public budget is difficult to find. This holds especially for countries, where – like in South Africa – the energy supply is state-owned. In a criterion like “effects on the trade balance”, a measurement of direct impacts may lead to meaningless results: As any foreign investments, CDM projects will have a negative impact on the trade balance. However, if the capital inflow is productive and long-term, the country will benefit from this investment.

1.4 Temporal and local system boundaries
For each application of sustainability criteria, the evaluator must clearly pre-define the temporal and local system boundaries. The importance of a criterion like “employment generation” might vary considerably if the effect is calculated during the next 12 months or during the next 50 years. For the SD assessment of CDM projects, we assume a time frame according to the baseline of the project (e.g. 10 years).
Accordingly, it is important to define whether the criteria shall be weighted on a national, on regional or on local level. The presented set of criteria is intended to be applied on the national level. If applied on the local level, some of the criteria have to be adjusted.

Step 2 – Indicators to Measure the Criteria

2.1 How to define measurable indicators
Sustainability criteria are sub-targets that shall be pursued in order to ensure a contribution to sustainable development. To perform a sustainability assessment of a CDM project, the evaluator must answer the question, to what degree a certain project does fulfil these targets.
Each criterion must therefore be associated with a measurable indicator. It is important to note that estimating the effects of a project in terms of a certain criterion can never be entirely objective. As described in step 1, there is no scientific reason to select a specific set of criteria; it is always up to the model developers to agree on a first set. The same applies to the indicators, which measure the (weighted) criteria: If we estimate the degree of “capacity development”, we need a method as well as a scale to find out to what degree a project meets our requirements. To ensure reproducibility of the measurements, it is important to define them as transparently and uniformly as possible.
We therefore propose the following principle, knowing that objectivity can never be entirely guaranteed:
1) A first SUBJECTIVE part defines the methodology of the assessment, including selection of indicators, defining of methodology and scale. This ALWAYS includes subjective elements and can never be totally comprehensive.
2) A second OBJECTIVE part measures the chosen indicators of the particular project.
Many criteria are not directly measurable. In those cases, the indicator must be chosen in a way that it maps the intention of the persons, who selected and weighted the criteria, as accurately as possible.
The indicators should be precise, but at the same time simple and quickly applicable on a project level. Defining an indicator is a compromise between efficiency and effectiveness: If the indicator requires too many data, or if the necessary project data are very difficult to collect, the assessment procedure will be very costly and time-consuming. However, if the indicator is not comprehensive and does not map the target as precisely as possible, the results will become irrelevant.

2.2 Quantitative and Qualitative Indicators

We propose to distinguish four categories of indicators. They can be quantitative or qualitative in their assessment. Moreover, both types can either express an absolute value of the project, or they express a relative change. As discussed later, we propose to chose “change to project baseline” as the measurement of relative change.

Summary – Definition of Indicators

Quantitative indicators, relative scale:
1. Define the indicator with a measurable unit. The indicator must map the intention of the criterion, which has been weighted.
2. Calculate the value for project and baseline.
3. Normalize the difference between project and baseline value. This step is needed as projects differ in their size.
4. Define a scale for the indicator, which translates the measured values into a “degree of satisfaction”.

Quantitative indicators, absolute scale:
1. Define the indicator with a measurable unit. The indicator must map the intention of the criterion, which has been weighted.
2. Define a scale for the indicator, which translates the measured values into a “degree of satisfaction”.

Qualitative indicators:
Define the indicator directly as a scale, which consists of the qualitative states the indicator can take on. These states express a “degree of satisfaction”.

Semi-quantitative indicators:
Principle 1: Select one core issue only
Principle 2: Compile all relevant aspects quantitatively, make qualitative judgement
Principle 3: Divide the criterion in further sub-criteria.

a. Quantitative Indicators

A model developer should always strive to define the indicators quantitatively, as it thereby provides maximum transparency for investors or the concerned public. In most cases, the aspects of sustainable development cannot be expressed in absolute terms, but as improvements or deteriorations. What can be measured is the contribution of a CDM project to the sustainable development of the host country relative to a reference case. According the UNFCCC rules, every CDM project has a well defined reference case (baseline), against which the amount of certified emission reductions is calculated (CERs). Therefore, we suggest to use the same baseline project to compare the performance of each sustainability criterion. For example, jobs that will be created in
the CDM project are compared to the number of jobs, which would have been created in the baseline project.

Some indicators are defined in absolute terms. These indicators do not express improvements compared to a reference case, but they express the degree, to which a target on an absolute scale is met. Our indicator for “microeconomic efficiency” for example is the internal rate of return (IRR) of the project.

**Normalisation Regarding Project Size:**

Projects differ in their size. To make them comparable, we therefore have to find a way to normalize these absolute changes. Generally, there are two ways to perform this normalization:

**Normalization Principle 1:**

For the normalization of the “absolute change” we could use an external, project specific parameter, which reflects the project size. This could be a financial parameter like the Net Present Value (NPV) of the project, or the amount of emission reductions generated (CER). The unit of the indicator would finally be “Jobs created per 1000 CER”

**Normalization Principle 2:**

Alternatively, we could directly calculate a percent change to baseline. The unit of the indicator would then be “% change in jobs compared to baseline”.

Advantage of principle 2 are that the unit is intuitively easier to understand. It also avoids to introduce another parameter. Main disadvantages of principle 2 are that the calculation of relative change is less robust than a normalization of absolute change. It might for example be reasonable that a small project, which yields a change from 1 to 2 jobs should receive the same scoring as a large project, which brings a change from 10 to 20 jobs. (in both cases a 100% change to baseline). However, principle 2 bears the risk that small detail could have a disproportional influence on the scoring. Imagine a project where in the baseline a water pollutant has been emitted in a very low quantity. If the project now avoids emitting this pollutant, the indicator for “water quality” measures a 100% decrease and scores the maximum value of –1, whereas the real benefit for the environment was actually insignificant. In the application study on South Africa, the Tunnel Kiln (Project 1) showed a 30% improvement in Land Use compared to baseline. Regarding the absolute figures, Land Use seems not to be a relevant issue of the project: as it scored only 3mP (milli-points) compared to about 200mP of the issue Respiratory-Inorganic under “air quality”, which in this case is dominated by the high level of dust emissions.

Although percent change to baseline is easier to comprehend and to apply, we therefore suggest to use the normalization principle 1 wherever possible.

**b. Qualitative Indicators**

For several criteria, it is not possible to define a quantitatively measurable indicator. However, in order to receive a comprehensive assessment of a project’s contribution to sustainable development, it is inevitable to integrate quantitative, semi-quantitative as well as qualitative indicators.

Qualitative indicators can again be expressed as improvement or deterioration compared to the baseline, or they are expressed in absolute terms. Which ever way they are defined, the scales of qualitative indicators always consist of discrete – not measurable – states, which the indicator can take on. To valuate the indicator “Stakeholder Development”, for example, pre-defined levels that reflect factors like quality, intensity or number of involved people can be applied.
Like quantitative indicators, qualitative indicators can take on a maximum value of 1 and a minimum of -1.

**c. Semi-Quantitative Indicators**

Theoretically, every qualitative indicators could be transformed into a quantitative one. With unlimited time and financial resources, as well as with perfect information available, any impact of a project could be measured. The definition of selected criteria decides, whether the ideal quantiative measurements are reasonably applicable, or whether a qualitative approach has to be taken.

“Employment generation” for example can quantitatively be expressed in “man-year created”. Other criteria, however, are quantitative in their nature, but they are too complex to have a unit for direct measurement. The “availability of service” increases or decreases in its quantity, but there is no simple unit to measure the change.

Three possibilities could provide a way forward:

**Principle 1:** Selection of core aspect. In the example of criterion “improved service availability”, an expert panel could decide on one service that is most crucial for the country. The indicator would then for example only measure the “change in access to sanitation facilities”. This means a strong simplification, but it could provide a reasonable first approach under limited resources. Indicators that are defined according to this principle can eventually be treated like other quantitative indicators.

**Principle 2:** Quantitative compilation and qualitative judgments. This approach consists of two steps: First, list changes in all services. Then, decide which aspects are worth further consideration. Irrelevant aspects should be discarded, as they only distort the overall picture and cause unnecessary evaluation work. Finally, give a qualitative judgment for the scoring of the indicator. This judgment includes the relevance of the considered aspects, the project size as well as the sensitivity of the project perimeter in terms of these aspects. This approach is frequently found in Environmental Impact Assessments. See under “Environmental Criteria” in appendix 1 for more details.

**Principle 3:** Divide the criteria. “Improved Service Availability” could be divided further into “direct access to drinking water”, “connection to the electricity grid”,… These indicators are then quantitatively measurable, but the effort to weight the criteria increases.

### 2.3 Scales for the Indicators – the Concept of Utility

Each indicator should measure, to what degree a CDM project will fulfill a certain sustainability criteria. Or, in the terminology of the MAUT: Each indicator should measure “the utility of a project with respect to a criterion.” Therefore, all indicators have

<table>
<thead>
<tr>
<th>Scores and Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = indicates that the project meets the criterion with utter satisfaction (maximum utility)</td>
</tr>
<tr>
<td>0 = indicates that the project has neither a positive nor a negative impact on the criterion (average utility)</td>
</tr>
<tr>
<td>-1 = indicates that the impact of the project is strongly opposed to the intention of the criterion (minimal utility)</td>
</tr>
</tbody>
</table>

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18 Here, “to measure” means “to estimate / predict quantitatively”. All these estimations still bear a (sometimes very large!) uncertainty.
uniform scales, no matter whether they are defined quantitatively or qualitatively. Exactly this is a strong point of the MAUT: it allows for an integration of qualitative and quantitative assessments, which, as described in the following sections, is inevitable for the SD assessment of CDM projects.

In the definition presented here, each indicator can take on a maximum value of 1 and a minimum of -1.

In the MAUT, a utility cannot be negative per definition. If the results are needed for further calculations (aggregations), we must transform the “scores” on the scales (ranging from -1 to +1) to “utilities” (ranging from 0 to +1). For details on these different ways of calculation see step 4: Application / Aggregation.

**Extreme values**

The first and most important step is to define the maximum and the minimum value that each indicator can take on. In the first version of our approach, we proposed to search – for each indicator separately – the “best practice available”. The “change to baseline” of this best practice was supposed to set the maximal value 1.

However, the case study in South Africa showed that in this early stage of the CDM it is virtually impossible to find justified values for a best practice case. Therefore we had to rely on simple assumption when defining the points of maximal / minimal utility. Further research is needed to establish meaningful scales. Which ever way the extreme values of the scales are defined, it is important that the participants of the weighting process (see Step 3) know and understand them, as they will want to place their weights accordingly.

**Shape of utility function:**

How are the values between the extreme points translated to the scale? For quantitative indicators, the scale could for example increase linearly between the minimum and the maximum value. Linear scales were selected for all indicators during the case study in South Africa. However, it might as well be justified to select an exponentially increasing scale.

For qualitative indicators, the definition of the scales is more complex and perhaps more controversial. Not only maximum and minimum values, but also the intermediates must be described verbally. For all qualitative indicators in this study, further research to develop appropriate scales is needed.

Figure 2 shows the criterion “service availability” as an example of refining the scale in 5 categories.

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19 It is important to note the difference in our definition of “value” and “score”: The values are the measured data from the project, e.g. the % of turnover that will go to disadvantaged people. These values are then translated into abstract scores, which express their respective utility (e.g. +0.5).
2.4 Categorization of the indicators for the Case Study in South Africa

The 12 criteria that are in use can now be categorized into quantitative / qualitative indicators with relative / absolute scales. For the case study in South Africa, we have performed such a categorisation. Between the dashed lines are those criteria, for which a purely quantitative indicator could not be derived. For those, the indicator was defined by one of the approaches presented under “semi-quantitative indicators”. In appendix 1, all criteria with their respective indicator are listed in detail the way they have been in use for the application in South Africa.

<table>
<thead>
<tr>
<th>Scale relative to baseline</th>
<th>Quantitative indicator</th>
<th>Qualitative indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment Generation (Ec)</td>
<td>Service Availability (Soc)</td>
<td>Capacity Development (Soc)</td>
</tr>
<tr>
<td>Equal Distribution (Soc)</td>
<td>Air Quality (En)</td>
<td></td>
</tr>
<tr>
<td>Mineral / Energy Resources (En)</td>
<td>Water Quality (En)</td>
<td></td>
</tr>
<tr>
<td>Land Resources (En)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute scale</td>
<td>Microeconomic Efficiency (Ec)</td>
<td>Regional Development (Ec)</td>
</tr>
<tr>
<td>Stakeholder Participation (Soc)</td>
<td>Sustainable Technology Transfer (Ec)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: The indicators are categorised according to their scales
Step 3 – Weighting the Criteria

According to the specific context of a country or even a region, the relative importance of each criterion will differ. To take these differences into account, our approach proposes that the pre-defined set of criteria is weighted directly in the country, where the set is to be applied.

At each branching in the objective-tree of criteria (See figure 1), the criteria or sub-criteria are weighted against each other. Participants in the survey are asked to assign relative importance of one criterion in comparison with another one.

3.1 Methods to Weight Criteria

There are several methods to perform the criteria weighting. Some of them, which are suitable for SD assessment of CDM projects, have been described in the SUSAC ranking methodologies (Thomas et al., 2001). Several methodologies only provide a ranking of the criteria. However, qualitative (ordinal) figures must not be used for further calculations and aggregations! We therefore explicitly consider only methods that do allow for quantitative (cardinal) judgements. In this approach, we propose two methods that both provide quantitative results, but exhibit very different properties.

Direct weighting:

The participants distribute percental weights to the criteria of each branch. The total of the distributed numbers must add up to 100%.

By direct weighting, the participants are asked to normalize the values themselves, as the weights they can distribute must add up to a pre-defined total. The advantage thereby is that the participants are urged to focus on the relative importance of the criteria. An increase in the value of one criteria directly leads to a decrease in the other criteria. The trade-off between the different alternatives becomes more obvious.

Direct Weights - Aggregation of preferences and Combination of Individuals

Aggregation: The participants weight the criteria and sub-criteria at each branch in the objective tree. If we want the relative importance of all the criteria at the lowest level, we need to aggregate the weightings. Thereby, we simply follow the hierarchical line of each criterion on the lowest level. On the way up to the top level (goal) we multiply all the weights.

Example: Improved Service Availability gets 30 points (percent); Social Development gets 40 points (percent). The relative importance of Service Availability is therefore \( p = 0.3 \times 0.4 = 0.12 \rightarrow 12\% \). The relative importances of all criteria on the lowest hierarchical level add of course up to 100% (See also Figure 3.)

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20 Similar procedures are (used e.g. in WEB-HIPRE, http://www.hipre.hut.fi):

Swing Weights: The criterion with the highest importance is assigned 100 points. All the other criteria receive points relative to this most important criterion.

SMART: The criterion with the least importance is assigned 10 points. All other criteria receive points relative to this least important criterion.

SMARTER: The criteria are ranked.
Combination of Individuals: The evaluator can combine the individual judgements to calculate the combined preferences of a pre-defined group. It is shown that the arithmetical mean is an appropriate choice to calculate the combined values. (Bolloju, 2001).

Figure 3: To calculate the preferences of the criteria, we need to multiply all the importance weights along the line up to the goal.

Direct Weighting
The process of direct weighting is straight forward.
1 You have a total of 100 points to allocate.
2 Distribute the 100 points on the criteria. The more important a criteria is, the more points you give.
3 After having allocated the 100 points, indicate on a scale from 1 to 5 your level of certainty (how certain did you feel when allocating the points?) 1 = very certain; 5 = very uncertain.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Direct Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion 1</td>
<td>25</td>
</tr>
<tr>
<td>Criterion 2</td>
<td>10</td>
</tr>
<tr>
<td>Criterion 3</td>
<td>40</td>
</tr>
<tr>
<td>Criterion 4</td>
<td>25</td>
</tr>
</tbody>
</table>

AHP (Analytical Hierarchy Process):
The participants compare the criteria of each branch pair-wise. Hence, each criterion is weighted relative to all other criteria of the same branch. The evaluator inserts the results into a matrix, out of which a software again calculates the relative weight of each criterion.

Advantages: The participants focus on only one comparison at a time. Therewith, their reflections generally come to expression more precisely. As a useful side result, this calculation gives a value for the “level of inconsistency” in the judgements of the participant (see also under 34 - uncertainties).
Disadvantages: The number of comparisons increases exponentially with increasing number of alternatives. A computer is needed to process the answers and to calculate the relative weights of the criteria.

The pairwise comparisons can be done in different ways. The crucial question is: How are the participants’ judgements best translated into quantitative figures? The software Expert Choice for example provides four options: graphical multiple bars, graphical pairwise, numeric pairwise and verbal pairwise. As our survey is not performed online, the two graphical options must be excluded. Instead, we used a combination of the verbal and numeric options. Psychological tests have come up with a scale that should be most exact in translating verbal statements to numbers. The scale is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Verbal Comparisons in the AHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equally important</td>
</tr>
<tr>
<td>3</td>
<td>Moderately more important</td>
</tr>
<tr>
<td>5</td>
<td>Strongly more important</td>
</tr>
<tr>
<td>7</td>
<td>Very strongly more important</td>
</tr>
<tr>
<td>9</td>
<td>Extremely more important</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate values to reflect compromises</td>
</tr>
</tbody>
</table>

**Table 2: verbal comparisons in the AHP**

**AHP - Aggregation of preferences and Combination of Individuals**

**Aggregation:** The pairwise comparisons of the AHP (ration comparisons) must first be translated into relative weights. This translation can be done using an eigenvalue approach (Triantaphyllou, 2000). This step must be done with a computer. For the application in South Africa, we used the software package Expert Choice. WEB-HIPRE is a free internet interface that allows the user to process his AHP models.\(^{21}\) Once this translation is done, the aggregation continues as described under Direct Weights.

**Combination of Individuals:** There are two ways of combining the judgements of individuals in the AHP method.

1. Aggregation of individual judgements (AIJ), whereby the judgements (pairwise comparisons) are combined before translation to relative weights.
2. Aggregation of individual priorities (AIP), whereby all individual judgments are first translated to relative weights and then combined.

It is argued that the choice of combination method depends on whether the group is assumed to act as a unit or as separate individuals (Forman et al., 1998). Individual identities, such as the individual levels of inconsistency, are lost with AIJ. As for our use the group is not homogenous and consists of individuals with respective values, AIP seems to be the more appropriate combination method. Unfortunately, the software Expert Choice performs only AIJ with its feature “combine individuals”. However, the evaluator can easily use Excel to perform the AIP.

\(^{21}\) [http://www.hipre.hut.fi](http://www.hipre.hut.fi)
3.2 Different Ways to Conduct the Survey

Workshops

Ideally, the criteria weighting is done at a workshop. The following issues must be clarified before the procedure:

- The participants are aware of their task, the goal of the procedure
- The participants understand the questions
- The participants understand the methods and the value scale (they must be familiar with the meaning of the defined cardinal scale, in order to express their emotional values as precisely as possible)
- The participants are aware of the time horizon, to which they assign the importance of the criteria.

**Procedure of the workshop:** The weighting itself should be done by groups with 3 to 6 members. Two systems are proposed for the group to do their weighting process:

**Delphi System:**
1. All members do their weighting individually.
2. All results are presented in the first round. In this discussion, differences due to misunderstandings or different interpretations of the question are clarified.
3. All members do their weighting again.

**AHP (Analytic Hierarchy Process)**

1. Go through the questions line by line. In each line you are asked to compare the relative importance of two criteria.
2. Check the box that best expresses your preference: from 1 (equally important) to 9 (extremely more important)
3. For each pair-wise comparison, indicate on a scale from 1 to 5 your level of certainty (how certain did you feel when allocating the points?) 1 = very certain; 5 = very uncertain.
4. In the second round, some differences may still persist. First, the moderator asks, whether the participants would agree on a compromise. If the participants hold on their positions, both weighting variants are noted. The evaluator must include these variants into a sensitivity analysis.

Proposal System:
1. All members do their weighting individually.
2. One member of the group presents his / her results (a proposal). The other members comment on the proposal until mutual consent is reached.

This system is faster, but the group members should be familiar to each other.

Interviews

Workshops are by far the most transparent and fair method of conducting the survey. However, they are as well the most difficult to organise. At the case study in South Africa for example, both of the planned workshops failed due to several reasons. If workshops are impracticable, direct interviews are the second best alternative. Time required per interview proved to be at least 30 minutes.

Mailing the questionnaire

Sending out questionnaires is the third option to conduct the survey. This is obviously by far the most efficient way to involve a large number of participants. However there are a couple of serious disadvantages:

- If participants do not understand the system properly, they have no possibility to ask.
- The evaluators will never know under which conditions the questionnaire has been filled out, e.g. whether participants have actually studied the criteria.
- If the evaluator is not present, obvious inconsistencies that result from simple errors or misunderstandings will not be detected and corrected. They either hamper the quality of the survey or they simply result in invalid questionnaires.

3.3 Who should assess the criteria?

This is a very sensitive question, as the results of the questionnaire are of course strongly influenced by the cultural, social and scientific background of the participants. There are several options how to conduct the procedure. The weighting procedure can be performed among a group of decision-makers within the country. Alternatively, the procedure could be conducted among a group of scientists or experts (economists, natural scientists, ...). Finally, a group of stakeholders such as NGOs, representatives from the industry, farmers ... could participate in the weighting process of the criteria. The results and the meaning of the procedure will of course depend on the chosen circumstances, as the distributed weights are never objective facts, but rather represent the different attitudes, backgrounds and values of the stakeholders.

It must be stressed that which ever way the evaluators decide to conduct the survey, they should explain their procedure, their assumptions and conclusions clearly. The first and probably most crucial question is, whether the criteria should be assessed by a panel of experts only, or whether the weighting is done community-based, i.e. including a maximum range of stakeholders. In reality, the decision might be somewhere in between, or it might even be driven by time or financial restrictions. A possible way forward is a mainly expert-based survey, which is compared with a random sample of
questionnaires completed by the public. However, the advantages and disadvantages of having an expert-only panel to weight the criteria are worth a consideration.

![A panel of experts weights the criteria](image)

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Judgments presumably more objective</td>
<td>• Important issues to the public might be overlooked by the experts</td>
</tr>
<tr>
<td>• Cultural barriers play smaller role</td>
<td>• Assessments not community-based</td>
</tr>
<tr>
<td>• Number of possible participants smaller; survey easier to conduct</td>
<td>• Selection of experts always subjective. “Qualification profile” difficult to define</td>
</tr>
<tr>
<td>• Credibility of results in the eyes of public (a small number of well-known participants might prevent fraud)</td>
<td>• Balance of judgments is questioned, as majority of experts might be from urban, upper-class background</td>
</tr>
</tbody>
</table>

*Table 3: Should a panel of experts or the broad public weight the criteria? Advantages and disadvantages.*

Especially if a representative random sampling of participants in the country is not feasible, personal information from the participants must be collected and monitored, too. Those factors eventually influence the interpretation and discussion of the results of the questionnaires. The following information should be provided:

- Regional background (urban / rural origin, province of origin)
- Cultural background (In South Africa for example, the “culture” of a participant might influence his / her preferences more than the geographical origin. However, “culture” can be a rather artificial concept, which does not provide a meaningful distinctions. Although Apartheid is abolished in South Africa, official statistics still present separate figures for “Whites”, “Blacks”, “Coloreds” and “Indians”.)
- Social background (The level of education as well as wealth of the participants certainly influence their perceptions)
- Professional background (Government, NGO, business, university, …)
- Age of participants
- Gender of participants  (This might especially hold for countries, where the social role of men and women is clearly distinguished.)

In the application on South Africa, the questionnaires were completed by experts from different professional backgrounds. For all other distinction aspects, a representative sampling could not be provided.

### 3.4 Uncertainties / Inconsistency / Remarks

The hierarchical tree of the criteria is already pre-defined by the evaluators. The participants cannot change it during the valuation. However, it is very important for the quality of the survey to understand the context, in which a participant has completed the questionnaire. There are three ways how a participant can provide information to the evaluator on the weighting process itself.
Uncertainties:
At each item of the questionnaire (i.e. every time a participant has to place a weight), the level of uncertainty while answering the question is asked, too. The participant therefore provides a number ranging from 1 (very certain) to 5 (highly uncertain).

Inconsistencies:
As a side result of the AHP method, there is a value for the “level of inconsistency” of the participant. The reason for this is that that the participants perform pair-wise comparisons in a circle: They compare criterion A with B, B with C, but also C with A. As a general rule, the inconsistency should not be higher than 10% 22. For the application on South Africa, we set the cut-off at 20%.

Remarks / Inputs:
Before and after each workshop or interview, the evaluator asks the participants for general comments about the procedure. In South Africa, we asked four specific additional questions.

3.5 Direct Weighting and AHP: Comparison of the methods in a Case Study

Different Properties of the methods
Direct Weighting and AHP both yield quantitative weights for the criteria. However, the decision situation, in which a participant has to indicate his preferences, is very different. Therefore, we have included both methods in the survey that was conducted in South Africa. The results of those comparison are presented here.

From the case study the following properties of the two methods could be observed:

Direct Weighting and AHP came up with nearly the same ranking of the criteria (see table 4).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Direct</th>
<th>AHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Employment Generation</td>
<td>Employment Generation</td>
</tr>
<tr>
<td>2</td>
<td>Service Availability</td>
<td>Service Availability</td>
</tr>
<tr>
<td>3</td>
<td>Capacity Development</td>
<td>Capacity Development</td>
</tr>
<tr>
<td>4</td>
<td>Water Quality</td>
<td>Water Quality</td>
</tr>
<tr>
<td>5</td>
<td>Sust. Technology Transfer</td>
<td>Air Quality</td>
</tr>
<tr>
<td>6</td>
<td>Air Quality</td>
<td>Sust. Technology Transfer</td>
</tr>
<tr>
<td>7</td>
<td>Equal Distribution</td>
<td>Land Resources</td>
</tr>
<tr>
<td>8</td>
<td>Regional Economy</td>
<td>Stakeholder Participation</td>
</tr>
<tr>
<td>9</td>
<td>Land Resources</td>
<td>Equal Distribution</td>
</tr>
<tr>
<td>10</td>
<td>Stakeholder Participation</td>
<td>Regional Economy</td>
</tr>
<tr>
<td>11</td>
<td>Microeconomic Efficiency</td>
<td>Microeconomic Efficiency</td>
</tr>
<tr>
<td>12</td>
<td>Min. / En. Resources</td>
<td>Min. / En. Resources</td>
</tr>
</tbody>
</table>

Table 4: Ranking of Direct Weighting and AHP in the application on South Africa (see part II for more details.)

22 according to Thomas Braunschweig, Department of Agricultural Economics, Swiss Federal Institute of Technology
The priorities in the AHP method spread more than in Direct Weighting. This means that the same participants make more extreme judgements when doing AHP than when weighting directly. One possibility to quantify this effect is to calculate the standard deviation within a block of weighted criteria. This is an indicator of how widely the single priorities spread from the average of the group.

On average, the standard deviations of the criteria within AHP assessments was at 18%. Within Direct Weighting it was only at 11%. The standard deviations resulting from direct weights can be subtracted from the standard deviations resulting from the corresponding AHP. Figure 4 shows that in most cases, the relative weights from AHP spread more than those from Direct Weighting.

**Figure 4:** The majority of the 92 comparisons showed that AHP samples spread more than Direct Weighting samples.

**Figure 5** shows the priorities of some criteria. The ranking order is about the same, but the priorities are distributed more equal in direct weighting.
As a consequence, AHP tends to show more extreme priorities for the criteria. Figure 5 shows this fact for some of criteria; AHP gives important criteria even higher, unimportant criteria even lower priorities.

Finally, it is instructive to watch the spread of participants' priorities in one single criterion. As the example, we show "employment generation", the criterion with highest priority in both methods. Figure 6 shows that no extreme judgements occur in direct weighting.

\[\text{Figure 6: The preferences for Employment Generation in the AHP method spread much more (top left) than in the Direct Weighting method (bottom left).}\]

**Accuracy of the methods**

In an experiment, the properties of the different weighting options available in the software Expert Choice have been investigated (Millet, 1997). These include Direct Weighting as well as of several types of pair-wise comparisons. He found that in terms of accuracy, the AHP methods were superior to the direct weighting method. Although the decision situations, with which participants are confronted in our approach, are far more complex than the one in the mentioned experiment, this finding still gives a hint that AHP could be an appropriate choice.
Uncertainties of the participants

In the survey we asked the participants about their level of certainty when assessing the criteria. The scale for the uncertainty was as follows:
1 – certain
2 – moderately uncertain
3 – strongly uncertain
4 – very strongly uncertain
5 – extremely uncertain

Those participants, who filled in the respective fields, seem to feel somewhat more certain with the AHP than with Direct Weighting. This is intuitively understandable: a pair-wise comparison is less complex to perform than a distribution of weights to three or four criteria at the same time.

![Figure 7: The participants seem to feel more certain when performing AHP. (1=certain, 3=moderately uncertain).]

Step 4 – Assessment of CDM Project Proposals

In step 1 we have found a set of 12 sustainability criteria. In step 2 we presented a way to assign indicators to all criteria. Each indicator can have a quantitative or a qualitative scale, which should reflect the degree of utility a project can achieve in terms of the respective criterion. In step 3 we presented methods to weight the criteria and thereby find their relative importance. With all steps completed, the methodology is now ready to be applied on CDM project proposals.

The methodology is suitable for renewable energy, energy efficiency, fuel switch, and fugitive methane capturing projects, regardless of project size and location. Theoretically it is also applicable on LULUCF projects, but we have not conducted research in this field and several criteria would certainly have to be formulated differently.

Step 5 – Aggregation of the results

The final aggregation is a number that reflects the overall utility of a project in terms of contributing to sustainable development in the host country during the crediting period. Or, in order to focus on the fact that we explicitly have dealt only with directly
measurable potential impacts of CDM, this number reflects “the utility of the project in achieving the pre-defined sustainability targets.”

In line with the MAUT, the aggregated utility $U$ of a potential CDM project $P$ can now be formulated as:

$$U(P_i) = \sum_{j=1}^{12} w_j(c_j(P_i))$$

where:
- $c = (c_1, ..., c_{12})$ the pre-defined criteria with indicators
- $w = (w_1, ..., w_{12})$ the set of weights of the criteria
- $P = (P_1, ..., P_n)$ the list of projects

Note that the set of utility functions is not mentioned explicitly, as they are included in the definition of the indicators.

<table>
<thead>
<tr>
<th></th>
<th>Criterion 1</th>
<th>...</th>
<th>Criterion 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>(Δ μg SO2 / CER)</td>
<td></td>
<td>(qualitative Scale)</td>
</tr>
<tr>
<td>Project 1</td>
<td>1.64</td>
<td></td>
<td>++</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project 3</td>
<td>19.3</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4: Values of application and criteria form a matrix.

For the aggregation of the results, it makes an important difference whether we multiply the weight of a criterion directly with the score on the respective scale, or whether we multiply it with the utility. In the MAUT, a utility cannot be negative per definition; in the worst case the utility is Zero. In the first case, the aggregated sum can actually consist of negative summands, too. In the second case, all summands are per definition at least 0.

If the aggregated results are used further, e.g. to compare the projects, we must use the utilities for the calculation.

The final aggregation, and especially the interpretation of the results however is a political process. A country might decide to require a minimum final score for a project to be approved. It could as well require that none of the criteria must exhibit an utility smaller than “average”. Finally, in combination with thresholds for CDM projects (eligibility screens) the results could as well only be used as a “fine tuning” to declare the country’s preferences.
Part II
Application of the methodology
In South Africa

Global People’s Protest March at the WSSD,
Alexandra Township, August 2002
Part II: Application in South Africa – a Case Study

A case study, to apply the proposed methodology “Multi-Criteria Decision Analysis for Sustainability Assessment of CDM Projects” was done in South Africa from September 5th to October 1st, 2002.

The aim of the case study was twofold: The methodology was applied in South Africa to gain experience with its different components. In particular, we performed the weighting process to identify relative importance of the sustainability criteria, and we tried to apply them on three potential CDM project proposals. On the other side, we discussed this methodology as an option in the current political context of South Africa in terms of CDM project approval.

We performed this application jointly with Alan Brent, chair for Life Cycle Engineering at the University of Pretoria (UP). The partnership included the development of the questionnaires, as well as the selection and discussion of CDM project proposals. 32 persons from government, NGOs, industries, universities as well as consultants have weighted the sustainability criteria. At the same time, they gave their inputs on the proposed methodology. We have applied the sustainability criteria on three potential CDM projects, which included energy efficiency in a chrome plant, methane recovery in a landfill site as well as methane recovery in a waste water treatment plant.

Finally, we discuss the methodology in the context of the specific political, geographical and social circumstances of South Africa. We show experienced advantages and shortcomings of the considered approach.

The application of the methodology is done according to the steps 1 to 5, as outlined in part I of this paper. Before the actual application, we provide some background information about the CDM as well as the current state of discussion in terms of host country approval in South Africa.

CDM Approval in South Africa – Background and Current Discussion

South Africa has ratified the Kyoto Protocol on March 13th, 2002. South Africa is one of the “big players” on the CDM market. It is for example expected that without the US participating in the Kyoto process the vast bulk of CDM money will flow to a few of the large developing countries such as India, China, Brazil and South Africa (Huq, 2002). The total GHG emissions were 379.8 MtCO₂ equivalents in 1994. (Switzerland: ca. 44Mt). The total emissions for each sector, calculated as CO₂ equivalents, show that the energy sector contributed 78%, agriculture 9.3%, industrial processes 8.0%, and waste 4.3% to the total emissions in 1994 (National Communication to the UNFCCC; data taken from NSS, 2002.) Not surprisingly, a lot of interested parties are involved in the ongoing discussion about implementation of CDM, and especially the definition of sustainability criteria needed for host country approval.

The CDM process: Institutions and Stakeholders

Government: In South Africa, the Department of Environmental Affairs and Tourism (DEAT) is responsible for the administration of matters relating to the UNFCCC. Under this department, the Directorate of Global Climate Change and Ozone Layer Protection has been coordinating the establishment of the criteria for South African approval of
CDM projects. The Government Committee on Climate Change (GCCC) is an intra-governmental body to coordinate issues related to climate change across the departments. At the time of writing there was still no consensus between the DEAT, the Department of Trade and Industry (DTI) and the Department of Minerals and Energy (DME) about where exactly the Designated National Authority (DNA), the official body for host-country approval, should eventually be situated.

A complicating factor is that competences between the national, the provincial and the local governments are often distributed in a rather complex manner. Environmental legislations like the Environmental Impact Assessment (EIA) for example, which play an important role in the CDM approval process, are applied at all three levels.

In 1996 a National Committee on Climate Change (NCCC) was constituted to advise and support the DEAT. The committee includes representatives from central and provincial government, non-governmental and community-based organizations, business and industry, and labour. The objective of the NCCC is to advise the Director General and the Minister of the DEAT on national issues related to climate change (NSS, 2002).

The government itself does as well act as CDM project developer. The local authority in Cape Town for example wants to develop proposals as a member of “Cities for Climate Protection”.

**Industry / Labour:** The National Economic Development and Labour Council (NEDLAC) is a statutory body to mediate differences between government, business and labour groupings. As NEDLAC is quite powerful in consensus reaching, this body will play an essential role when it comes to approving CDM projects. Organised business is represented by Business South Africa, which is an umbrella body for 19 different employer organisations, such as the Chamber of Mines, the South African Chamber of Business, the Banking Council and the Steel and Engineering Industries Federation of South Africa. Organised labour is represented by the three main labour federations in South Africa: Cosatu, Fedusa and Nactu. In the ANC government, which leads the country since abolishment of the apartheid system, trade unions traditionally have a very prominent voice.

**Industry:** Apart from the umbrella organisation Business South Africa, other large industries have stakes in the CDM process; particularly ESKOM, South Africa’s monopoly energy supplier.

**Academia:** From an academic point of view, the University of Cape Town (UCT) bears broad knowledge about the CDM mechanism. The UCT’s Energy & Development Research Center (EDRC) has published several papers on the CDM in the energy sector. The leaders of the ERI maintain close ties to relevant NGOs, especially to Southsouthnorth, with whom they did joint publications, too. At the University of Pretoria (UP) the chair of Life Cycle Engineering looks at the assessment of potential CDM projects from an LCA perspective.

**NGO:** There are several NGOs actively participating in the CDM process in South Africa. Southsouthnorth (SSN) is an international organisation that develops CDM projects of high sustainability standards. SSN has developed one of the very few sustainability indicator sets that have been applied on CDM projects. Through its push for sustainable CDM, SSN is linked to several NGOs. Earth Life Africa is an environmental NGO with branches in several South African cities. One of their projects is the Sustainable Energy and Climate Change Partnership (SECCP). This joint South-North NGO initiative links NGOs in several countries from the Southern hemisphere. It is co-sponsored by the Danish development agency DANIDA. One of SECCP’s activities is the support of the South African Climate Action Network (SA-CAN). The network actively participates in the discussion on SD standards for CDM projects and participates in the NCCC. Other
NGOs active in climate change issues include Globe Southern Africa, the Minerals and Energy Policy Center and Sustainable Energy Africa SEA.

Consultancy: Several consultants are involved in the CDM. KPMG has performed the validation of the compensation projects of the Climate Legacy and will most probably apply at the UNFCCC to become a Designated Operational Entity (DOE). PricewaterhouseCoopers (PWC) is interested in doing so, too. A number of smaller consultancy offices are currently developing CDM project proposals. These include for example Resource Recovery Systems (PTY) (Project 2: Sebokeng Waste Water) and the Palmer Development Group (Project 3: Weltevreden Landfill Site).

Host Country Approval – Perspectives and Interests

In May 2002 the Directorate of Global Climate Change and Ozone Layer Protection sent the first version of approval criteria for CDM projects out to the NCCC. The proposed approval criteria had the form of a checklist, which should serve as guidelines to be followed by the DNA when deciding on project approval.

Involved stakeholders were invited to raise comments and critics. At an extended workshop in June, members of the NCCC discussed these approval criteria.

This discussion happened to take place at an interesting time: South Africa was in the last preparations for the World Summit on Sustainable Development WSSD, which with over 40'000 delegates from around the world was said to be one of the largest UN events that ever happened. Many South Africans stated that the country saw a lot of discussion and movement in terms of environmental protection and social development in year 2002.

Accordingly, the discussion about sustainability criteria for CDM project approval was led intensely. How stringently should SD criteria be applied? The following table shows an overview on some of the controversially discussed issues.

<table>
<thead>
<tr>
<th>Should South Africa apply stringent Sustainability Criteria for CDM project approval?</th>
<th>no, because</th>
<th>yes, because</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attractiveness for investors</td>
<td>Investors would be scared by complex and stringently applied sustainability requirements and would chose the country with the laxest SD criteria (race to the bottom).</td>
<td>Not complexity and stringency, but fuzziness and insecurity in the definition of SD would scare investors. They want to have clarity about the rules and certainty about their application in an early stage of the project planning.</td>
</tr>
<tr>
<td>Costs</td>
<td>Sustainability Criteria increase transaction costs and makes projects unattractive for investors.</td>
<td>Validation, not SD assessment, bear the lion's share of the transaction costs. Sacrificing a solid SD assessment is the wrong place to save money. CDM projects with clear SD benefits could attract additional money.</td>
</tr>
<tr>
<td>Quickness</td>
<td>South Africa must move quickly. If South Africa loses even more time in the discussion about SD criteria, the country misses its chance on the CDM market. South Africa is in strong need of these investments. Many Latin</td>
<td>Approving projects hastily is no good. Funds for CDM projects are premium investments; a small percentage of the total investments in South Africa. This money should not be used to quickly harvest the “low hanging fruits”, cheap and potentially unsustainable projects.</td>
</tr>
</tbody>
</table>
Sustainable Development Assessment of CDM Projects - ETH Zurich, Energy & Climate

American country for example are now ready to approve projects. Without the US participating, the CER price is currently so cheap that South Africa would only waste its emission reduction potential.

<table>
<thead>
<tr>
<th>Experience vs. caution</th>
<th>We need projects evaluated as soon as possible. Otherwise it is impossible to actually gain experience with the CDM mechanism.</th>
<th>If the first CDM projects produce negative impacts, the public opinion will turn against the mechanism. This could hamper the CDM process as a whole.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job threshold</td>
<td>CDM projects will create technological inputs, which are needed in South Africa. A short term direct job loss will in the long term be compensated by better qualified jobs.</td>
<td>Long term effects on employment cannot be proven. CDM projects that lead to a direct job loss will cause uproar among NGOs and the population of South Africa.</td>
</tr>
<tr>
<td>Fairness</td>
<td>CDM projects are sustainable already. Why should the CDM projects meet additional SD criteria, while through their GHG reductions they count to the 2% of best projects anyway?</td>
<td>It is unfair if industrialized countries fulfil their emission reduction commitments in developing countries through projects that do not clearly contribute to sustainable development.</td>
</tr>
</tbody>
</table>

Table 5: Should stringent SD criteria be applied for CDM in South Africa? Discussions go on even within NGOs or business groups.

South African SD criteria – Guidelines / Checklist

In August, the government issued the next version of the approval criteria for CDM projects (Directorate of Global Climate Change and Ozone Layer Protection, 2002). This list is tabled below. In terms of the sustainability assessment the approval procedure works as follows:

1. The Secretariat will evaluate the project against the sustainable development criteria and make an recommendation to approve or reject the project.
2. The validated PDD will be circulated to all relevant Departments for comments with a recommendation attached to approve or reject the project as a CDM project.
3. Comments will be returned to the Secretariat for evaluation. If the Secretariat feels additional discussion is warranted it may arrange a direct discussion with the Department concerned.
4. The project proponent will be notified of the decision. Reasons will be given for the decision. A formal letter of approval will be provided that will indicate “written approval of voluntary participation from the designated national authority, including confirmation by the host Party that the project activity assists it in achieving sustainable development”

The criteria are meant as a qualitative guideline for the DNA. The document states: “The Secretariat will not “score” projects with projects meeting a certain score being deemed to meet sustainable development goals. Rather the criteria are seen as providing a formal checklist which will guide the Secretariat in applying its mind to the approval decision and balancing the various project impacts.”

Compared to the first version, the list is more condensed, and several criteria were either integrated or dropped. The first version included a passage, where the possibility of a rating of projects was outlined: “In the future the CDM Secretariat may want to develop a portfolio of projects or to promote and market CDM projects in other ways. It is likely that only preferred projects will be included in the portfolio. In this regard there may need to be a comparison between projects; with those projects that particularly support South
Africa’s sustainable development needs being specifically promoted. Under the comment column of the table it is noted where a sustainable development criterion would be primarily used for identifying preferred projects over and above for approving projects.” Such a rating system would be in line with the aim of our methodology. However, that passage as well as the mentioned “comment column” were dropped in the current version.

**Proposed Sustainable Development Criteria for Project Approval**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental impacts</strong></td>
<td>• Air quality changes in terms of priority pollutants</td>
</tr>
<tr>
<td></td>
<td>• Water quality changes in terms of priority pollutants</td>
</tr>
<tr>
<td></td>
<td>• Other impacts (e.g. noise, safety, property value, visual impacts, traffic)</td>
</tr>
<tr>
<td><strong>Change in usage of natural resources</strong></td>
<td>• Change in usage of water, fuel or other non-renewable natural resources</td>
</tr>
<tr>
<td><strong>Biodiversity impacts</strong></td>
<td>• Changes to local and regional biodiversity</td>
</tr>
<tr>
<td><strong>Economic impacts</strong></td>
<td>• Macroeconomic impacts</td>
</tr>
<tr>
<td></td>
<td>• Balance of payment impacts (increase or decrease in foreign exchange requirements)</td>
</tr>
<tr>
<td><strong>Appropriate technology transfer</strong></td>
<td>• Cleaner technologies to be used in the project (from international or local sources)</td>
</tr>
<tr>
<td></td>
<td>• Technological skills to be transferred and future self reliance of project</td>
</tr>
<tr>
<td></td>
<td>• Previous successful application of the technology</td>
</tr>
<tr>
<td></td>
<td>• Is technology appropriate to South Africa</td>
</tr>
<tr>
<td></td>
<td>• Does project provide demonstration and replication potential</td>
</tr>
<tr>
<td><strong>Social impacts</strong></td>
<td>• Alignment with national, provincial and local development priorities</td>
</tr>
<tr>
<td></td>
<td>• General assessment against available policies and plans</td>
</tr>
<tr>
<td><strong>Social equity and poverty alleviation</strong></td>
<td>• Job creation (number of jobs created/destroyed, duration of time employed, distribution of employment opportunities, types of employment, categories of people to be employed in terms of gender and racial equity)</td>
</tr>
<tr>
<td></td>
<td>• Local economic development impacts</td>
</tr>
<tr>
<td></td>
<td>• Whether project location has particular developmental needs</td>
</tr>
<tr>
<td></td>
<td>• Distribution of project benefits</td>
</tr>
<tr>
<td><strong>General Criteria</strong></td>
<td>• Frivolous projects;</td>
</tr>
<tr>
<td></td>
<td>• Projects clearly unlikely to succeed;</td>
</tr>
<tr>
<td></td>
<td>• Grossly unfair distribution of benefits from the project</td>
</tr>
</tbody>
</table>

Table 6: SD criteria for CDM in South Africa as proposed by the government

**Alternative Proposal – 3 Thresholds**

A group of involved parties strongly pushes for a number of stringent thresholds instead of the proposed generic guidelines. As Harald Winkler from the EDRC at the University
of Cape Town put it: “We need something measurable. Therefore three clear tests are most appropriate.”

At the time of research, Southsouthnorth (SSN) had taken on the lead in trying to find a compromise between business and NGOs. The group proposed the following short list of thresholds:

<table>
<thead>
<tr>
<th>Proposed Sustainability Thresholds for CDM approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social: no direct job losses</td>
</tr>
<tr>
<td>Environmental: no adverse impacts on local environment; e.g. air quality</td>
</tr>
<tr>
<td>Economic: local manufacturing capacities; e.g. local content more than 50%</td>
</tr>
</tbody>
</table>

However, from the discussion it was obvious that the environmental and in particular the economic threshold were far from being generally agreed upon. Indeed the major concern of the group was the social threshold – to prevent CDM project proposals that would lead to a direct job loss.

**MCDA for CDM assessment in South Africa**

Several approaches have been conducted in South Africa to assess CDM project proposals on their sustainability impacts with Multi-Criteria Decision Analysis.

In 1998, the EDRC published a framework for the establishment of AJJ criteria (Hirst, 1998). The authors concluded that “the central challenge of developing national AJJ criteria is to strike an appropriate balance between (strong) guidance, so that projects are acceptable to the host country, and the flexibility to allow for innovation and broad experience.”

SSN has a wide experience in applying sustainability indicators on CDM project proposals. (see also under “Sustainable Development Indicators on a Project Level” in the introduction).

For the Country Study, Randall Spalding-Fetcher et al. prepared methodology how to evaluate alternative mitigation projects to prioritize them for inclusion in a national mitigation scenario (Spalding-Fetcher et al., 2002). The authors proposed quantitative and qualitative criteria (See appendix 2 for the proposed list of criteria).

**Lack of Information**

Many of the contacted people complained that the information flow about the progress in CDM related issues was very sparse. Potential CDM project developers, both private and governmental, seem to have troubles with keeping track with the discussions. Much knowledge seems to be concentrated in the NCCC, but it is not carried out to a broader public.

The government is quite wary in releasing information. “I can’t answer” is frequently heard, if matters are not ultimately decided upon yet, as the officials have to get permission first. In addition, neither the different reports of the South Africa Country Study nor the country’s National Communication to the UNFCCC are publicly available. Other people complained that the negotiating process was conducted inefficiently. In the opinion of Rob Short, environmental specialist at the Development Bank of South Africa (DBSA) for example, further discussions about sustainable development in the CDM
process are of no utility, as they only prolongate the negotiating process. The DBSA would therefore plan to just wait for what the DEAT decides.

Sustainable Development in the South African context

When discussing a methodology for assessment of CDM projects in South Africa, we frequently come across historical, political, social, economical and geographical facts of the country, which are absolutely crucial to our considerations – but which are impossible to comprehend all at once. South Africa is with about 44 millions of people the 5th largest country on the continent. Sustainable Development of South Africa starts with the country’s past – and leads to a future determined by people’s actions, hopes and sorrows. An impressive picture of the former is provided in Nelson Mandela’s autobiography “Long Way to Freedom” (Mandela, 1994). For the latter, we can only try to observe and discuss.

It was not before 1994 that South Africa abolished the racist apartheid system, under which non-white persons had no voting rights, and established a new constitution as well as a restructuring in the government. Before the change, all universities were strictly appointed only to one, and to an overwhelming part to the white, population group. For decades South Africa experienced worldwide sanctions due to its racist policy. During that time, the country had to be self-sufficient in many areas. For example the country does not have any crude oil resources, whereas coal is abundant. Therefore a method was further developed to convert coal into liquid fuel. Still today, South Africa gains 23% of its petrol from coal conversion.

Energy research was highly secret. South Africa developed much technology itself, as it could not be purchased elsewhere. The country had as well its own atomic programme. Still today energy institutes are often reluctant to release information. This holds as well for ESKOM, the state owned monopoly energy supplier. ESKOM generates 89% of its energy from coal, and is the emitter of over 60% of the GHG in South Africa. ESKOM has of course a major interest in the CDM mechanism. However, it was impossible to collect any concrete data other than published on their homepage.

After the political change in 1994, South Africa suffered an immense brain-drain. Many government officials, industrialists and scientists left the country. At the WSSD, a shortage of 500'000 skilled people for South Africa was estimated.

Indeed, South Africa will face a range of serious problems in the coming decades. Among them are the unequal distribution of wealth, the immense rate of people infected with HI virus, the high criminality, an increasing number of informal settlements despite large housing programmes and the critical political situation in neighbouring countries (Zimbabwe). But on the other side, there are optimistic and encouraging issues to be found throughout South Africa. The country has achieved to transform its age-old structures without major eruptions of violence. Many peoples' organisations, small NGOs and women groups have successfully sprung up across the country, where people come together to work themselves on a more promising future. Internationally, the country is mediator in several African conflicts; and after all, South Africa has just hosted the WSSD, the UN’s largest ever world summit.

Alexandra Hofmänner, a Swiss - South African post-doc, is currently launching a department for the history of energy research at the University of Cape Town. She states that if a methodology for technology assessment from the North is brought to South Africa without paying attention to the countries specific technological development, the
risk of failure or meaningless results is extremely high. The knowledge transfer between North and South must be a bilateral exercise.

**Step 1 – The Set of Sustainability Criteria**

Step 1 of the methodology consists of finding an appropriate set of criteria to be assessed. As outlined in part I, we have compiled a list of social, environmental and economic criteria from various sources.

**Step 2 – Indicators and Scales**

Step 2 includes a set of indicators that are linked to the criteria. The purpose of these indicators is to identify, to what degree a certain CDM project will meet the respective criterion, or – in the terminology of the MAUT – how big the utility of a project is regarding a certain criterion. The detailed description of criteria and indicators, as they were used in the application in South Africa, are presented in appendix 1.

The major challenge in step 2 proved to be the definition of scales for the indicators. The original idea was to find a “best-practice case”, which was supposed to calibrate the scale: For example, the proposed CDM project that would create the most jobs (man-year) per emission reduction should define the maximum value 1 on the scales. Unfortunately, in this early stage of CDM it proved to be very difficult to identify these best-practice cases. We finally set the scales intuitively, noting that further research is needed in this issue.

**Step 3 – Weighting the Criteria**

**Weighting the Criteria – Survey**

Step 3 of the proposed methodology consists of the weighting of the sustainability criteria. For this purpose, we conducted a survey among different persons in South Africa. The survey was not designed to yield representative results. Much more, its intention was to gain experience for possible larger surveys in the future. As described in Part I of this paper, we let the participants perform both the Direct Weighting method and pair-wise comparisons of the AHP method. Apart from the weighting procedure, we asked all the participant a couple of additional questions regarding the survey itself. (The questionnaire as conducted in South Africa can be found in appendix 5)

Parallel to our survey, Alan Brent at the University of Pretoria used the same methodology in a similar survey together with Harmke Immink, PricewaterhouseCoopers. The DEAT, where the Designated National Authority will probably be located in the future, officially participated as well in that survey. The target group of that survey was mainly the industrial and financial sector; its aim was to address a broader range of people not necessarily active in the CDM. To a large part the questionnaires were mailed to the participants. Unfortunately, no final results were available yet at the time of writing this report.
Participants of the survey

The primary target group for this application were people, who are involved in the CDM mechanism. In addition, we gave questionnaires to a group of teachers at an elementary school in a township near Pretoria.

As well, we intended to reach a certain balance between people from different sectors. We therefore distinguished the participants according to their field of activity: Government, business (consisting of industry and services), NGOs, academia, as well as the mentioned group from a township. The following boxes show the respective number of participating people in the survey. Although South Africa has left the dark past of the apartheid regime behind, and all South Africans enjoy the same rights, the distinction of population groups is still very widely used. It is for example an important parameter in the national statistics (Statistics South Africa, 1996).

<table>
<thead>
<tr>
<th>Participants by Sector</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>7</td>
</tr>
<tr>
<td>Business</td>
<td>6</td>
</tr>
<tr>
<td>NGO</td>
<td>9</td>
</tr>
<tr>
<td>Academia</td>
<td>6</td>
</tr>
<tr>
<td>Township</td>
<td>4</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants by Population Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>19</td>
</tr>
<tr>
<td>Black</td>
<td>12</td>
</tr>
<tr>
<td>Coloured</td>
<td>1</td>
</tr>
<tr>
<td>Indian</td>
<td>0</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

Average age of participants: 37 years
Gender of participants: male 20; female 12

**General Questions**

**Do you know about the Kyoto Protocol?**

- Never heard about it 5
- I read something about it 2
- I know broadly what it entails 5
- I follow the progress and development 19
**total 31**

**Do you understand the Clean Development Mechanism (CDM) of the Kyoto Protocol?**

- No 7
- Someone else in my organization will take care of it 1
- Thinking about participating or submitting a project 3
- Actively involved in making it happening in South Africa 20
**total 31**

**Do you perceive the Clean Development Mechanism as an opportunity for South Africa?**

- I don't know 7
- No, it looks like exploitation 0
- It would be good if certain industries benefit 7
Most of the questionnaires were completed in face-to-face interviews. At the beginning we had as well planned to conduct two workshops for different interest groups: one in Pretoria and one in Cape Town. However, it proved to be difficult to arrange for workshops in the busy time around the world summit (WSSD).

Six of the questionnaires were completed within a presentation of the proposed methodology at a Parallel Event to the WSSD\(^\text{23}\).

Four questionnaires were completed by teachers in a township. We trained one of the teachers how to perform the weighting process, and asked her to complete the questionnaires with her colleagues. We had to do this as it is not allowed for external persons to conduct a survey at schools. Unfortunately we later had to discard all the four questionnaires, as they all proved to be very inconsistent – far more than any other questionnaires. The reason for this is unclear, however it gives a hint that the personal contact to the participants is essential for this type of survey.

Results from the survey

Inconsistency levels in the AHP method

32 persons participated in the survey. Two of them did only fill in the environmental criteria and will therefore be excluded from the aggregation.

23 participants completed both the direct weighting and the AHP pair-wise comparisons. The remaining 7 completed only AHP.

The AHP provides a level of inconsistency of participants’ judgement as a side result. If this level is extraordinarily high, it gives a hint that the participant probably had difficulties with the weighting process or that there is an error in the judgements. We decided to exclude participants with an inconsistency level of more than 20% (see part I, section 3.4 for more details).

The following figure shows all participants’ levels of inconsistency:

---

The inconsistency level of four participants is not even shown on the graph. The highest levels were recorded at 0.91 and 1.00. Six participants were therefore excluded from further calculations due to high inconsistency. As mentioned earlier, all four participants from the township happened to be among the excluded. The remaining 24 build the base for further aggregation.

**Global or Local Issues?**

As a starting question, we asked participants to compare the relative importance of the following items:

“The CDM project contributes to the mitigation on climate change.”

vs. “The CDM project contributes to sustainable development”.

**Figure 8:** Inconsistency levels of participants. We excluded all participants with an inconsistency higher than 0.2. Unfortunately, all questionnaires from the township had to be discarded.

**Figure 9:** Are the Climate Change problematic or the local sustainability effects more important? Participants voted clearly for the latter.
The left edge of the scale means “climate change extremely more important”; the right edge means “sustainable development in South Africa extremely more important”. Figure 9 indicates that the majority of the participants prioritises the latter. (20 participants answered this question).

**Aggregation of Preferences – All Participants**

In the following section, we show only the results of the AHP method. Generally, the Direct Weights resulted in the same ranking order for the criteria. However, all priorities were distributed more evenly. For details regarding the comparison of the two methods see section 35 in part 1.

The easiest way to aggregate preferences is simply to take the average of all participants. As discussed in part 1, we took the arithmetical average of the preferences, and not of the pair-wise comparisons.

Figure 10 presents the overall aggregation of all participants’ preferences.

![Graph of Aggregation of Preferences - All Participants (method: AHP)](image)

*Figure 10: Aggregation of the preferences. Employment Generation proved to be most important, Minerals / Energy Resources the least important criterion.*

The participants in the survey give with 15% the highest priority to “direct employment generation”, followed by the social criteria “improved service availability” and “capacity development”. The environmental criterion “local water quality” finishes forth with a priority of slightly over 10%.

At the bottom end, “decreasing pressure on minerals and energy resources” as well as “microeconomic efficiency” get 5% or less priority.

Within one criterion, the priorities of participants spread considerably. The error bars (thin black lines) show the aggregated priority plus / minus one standard deviation.
Aggregation of Preferences – the Different Sectors

If the samples are large enough, the priorities can be aggregated according to different parameters like gender, origin, age or professional sector of participants. Although the number of participants in this application is too small for either of these distinctions and conclusions should therefore not be drawn, we show in figure 11 an aggregation according to different sectors as an example.

Interestingly, the final preferences across these groups of different sectors seem to be more homogenous than the preferences within the groups. With other words, the spread of participants’ judgements is larger than the spread of the averages of the groups. In figure 12 we have for each criterion calculated the arithmetical mean of the standard deviations of participants’ judgements (indicates the spread within a group). As well, we have calculated the standard deviation of the arithmetical means of participants' judgements (indicates the spread across a group).

Figure 11: Aggregation patterns of participants from different sectors. Unfortunately the number of samples is too small to allow for meaningful statements.
Figure 12: Differences within the participants of a sector are larger than differences across the sectors. This gives a hint that most people probably judge according to their personal convictions and values, rather than according to their professional sector.

Step 4 – Assessment of CDM Project Proposals

It was not a simple task to find potential CDM project proposals, for which enough relevant data were available. We found that data availability might as well become a challenge as well in a later phase of the CDM project approval. There is yet to be a decision on whether governments should approve projects prior to a full feasibility assessment and validation procedure or after such a procedure. Obviously, if the host-country approval comes before a feasibility study has been conducted, more data will be based on assumptions, and the range of uncertainty will be higher.

Project Pipeline

In South Africa, a real CDM project pipeline is not existing yet although South Africa could play a major role on the CDM market, there are only three concrete projects listed in the National Strategy Study (NSS)\(^{24}\)

Two of those projects are promoted by Southsouthnorth (SSN):

1. Belville South Landfill Gas (methane recovery)
2. Low cost housing upgrade Khayalitsha (energy efficiency)

The third listed project is promoted by Sasol: Natural Gas Conversion Project (fuel switch), including a gas pipeline from Mozambique to replace coal in Sasol’s coal-to-liquid-fuel – conversion.\(^{25}\)

The Johannesburg Climate Legacy (JCL), which was founded to compensate the GHG emissions of the WSSD (see introduction) selected 16 CDM-like compensation

\(^{24}\) NSS, 2002

\(^{25}\) This project is criticised by certain people as not being additional; at that production site, it was argued, Sasol was running out of coal anyway.
projects. Although these projects will – if they receive founding by JCL – cannot be elected as CDM projects any more, the JCL was important for capacity development in CDM issues. Generally, it was very difficult to access even rough data about planned involvements in the CDM. Wendy Poulton for example, the responsible person for CDM issues at the state’s energy supplier ESKOM, declared that the company could not release further information on CDM project proposals until the approval criteria are clear.

**Project 1 – Energy Efficient Tunnel Kiln for a Chrome Plant**

**Project**

The project includes a newly developed process for the production of liquid ferrochrome. This “tunnel kiln” process is a conceptual process for direct reduction of raw ore through a tunnel kiln with conventional equipment for the melting step. Ferrochrome production is highly energy intensive. The yearly production of 100’000t of ferrochrome requires about 240GWh of electricity. Compared to a standard process, which is the baseline, the tunnel kiln saves about 30% of process energy. As coal is by far the most important fuel for electricity generation in South Africa, these energy savings result in significant GHG emission reductions. This process is being developed at the CSIR in Pretoria, South Africa. Although several conceptual studies exist and pre-tests have been successfully conducted, the CSIR still needs to construct fully operating demonstration plants, before being able to implement the technology jointly with an industrial partner in South Africa. The new technology could be implemented in a newly built Ferrochrome plant like the one planned in the Mooinooi area.

![Image of a tunnel kiln](http://www.climatelegacy.org/)

*Project 1: A new, more energy efficient process for reducing chrome ore has been designed at the CSIR in South Africa. Instead of a traditional pelletising-sintering step, the plant is equipped with a tunnel kiln that already partly reduces the ore. This leads to significant energy savings in the last melting step, where the final reduction happens.*

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26 http://www.climatelegacy.org/
Baseline

South Africa holds a large share of world's chrome resources, which are mainly used in the steel manufacturing industry. Even with stagnating prices for chrome, it is estimated that every second year South Africa builds a new ferrochrome plant with an output of yearly 100'000 t FeCr. The "standard process", which is the baseline, is a world-class internationally used process that makes use of a pelleting-sintering treatment for chromite ore before smelting in a conventional smelting operation.

Project Location

(tentative): Mooi nooi area, Rustenburg, North West Province, South Africa. Outside of the towns Mooi nooi and Marikana, most people work either on the mines or farms. The grassroots social structure consist of formal rural, informal peri-urban communities and farm tenants. There are other informal settlements on privately owned land. People living in these settlements include mine workers, farm tenants and those seeking employment. There is neither a tribal authority nor an RDP Forum in any of these informal settlements.

GHG Reductions

The GHG reductions are the result of significant electricity savings in the last smelting step, when the chrome ore is finally reduced. In contrast to the pelleting-sintering step used in the traditional technology, the ore is partly reduced in tunnel kiln already. The authors of the LCA study, which compares the two production processes, estimates a yearly emission reduction of 138'000t CO$_2$ (Morrison et al., 2001).

Scores

Scores and more detailed project information are compiled in appendix 6.

<table>
<thead>
<tr>
<th>Scores of Project 1 - Tunnel Kiln</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social Criteria</strong></td>
</tr>
<tr>
<td>1. Stakeholder Participation</td>
</tr>
<tr>
<td>2. Improved Service Availability</td>
</tr>
<tr>
<td>3. Equal Distribution</td>
</tr>
<tr>
<td>4. Capacity Development</td>
</tr>
</tbody>
</table>
Project 2 – Methane Capturing and Electricity Generation in Waste Water Plant

Project

The project involves the establishment of off grid electricity generating capacity at Lekoa Water Company, Sebokeng, South Africa. Electricity will be generated using Jenbacher generators utilising methane rich digester gas from digesters at the Lekoa Water Company’s Sebokeng Works. The generators have already been installed in the late eighties. However, due to lack of funds and know-how the maintenance could not be done properly, and in 1995 the generators were switched off. The project includes a plan for overhauling the equipment, as well as developing the necessary capacity for maintaining it. Associated benefits that will accrue to the Sebokeng Water Care works will be an increase in treatment capacity due to additional heat recovery, which reduces the digesting time.

Project 2: Methane escapes untreated into the air at the Lekowa waste water plant. The project generates electricity from the waste gas and recovers the waste heat, too. Sebokeng township (bottom right) is a disadvantaged region in South Africa.
Baseline

The baseline has 2 components:
B1, Methane: (90% of the GHG reductions) Methane escaping into the air; at the Sebokeng works, methane rich digester gas escapes untreated into the air through an outlet.
B2, Fuel Switch: (10% of the GHG reductions) Fuel switch for electricity generation; in the baseline, electricity is taken from the grid, which consists to an overwhelming part of coal generated electricity from the state’s monopoly supplier ESKOM.
These two baselines are additional. Any sustainability impacts resulting from either of the baselines are summed up. In practice, as baseline B1 consists of simply letting the gas escape, air quality is the only implication of B1.

Coal Electricity Baseline in South Africa

For all South African CDM projects in the electricity sector the baseline is determined by the county’s electricity mix. In South Africa, ESKOM is the state owned monopoly energy supplier. The major part of the energy is generated from coal.

<table>
<thead>
<tr>
<th>Electricity Mix South Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity coal (SA)</td>
</tr>
<tr>
<td>Electricity hydropower (SA)</td>
</tr>
<tr>
<td>Electricity nuclear (SA)</td>
</tr>
<tr>
<td>Energy Africa (imported)</td>
</tr>
<tr>
<td>Electricity pump storage (SA)</td>
</tr>
</tbody>
</table>

There are two ways to determine the electricity baseline (Winkler et al., 2001):
One approach is to use data for recently constructed plants, assuming that these represent the best available technology.
The other approach includes calculating a forward-looking baseline that includes future plants. It needs to make additional assumptions about which plants would most likely be built.
Both approaches have their shortcomings: The first is difficult to apply on South Africa, as only one power station, Majuba, has been commissioned in the last seven years. The baseline would then consist of only one power station. The second approach invites for “baseline gambling”: Countries have an incentive to choose a reference scenario with high carbon intensity, so that CDM projects will be able to sell more credits.
Winkler et al. have therefore chosen a baseline that includes ‘near future’ plants. These include the two new units of Majuba, the recommissioning of two units in mothballed power stations, the importation of hydro, and a new gas plant.
As a first estimation, we planned to use the data from the Majuba power plant only. This coal plant is situated between Volksrust and Amersfoort in Mpumalanga province. It has an installed capacity of 4110 MW and employs approximately 550 people.
However, more specific data to this power plant were not available during the case study, neither for the construction nor for the operation of the plant. This lack of data is an important challenge to the measurement of all quantitative criteria that are calculated “compared to baseline”. For the environmental criteria, we took values for coal electricity generation from a South African LCA database (LCA, 2002) whereas for projects 2 and
3 the direct project emissions were considered. As the LCA data are more comprehensive and include all cradle-to-grave impacts, baseline values tend to be overestimated if compared to the direct projects' values only.

**Project Location**

Sebokeng Township has a population of ca. 50'000. Due to policies implemented by the former government, the area is predominantly inhabited by disadvantaged sectors of the South African population. The area has experienced a turbulent end of the apartheid regime, when in the early nineties clashes between black gangs led to many fatal casualties. The main employer in the area is the nearby ESKOM coal plant. Many people live from their own small business.

**GHG Reductions**

Capturing of methane accounts for the major part (5150t CO\(_2\) equivalents / year) of the GHG reductions. Electricity generation with biogas reduces another 650t CO\(_2\) / year.

**Scores**

Scores and more detailed project information are compiled in appendix 6.

<table>
<thead>
<tr>
<th>Social Criteria</th>
<th>Environmental Criteria</th>
<th>Economic Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td>2. Improved Service Availability</td>
<td>6. Air Quality</td>
<td>10. Micro-economic Efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.75</td>
</tr>
</tbody>
</table>

**Project 3 – Methane Capturing and Electricity / Fuel Generation on Landfill Site**

**Project**

The project will capture the landfill gas (LFG) at the Weltevreden Landfill Site, which consists to about 50% of methane. There are 3 options under consideration on how to use the LFG:
P1. Fuel Switch for refuse trucks (Diesel -> LNG): Upgrading to natural gas quality by removing CO2 and trace gases; truck conversion for gas fuelling. Remaining methane is used for electricity generation
P2. Fuel Switch for electricity generation (Coal -> LFG)
P3. Flaring of the LFG. Even if economically feasible, flaring only is not a desired option and is not considered any further.

Project 3: The project captures landfill gas at the Weltefreden landfill site. The gas is either used as a fuel for refuse trucks, or for electricity generation.

Baseline

The baseline has 2 components:
B1, Methane (LFG): (~90%) Methane from Landfill Gas (LFG) escaping into the air
B21, Diesel (~10%): Refues Trucks are running on diesel
B22, Coal: (~10%) electricity is taken from the grid, which consists to an overwhelming part of coal generated ESKOM electricity.

The coal baseline replaces slightly less CO2 than the diesel baseline.

These two baselines (B1+B21 / B1+B22) are additional. Any sustainability impacts resulting from either of the baselines are summed up. In practice, as baseline B1 consists of simply letting the gas escape, air quality is the only implication of B1.

Project Location

Brakpan, which started as a mine settlement, consists of a core of commercial and industrial areas, with adjacent residential suburbs. The majority of the population lives in Tsakane, 15 kilometers across the highway that intersects the district. This is a high-density urban sprawl consisting of small formal houses and growing areas of informal settlements. The district contains all the features of rapid urbanisation. A gold mine has been operated just next to the project site.
GHG Reductions

Capturing of methane rich landfill gas accounts for the major part of the GHG reductions (48,000t CO₂ equivalents / year). P1 (replacement of diesel) reduces another 16,500t CO₂ / year; P2 (electricity generation with biogas) another 18,500t CO₂ / year.

Scores

Scores and more detailed project information are compiled in appendix 6. For the environmental criteria, only P2 (electricity generation) was included due to a lack in data for the diesel baseline B21. For all other criteria, P1 and P2 yielded the same values.

Scores of Project 3 - Landfill Site

<table>
<thead>
<tr>
<th>Social Criteria</th>
<th>Environmental Criteria</th>
<th>Economic Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Improved Service Availability</td>
<td>6. Air Quality</td>
<td>10. Micro-economic Efficiency</td>
</tr>
</tbody>
</table>

Housing Projects

First, we had planned to assess a fourth CDM project proposal, which was an energy efficient housing project. In South Africa, there are several eco-housing initiatives on the way; one of the most successful is the Kutlwanong Home Initiative in Kimberley, Northern Cape. The ECO Homes Advisors program, a PEER Africa and IIEC initiative, is empowering Kutlwanong residents and other South African citizens to promote energy conscious development throughout the country. This project is at the heart of a holistic community development plan, which includes goals of social, political, environmental, cultural, and sustainable, economic development. Because of their remarkably monitoring and reporting activities and their early start (1994), this will be the first housing project, which will be able of selling their CDM credits if the international trading starts.

Sustainability Assessment – a challenge

Unfortunately, the assessment of a housing project proved to be very difficult.
South Africa’s housing programme is in crisis. Many housing initiatives are under way, but there is still a backlog of about three million units. Shack families sweat in summer and shiver in winter and are exposed to high levels of indoor air pollution from fuels they burn to stay warm. Worse still, the quality of the approximately 750 000 houses that have been delivered in the past five years is extremely poor. The normal strategy for low-cost housing projects to achieve cost-efficiency is to wed standard design, minimum cost materials and mass production. Housing authorities generally accept these techniques as the best methods for meeting the huge demand. Large building companies and material supply firms also like this approach because it equates with maximum profit through repetition.

Even if better delivery is achieved, the reconstruction and development programme "matchboxes", as these structures are known to residents and developers alike, are failing to provide decent homes. They are cramped and ugly, are unsustainable in environmental terms and provide no insulation against sharp temperature changes, leading to major lifetime heating and cooling costs.

In general, the satisfaction quota with new housing is rather small. To make a new housing complex acceptable for the people, initiatives have to be accompanied by a development plan like in the case of the Kutlwanong Home Initiative. The application of our set of sustainability indicators proves to be very complex in these cases, as the system boundaries are not easy to define. Should for example all the social implications of the accompanying activities be included for the criteria “capacity development”? On one hand, these activities are certainly not part of the actual CDM project, but on the other, the project most certainly fails without these activities.

Further research is needed to answer the question, how projects can be assessed, which exhibit a complex network of direct social implications like efficient housing.

Step 5 – Aggregation of the results

Finding the Overall Utility of a Project

The final step of this methodology is the aggregation of the results from all previous steps.

In step 1 we have defined the 12 sustainability criteria. This has not been done with stakeholder participation, but by deriving a set of criteria from existing literature and application.

In step 2 we have linked the criteria with measurable indicators. We have assigned a scale to each indicator to reflect different degrees of utility. This has been done for the specific case of South Africa, considering the availability of data.

In step 3 a survey has been conducted in South Africa, where the participants were asked to weight the criteria according to their preferences.

In step 4 we have applied the indicators on three CDM project proposals. We received a matrix of scores from the different projects regarding the set of sustainability criteria.

The aggregation itself consists of a simple multiplication: The utility of a project regarding a certain criterion is multiplied with the criterion’s weight. Therefore, no new uncertainties are introduced in this step: the significance of the aggregation depends on the significance of the definition of scales (step 2), the weights (step 3) and the application (step 4).
As discussed in part I of this paper, for better comprehensibility it is useful to present the scores on a scale that ranges from \(-1\) to \(+1\). Thereby, we can directly distinguish all improvements or positive characteristics from all deteriorations or negative characteristics, as the latter show a negative sign.

However, whenever the projects are intended to be compared, the scores on the scales must be transformed to “utilities”. Utilities can per definition not be negative, and their scales range from \(0\) to \(+1\).

To convert the scores into utilities, we used the simple transformation:

\[
U(p) = \frac{S(p)}{2} + 0.5
\]

where \(U\) is the utility of the project and \(S\) the respective score on the scale. Table 8 presents the aggregated utilities of the three project proposals. The utility – or the degree to which it contributes to sustainable development – of project 2 (methane from waste water plant) seems to be slightly higher than the utility of project 1 and 3. All the projects score well above 0.5, which is the point of “medium utility”: 0.5 means that the positive contributions of the project just outweigh its negative contributions. An utility of less than 0.5 means that the project is actually adverse to the goals of sustainable development.
Table 8: Aggregation of utilities. The scores on the scale are transformed into utilities, which are multiplied by the weight of the criterion. Finally, the weighted utilities are summed up to yield the final score of the project. An utility of above 0.5 means that the project bears more positive than negative impacts.
Sensitivity Analysis

The final utilities of the projects proved to be quite close. We should therefore know how robust the findings are – a slight change in the weightings or slightly different data in the application should not lead to a reversal in the ranking order of the projects.

The software Expert Choice allows a sensitivity analysis of the weighting process, but unfortunately not for project assessments that are directly entered into the program.

Sensitivities of weights and assessments are of course interlinked. The sensitivity of an assessment is large, if the respective criterion has a high priority. On the other hand, high sensitivities in the weights can be found, where the projects exhibit large differences in their scoring.

Here, this was the case in economic criteria. From figure 13 we can see that because of the low importance of Microeconomic Efficiency, Project 2 (Methane from waste water) overall scores high in economic criteria, in spite of the project's very small utility in this criterion. The left axis in the figure represent the relative importance of the criteria. The right axis stands for the overall performance of the projects.

![Figure 13: The performance of the three projects in economic criteria. Because of the low importance of Microeconomic Efficiency, the Waste Water overall scores high in economic criteria, in spite of the project's very small utility in this criterion.](image)

A further increase of the importance of Employment Generation from now 42% (red vertical line, see figure 14) to 46% (dashed line) would reverse the order, and the Waste Water Plant would even be leading in economic criteria.
Figure 14: Sensitivity of Criterion Employment Generation. A slight increase in its importance (from straight to dashed line) would reverse the ranking order of the project in terms of economic criteria.

Overall Performance

Figure 15 shows the overall utilities of the three projects split into the blocks of social, environmental and economic criteria. The axis on the left indicate relative importance of the criteria.

The sensitivity analysis shows that Tunnel Kiln and Landfill change their positions if either the importance of the social criteria increase to 40% (from 36.3) or the importance of the economic criteria decreases to 29% (from 30.1). Waste Water loses its leading position only under drastic changes; this is if the importance of social criteria decreases to 15% or if environmental criteria increase to over 60%.
The most important point when discussing the robustness of the results is the fact that the score of a project assessment can change much easier than the weight of a criterion. The criteria are the result of a survey with a large number of participants. Once established, these weights are applied on all project proposals. Assessing a project on the other hand is a very specific act. New data or a change of plan can change the scores drastically. This stresses once more the importance of having clearly defined indicators and scales. A sophisticated weighting process is of no use if the criteria finally cannot be applied properly.

Discussion and Conclusions

Discussion of the methodology

To structure the discussion of the methodology, the participants were asked to answer four additional questions. In many cases, those questions led to intense discussions that went far beyond their actual intention. As well, on each sheet of the survey, the participants had a space to state their comments on the weighting. In the following section, some of the relevant comments are grouped together.

Which Criteria (aspects of sustainable development) are missing? Please specify.

General
- Risks; in particular to exclude nuclear power plants. Even if nuclear plants are generally excluded from the CDM, any sustainability tool should be sensitive for the risks of these technologies.

Social Criteria
- Gender balance / equity
- Self-sufficiency
- Quality of jobs
- Health benefits (housing projects!)
- More focus and details on the criteria for underprivileged communities, especially to provide basic services.

Environmental Criteria
- Biodiversity
- Distinction between indoor- and outdoor air quality

Economic Criteria
- Technology transfer not only from the North.
- Contribution to sectoral preferences.
- Empowerment of disadvantaged mirco-, small- and medium enterprises
- Improvement of international competitiveness

Which Criteria (aspects of sustainable development) would you drop? Please specify.

General
Some sustainability indicators could be useless, as they are already in legislation (e.g. child labour). In particular, the assessment should not duplicate the requirements of the EIA procedure.

Social Criteria
- Improved service availability to be replaced with “net efficiency improvement”
- Stakeholder participation requires capacity development; without knowledge meaningful participation is impossible

Environmental Criteria
- “Minerals and fossil energy resources” should be divided into separate aspects as minerals are recyclable.

Economic Criteria
- regional economy (in South Africa everything is connected)
- Definition of “regional economy” is misleading – “regional” in the SA context means “within Southern African countries”. The way it is meant here the criterion should be under “social development.”
- Regional economy and employment generation are interlinked.

Is weighting of criteria an appropriate way to map the preferences in sustainable development of a country? Do you have other suggestions?
In the following bullets we mention several critical comments regarding the proposed methodology.
- There must be a minimum threshold to exclude certain projects from consideration as sustainable.
- National interests should be balanced by regional interests.
- The problem is that the system presents these issues as tradeoffs, even if that is not the intention – in fact we want projects that don’t make tradeoffs.
- This system is better for choosing from a portfolio than a once-off, ad-hoc project approval decision.
- The methodology is to little community based. This community feel like an object. The knowledge is in every community so different.
- A single benefit in one of the 3 pillars of SD or in any one criteria may be of such value to outweigh the importance of combined weighting of remaining pillars and criteria. This is particularly important in this early phase of introducing CDM to South Africa.
- The empirical background of South Africans is sometimes very limited. Nobody really knows, where the major problems are rooted – and to an even far less extent would people know a solution to them. The quality and the amount of information to the majority of the people is very low. A large part of the population were never properly educated. Therefore it is impossible to include them into the survey. On the other hand, these are the people for whose needs sustainable development should stand for in the first place.
- People have few time and financial resources to attend workshops. At the same time, South Africans have experienced an extraordinary number of foreign researchers, who conducted promising surveys, only to disappear soon to write their thesis. Therefore, people are quite suspicious about surveys, which are not linked to a directly visible benefit.
• It is appropriate.

**Other general comments:**

• In this early phase, the aim should be to achieve flexibility in criteria without compromising the intention to achieve sustainability. A more structured approach could come under consideration after significant experience has been gained — then allowing for more meaningful comparisons.

• According to Agus Sari, Executive Director of the Indonesian NGO Pelangi that is part of the Southsouthnorth network, few projects can in practice show that they really help or hamper sustainable development. Within a sustainability assessment in Jakarta, Indonesia, two teams came up with totally contradictory results.

**Clarity**

• It should be stated more clearly that local sustainable development is meant (i.e. excluding climate change)

• It is important to declare that this weighting applies for evaluation of CDM only, not SD in general.

**Perceptions and values of participants**

• “Preferences in SD of a country” are more a reflection of individual political / economic preferences than of what is sustainable; to determine sustainability it would be more appropriate to assess, which resources are under highest pressure.

• Different perceptions, values and understandings of the world play a role. For example, both direct job creation and a new efficient technology with a new supply chain can have positive effects for the employment situation. Which one is judged more important depends as much on the individual conviction as on the specific circumstances of a host country.

**Conclusions**

**Conclusions Regarding the Methodology**

In the introduction to this report, we have postulated several requirements for a methodology to assess sustainability impacts of CDM projects. In the following section, we draw a conclusion regarding these aspects.

• transparent: The approach shows the criteria weighting and the application on projects transparently. However, its complexity proved to be at a high level. Even an approach that is perfectly transparent in theory can become unfair if all stakeholders have not the chance to comprehend it properly. Future research is needed for a transparent definition of the scales.

• robust: Most participants in the survey agreed that the methodology is robust, if correctly applied. Some people argued that whenever trade-offs are principally allowed, a risk of “green-washing” of a project exists and the methodology could not lead to a strict exclusion of a certain project. For implementation in a host country, an MCDA approach would ideally be combined with thresholds. (see also under “the way forward”)

• simple to apply: The required effort for application of the indicators on the project proposals proved to be reasonable. The main problem was that the assessed projects were all still in quite an early stage of realisation. The effort for
conducting a survey with meaningful outcomes is the biggest challenge. The process to derive the scales transparently (maximum / minimum values of the indicators) could cause further challenges.

- **comprehensive**: The majority of participants experienced the amount and the diversity of the chosen criteria as comprehensive enough. As a matter of fact, the approach does only measure the project’s direct impacts regarding the given criteria. As far as we experienced, any attempt to account for complex interrelations, which tries to include impacts several steps “downstream”, would lead to an unsatisfactory loss of transparency. Therefore, we must conclude that the approach cannot measure “the project’s impacts on sustainable development in the host country”, but it can measure “the project’s direct effects regarding a weighted set of social, environmental and economic criteria”.

- **fair**: The approach provided fair conditions for the considered projects. It was applicable on projects of very different technologies and size. Those projects were as well located in different areas. The Ferrochrome Plant will be privately owned, the Waste Water Plant and the Landfill Site are owned by the state. Meanwhile, the approach might be more difficult to apply in the complex case of a housing project. As well, it is theoretically applicable but not designed for LULUCF projects.

### Lessons Learned

#### Application of the Methodology

**Participants should provide intuitive judgments**

The circumstances, under which participants fill out the questionnaires, should be as uniform as possible. The participants should therefore be asked to always perform intuitive and personal judgments when assessing the relative importance of the criteria. It is well possible that certain participants feel obliged to follow their company’s, NGO’s or governmental institution’s perception, which might differ from their own. From the first application of this methodology in South Africa we learned that this dilemma proved difficult to be entirely clarified. There were even one person, who refused to complete the questionnaire, because she found herself unable to distinguish her personal from her professional interests.

**Experts or public participation?**

This question cannot be answered yet, as the survey was almost exclusively conducted among people active in the CDM process. Unfortunately, the questionnaires to be completed in a township did not provide useful results. This experience indicates that the evaluators should conduct the survey only in direct contact with the participants. This can either happen through interviews or workshops. Specific procedures should be developed to allow lesser educated people to join and understand the evaluation.

**Direct Weighting or AHP?**

AHP has two major advantages: Firstly, it is easier to comprehend. Secondly, the additional information of the inconsistency allows to exclude participants, who failed to understand the procedure.
As the two methodologies proved to come up with the same dimension of results, surveys resulting from AHP and Direct weighting could even be mixed. This might be necessary if an AHP-only process would prove to be too time consuming. Especially for non-experts in sustainability or the CDM mechanism, only AHP should be used.

**Only direct impacts of projects can be measured in a transparent way.**

It is crucial to explain the scope of the SD assessment to the participants. In South Africa, this was not always possible under time constraints. From the application we learned that the evaluators should always let the participants assess the sub-criteria (e.g. the four social criteria) first. When the participants are finally asked to aggregate (sustainable development), the evaluator should make clear once more that the weights indicate “the relative importance of the 4 social criteria compared to the 4 economic criteria” – and not “the relative importance of social development compared to economic development of the country”!

**General Issues**

**In some people’s perception the approach still allows for “green-washing”** =>

We believe that this is only true if the approach cannot be applied strictly enough. For improved acceptance, the intention and the scope of the methodology should be communicated very clearly. But at the same time, a certain degree of motivation, resources and respective capacities is required to guarantee a successful implementation. The methodology as well asks for a certain understanding of democratic processes. Otherwise the methodology will not generate meaningful data.

**Stakeholder preferences can never be mapped representatively** =>

The tool is probably most appropriate for countries, in which a process to include all stakeholders in a representative number is easier to achieve. This might especially hold for smaller countries with more uniform geographical and socio-political parameters.

**The approach is difficult to apply on projects with very complex social implications (e.g. housing projects).** =>

More experience must be collected with the application of the methodology on different technologies. At this stage, we do not know yet whether only for some specific cases or even for whole ranges of projects the indicators are difficult to apply.

**The scales for the indicators proved to be the weakest point of the application** =>

Further research is needed to provide simple procedures. In line with the applied multi-criteria decision analysis methodology, the scales must also result from a stakeholder process with respective surveys. Alternatively, a panel of expert could define them. Some of the scales could be linked to social / environmental / economic parameters. Which ever way the scales are defined, it is crucial that the participants, who weight the criteria, know the applied scales exactly, as the utility function will influence the relative importance of the respective criterion.
The way forward

“thresholds to prevent - criteria to promote”

The application in South Africa of the methodology “MAUT for Sustainability Assessment of CDM Projects” has revealed several weak points, for which further research – and in particular: further experience – will be necessary. Nevertheless, it overall seems to be a reasonable compromise between comprehensiveness and simplicity in application.

The most essential challenge of the methodology as a whole seems to be its complexity. Indeed, the methodology is not primarily designed to provide “yes / no” - answers to the question, whether a project should be approved or rejected. As the host country approval is a delicate task, where many interest groups watch decisions very carefully, the methodology might not be straight forward enough to deliver a quick first test for approval.

An interesting option for further application could include a combination of the multi-criteria decision approach with eligibility criteria (thresholds). Or, in the words of Laurraine Lotter, chemical and allied Industries’ association: “thresholds to prevent - criteria to promote”

Figure 16: In the future, a multi-criteria decision approach to rank the projects could come after several strict thresholds (eligibility criteria)

Is sustainability a concept too generic to be measured? Any sustainability assessment, if seriously performed, cannot ultimately produce exact results. However, if the uncertainties are carefully and transparently declared, we suggest that the challenge of assessing projects regarding their impacts on the sustainable development of host

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27 The concept of Sustainable Development does not allow such a simple answer anyway. In the political reality, “yes/no”-answers (thresholds) can nevertheless be very helpful to exclude projects that exhibit certain unwanted properties. However, these “eligibility criteria” should be declared as such, and should not claim to stand for an actual sustainability assessment.
countries should be accepted as this assessment provides valuable information about chances and risks of planned CDM projects. The CDM mechanism will bring a new type of projects, which for the first time legally require an approval regarding sustainable development of the host country – the chance to break a beautiful though abstract concept down to an applicable level must not be missed!
References


Sustainable Development Assessment of CDM Projects - ETH Zurich, Energy & Climate


SUSAC-Zambia. Recommendations on Assessment of Sustainable Development From Zambia’s National Development Perspective


Thorne S, Raubenheimer S (2001) Sustainable Development (SD) appraisal of Clean Development Mechanism (CDM) projects – experiences from the SouthSouthNorth (SSN) project.


Appendix 1: Criteria and Indicators in Detail

The following section presents the proposed criteria along with their respective indicators and scales as they have been in use for the case study in South Africa.

Social Criteria

“The project has positive effects on social development”

According to UNDP, Human Development is the process of enlarging people’s choices as well as raising their levels of well-being. A CDM project will have impacts on certain aspects of social development.

The criteria under this target estimate the direct impacts on the social development. System boundaries of the assessment of social development will be the region, where the project is implemented. Short-term as well as long-term impacts during the ten years after project implementation are considered.

The target of “social development” is divided into the following criteria. They all reflect one aspect of social well-being. It has to be noted, that the division could of course be done in a different way. In South Africa, “Gender Equality in Distribution of Project Benefits” has for example frequently been mentioned as a missing, but necessary criterion.

1. Stakeholder Participation (enlarging people’s choices)
2. Improved Services Availability (material well-being)
3. Equal Distribution of Project Turnover (social justice)
4. Capacity Development (intellectual capital)

28 http://hdr.undp.org/
1. Criterion: Stakeholder Participation

Description of Criterion
“stakeholders can participate in the project development.”

Indicator:
Qualitative indicator with descriptive scale

Measurement of Indicator:
The current CDM regulations require a publication of the project proposal on the internet during one month\(^{29}\). For a real dialogue with concerned stakeholders, this procedure is not appropriate, especially in countries, where only a limited number of people have access to internet. The indicator therefore examines, in what way the project developers plan to publish their plans and communicate them to concerned stakeholders. Relevant stakeholders are: people living in the area of the project, people who are involved in the project (labour, suppliers,…), relevant NGOs.

Scale:
This scale is proposed by the authors, but it is not based on scientific results. It therefore serves only as example and must be defined again for the specific circumstances in a host country.

\[\begin{align*}
-1 & \quad \text{stakeholders are not involved at all, no access to data is possible} \\
-0.5 & \quad \text{stakeholders are only informed on request} \\
0 & \quad \text{stakeholders are informed} \\
0.5 & \quad \text{stakeholders are invited to give inputs / raise concerns} \\
1 & \quad \text{stakeholders can participate in the decision process}
\end{align*}\]

\(^{29}\) http://unfccc.int/cdm/
2. Criterion: Improved Service Availability

**Description of Criterion**
“The project contributes to improved availability of essential services”

**Indicator**
Semi-quantitative indicator, change in availability of services.

**Measurement of Indicator:**
Principle 2: Quantitative compilation of emissions / qualitative judgments. Locally prioritised (core) services, as well as other essential services are investigated through survey or expert delphi and compared to baseline. Service under consideration are: access to fresh water, access to energy, facilities (roads etc.), telephone, sanitation.

**Scale:**
-1 = Compared to baseline: significant decrease in availability of core service
-0.5 = Significant decrease in availability of other service / moderate decrease in availability of core service
0 = no change to baseline
0.5 = Significant increase in availability of other service / moderate increase in availability of core service
1 = Compared to baseline: significant increase in availability of core service
3. Criterion: Equal Distribution of Project Return

**Description of Criterion**
“the share of the turnover, which benefits people below poverty line, increases”

**Indicator**
Compared to baseline: difference in percentages of turnover

**Measurement of Indicator:**
It is examined, who will directly benefit from the generated turnover of the project. The money, which goes to financially disadvantaged people is divided by the total turnover.

**Maximum values of scale:**

**Definition of utility function:**
linear

**Scale:**

<table>
<thead>
<tr>
<th>Score (utility)</th>
<th>Value of unit</th>
<th>Unit Equal Distribution (ED): $\frac{M_p - M_b}{T_p} = ED$</th>
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</tr>
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<td>-0.5</td>
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<tr>
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<td>5%</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

where:
- $M_p$= money to disadv. people in project
- $M_b$= money to disadv. people in baseline
- $T_p$= Average turnover of project
4. Criterion: Capacity Development

Description of Criterion
“the project generates opportunities for capacity development of high quality”

Indicator:
Qualitative indicator

Measurement of Indicator:
Opportunities for capacity development during the 10 years after project implementation are investigated and compared to the baseline. The amount of the created or destroyed opportunities for capacity development is considered along with the change in quality of education offered.

Scale:
-1 = significantly less opportunities or less sophisticated capacity development
-0.5 = slightly less opportunities or less sophisticated capacity development.
0 = no change in capacity development
0.5 = slightly more opportunities or more sophisticated capacity development
1 = significantly more opportunities or more sophisticated capacity development

Conclusions and Way Forward:
For this quantitative indicator with relative scale, the model developer must be careful that the baseline remains robust. If a change to baseline is the basis of estimation, then a weak baseline can lead to a relatively high score without major efforts (and vice versa). To solve this problem, an absolute scale with thresholds could be introduced, which ignores the baseline and sets requirements only for the project. However, the “minimal utility”, which like in other cases is a destruction of capacity development options, would in that case not be represented.

As an alternative, capacity development could be equipped with a quantitative scale. For its unit we can define $ to capacity development per $ of average turnover.
Environmental Criteria

“A CDM project should lead to decreasing pressure on the environment”.

The environmental criteria examine, to what degree the proposed project has positive or negative additional effects on the environment. The discussion on how these “impacts on the environment” shall be measured—and even quantified—covers a broad variety of aspects on very different scientific, cultural and philosophical levels. Why should a project lead to decreasing pressure on the environment—is it merely to protect the human beings living in it, or is it merely because the environment signifies a good or a value that shall be honored? How do the people of a host country, or of a certain area within a host country, perceive the environment—are environmental criteria, which are defined by a central government or even by external consultants, applicable and are they of any meaning at the actual project site? How is the natural environment defined, which is to be protected—is man-made environment included, or should an “original” state of the environment be targeted; and which state should be considered “original”? How can we account for the fact that all environmental compartments like air, water, soil are linked to each other, and how do we deal with uncertainties in the future fate of today’s environmental impacts? These questions are just samples to show the complexity of the issues, when attempting to create a tool to assess environmental impacts.

Generally, all environmental issues could be addressed. The only exception is the impact of the project on climate change. A reduction of GHG is what CDM is all about, and this issue is therefore not an “additional” environmental effect.

The environmental criteria proposed in this tool follow a very pragmatic approach. It must be stressed again that the criteria here cannot be comprehensive.

Quantitative measurement of environmental criteria

Ideally, the environmental criteria are measured strictly quantitatively. Therefore, a standardized Environmental Impact Assessment (EIA) is needed. To be able to perform a comprehensive assessment on the environmental aspects of a product or a process, a variety of tools, commonly known as Life Cycle Assessment (LCA) have been developed. The results of the LCA can then serve as input data for the actual EIA, which takes into account the specific conditions and sensitivities of the project locations. An EIA for potential CDM projects could set up in the following way: The project assessment team applies an uniform Life Cycle Assessment (LCA) on all projects. An LCA typically looks at different options of implementing a project, and it compares these options in terms of their environmental impact. An LCA aggregates the different emissions and impacts of a project into scores for different criteria. The difference

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An example of LCA methodology is the ECO-Indicator 99 (EI99) developed by Godekoop & Spiersma. EI 99 aggregates environmental impacts to three categories, which each consist of several environmental issues:
- Damage to Human Health (HH): Carcinogenes, Respiratory Organics, Respiratory Inorganics,
- Climate Change,
- Damage to Ecosystem Quality (EQ): Ecotoxics, Acidification / Eutrophication, Land Use
- Mineral and Fossil Resources (R): Minerals, Fossil Fuels

As the final results, EI99 yields aggregated values for all these categories. The environmental assessment of the Tunnel Kiln (Project 1) has been conducted using EI99.
between the aggregated values of project and baseline is called the “absolute change” in pressure on ecotoxics / land use / fossil fuels etc.

In LCA terminology, a “Functional Unit” means the entity to be compared between the project alternatives; it could for example be expressed as “1 kg of the output product”. All environmental data in the LCA are expressed in terms of this functional unit. As the CER is the crucial factor in the CDM mechanism, the functional unit in the case of assessment of CDM projects would logically be “CER created”. Only using this unit has the evaluator the possibility to compare projects of different size.

Finally, this figure should be multiplied by a factor that reflects the degree of sensitivity of the surrounding area in terms of the indicator. Alternatively, instead of defining a “degree of sensitivity”, the final aggregation can as well be done by treating the different environmental issues as sub-criteria and letting people weight them. As shown later, in the present study, we divided “environmental criteria” into the four sub-criteria of air quality, water quality, land resources and energy / mineral resources. The relative change in environmental impact (EI) of a project (p) could therefore be calculated by

\[
\sum_i \left( \frac{VP_i - VB_i}{CER_p} \right) \cdot S_i = EI_p
\]

where

- \(i\) = the different environmental issues under consideration
- \(VP\) = the aggregated absolute value of the project regarding issue \(i\)
- \(VB\) = the aggregated absolute value of the baseline regarding issue \(i\)
- \(S\) = the sensitivity of the project perimeter in respect to issue \(i\)
- \(CER_p\) = amount of emission reductions achieved by the project (a normalizing factor)

In reality, the conditions to perform this ideal assessment can frequently not be met. Firstly, all sophisticated LCA methodologies are very data intensive. They require detailed information on the project’s emissions. The effort to conduct a comprehensive EIA based on sound LCA results is justified – or even required – for large-scale projects. In South Africa, certain types of projects, which are expected to have major environmental implications, must undergo an Environmental Impact Assessment EIA (DEAT, 1998). For smaller projects, however, the need to perform an EIA would lead to disproportionately large and costly research.

Secondly, most of the existing LCA databases have been developed in industrialized, for example European, countries. Their impact assessments are consequently based on European conditions. To be meaningful for a specific host country, these databases have to be adjusted for its specific context. At the University of Pretoria and at other institutes, ongoing research is developing specific LCA tools for the South African context. In other, less developed countries, such research might simply be out of scope.

**Simplified Approach**

As all criteria, the procedure to measure the environmental criteria should be comprehensive, but simple enough in application. It should integrate both large projects, for which an LCA is available, and small projects. We have divided the environmental criteria into four sub-criteria, which are eventually weighted. It has to be noted, however, that those sub-criteria could be defined in other ways. A country for example, where air
quality has never been a problem, but where water resources are scarce, might choose to omit “air quality” and replace it with several issues related to “water quality”.

5. Mineral and energy resource (contribution to sustainable use of energy / to a reduced consumption of non-renewable mineral resources)

6. Air quality (contribution to improved air quality) This criterion includes respiratory diseases

7. Water quality (contribution to local fresh water quality)

8. Land resource (contribution to sustainable use of the land)

Strictly quantitative indicators to measure these criteria seem to be too data intensive. Therefore, we propose to apply principle 1 or principle 2 that have been described under “Semi-quantitative indicators.” In the following description of environmental indicator, we present at each case the principle that had been used in the application for South Africa. If the number of core resources under consideration can be limited without gross simplification, Principle 1 (selection of core resource) can be applied.
5. Criterion: Mineral and energy resources
(contribution to a reduced consumption of fossil fuels / mineral resources)

**Description of Criterion**
“the project contributes to decreasing pressure on fossil fuels / mineral resources”

**Indicator:**
Compared to baseline: change in consumption of core resource

**Measurement of Indicator:**
Principle 1: Selection of core resource, measurement of change in this resource.

**Maximum values of scale:**
Maximum utility (1): A Project that generates all CER with replacement of coal electricity. Electricity from coal South Africa: 570kg coal -> 1tCO2. Minimum utility (-1) reciprocal

**Definition of utility function:**
linear

**Scale:**

<table>
<thead>
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<td>$-570$</td>
</tr>
<tr>
<td>1</td>
<td>-570</td>
<td>$-570$</td>
</tr>
</tbody>
</table>

where:
- $t_{C_P}$ = t Coal per year in project
- $t_{C_B}$ = t Coal per year in baseline
- CER= Emission Reductions
6. Criterion: Air quality
(contribution to improved air quality)

**Description of Criterion**
“the project contributes to decreasing pressure on the regional air quality”

**Indicator:**
Semi-quantitative indicator; change in impact on air quality

**Measurement of Indicator:**
Principle 2: Quantitative compilation of emissions / qualitative judgments. Issues of
- Respiratory diseases
- odour
- carcinogenes

are examined and compared to baseline.

1. Identify pollutants: Identify significant air pollutants that are of concern in the project design. Pollutants can be related to: Identify a unit to measure changes in each pollutant. If an LCA is performed, calculate the aggregated values for the resource categories related to air pollution / respiratory diseases. Decide whether the issues is relevant enough to be further considered.

2. Calculate change: In all relevant pollutants the change to baseline of its unit is calculated.

**Scale:**
The scales range from a significant increase quality to a significant decrease in pressure on air quality.

Qualitative judgment: Give qualitative judgment for the scoring of the indicator. This judgment reflects the relevance of the project to air quality. It includes the project size as well as the sensitivity of the project perimeter in terms of these emissions. For example, high dust emissions matter more if the project stands next to a city than if it is located in an uninhabited rural area.

-1 = significant increase in respiratory or carcinogens
-0.5 = significant increase in odour / moderate increase in respiratory or carcinogens
0 = no change to baseline
0.5 = significant decrease in odour / moderate decrease in respiratory or carcinogens
1 = significant decrease in respiratory or carcinogens
7. Criterion: Water quality

(contribution to local fresh water quality)

Description of Criterion
“the project contributes to decreasing pressure on the regional fresh water quality”

Indicator:
Semi-quantitative indicator; change in impact on change in impact on fresh water quality

Measurement of Indicator:
Principle 2: Quantitative compilation of emissions / qualitative judgments. Issues of
- drinking water quality
- acidification
- eutrophization
are examined and compared to baseline.

1. Identify issues: Identify significant issues related to fresh water quality that are of concern in the project design. Identify a unit to measure impacts in these issues. If an LCA is performed, calculate the aggregated values for the resource categories related to water quality. Decide whether the issues is relevant enough to be further considered.
2. Calculate change: In all relevant issues the change to baseline of its unit is calculated.

Scale:
The scales range from a significant increase to a significant decrease in pressure on water quality.

Qualitative judgment: Give qualitative judgment for the scoring of the indicator. This judgment reflects the relevance of the project to water quality. It includes the project size as well as the sensitivity of the project perimeter in terms of these issues.

-1  = significant increase in pressure on one or more issues / moderate decrease in two issues
-0.5 = moderate increase in pressure on one issue
0    = no change to baseline
0.5  = moderate decrease in pressure on one issue
1    = significant decrease in pressure on one or more issues / moderate decrease in two issues
8. Criterion: Land resource
(contribution to decreasing pressure on land issues)

Description of Criterion
"the project contributes to decreasing pressure on the regional land resource"

Indicator:
Semi-quantitative indicator; change in impact on issues related to land resources.

Measurement of Indicator:
Principle 2: Quantitative compilation of emissions / qualitative judgments. Issues of
- soil pollution
- pressure on land use
- waste production
- erosion
- biodiversity
- unsustainable use of biomass
are examined and compared to baseline.

Measurement according to Principle 2: Quantitative compilation of impacts / qualitative judgments.
1. Identify issues: Identify significant issues related to land resources that are of concern in the project design. Identify a unit to measure impacts in these issues. If an LCA is performed, calculate the aggregated values for the resource categories related to land resources. Decide whether the issues is relevant enough to be further considered.
2. Calculate change: In all relevant issues the change to baseline of its unit is calculated.

Scale:
The scales range from a significant increase to a significant decrease in pressure on land resources.

Qualitative judgment: Give qualitative judgment for the scoring of the indicator. This judgment reflects the relevance of the project to land resources. It includes the project size as well as the sensitivity of the project perimeter in terms of these issues.
-1  = significant increase in pressure on two or more issues / moderate increase in four or more issues
-0.5 = significant increase in pressure on one issues / moderate increase in two or more issues
0   = no change to baseline
0.5 = significant decrease in pressure on one issues / moderate decrease in two or more issues
1   = significant decrease in pressure on two or more issues / moderate decrease in four or more issues
Economic Criteria

“The project has positive effects on sustainable economic development”

A CDM project will have economic implications for the host nation, and especially for the project perimeter. The criteria under this target estimate direct positive / negative economic impacts of the project.

Short-term as well as long-term impacts during the ten years after project implementation are considered.

The target “economic development” is divided into 4 criteria. As with social and environmental criteria, the implications of a project for the economy are very complex and virtually impossible to map quantitatively, especially if research capacities are limited and if project proposals are in an early stage. The criteria proposed here all concern direct effects of projects. For example, under “employment generation” we count only jobs that are offered in the project construction and the project operation phase. By introducing a new technology, a CDM project could indirectly generate further jobs, as new supplier chains might be necessary. Introducing all these aspects would enhance the comprehensiveness of the indicators, but at the same time make them imprecise and unpredictable in their application.

9. Regional Economy (Generation of wealth in a disadvantaged region)

10. Microeconomic Efficiency of the Project (Contribution to the attractiveness of investments)

11. Employment Generation

12. Sustainable Technology Transfer (Technical innovation for the country)
9. Criterion: Regional Economy

(Generation of wealth in a disadvantaged region)

Description of Criterion
“the project contributes to value generation in a disadvantaged region”

Indicator:
Semi-quantitative indicator; economic performance of project location

Measurement of Indicator:
Principle 2: Quantitative compilation of emissions / qualitative judgments. The indicator assesses the economic situation of the project location in context of the whole country. This indicator measures, whether the project brings benefits to an economically disadvantaged region. Therefore, regions within the country have to be classified according to their economic situation.

The following parameters are used to classify the regions taking the expected performance of the 10 years after project implementation into account:

- average income of working people
- unemployment rate
- GGP$^{31}$ per capita

In the application on South Africa, data for these parameters were frequently available on provincial level only.

Scale:
-1 = project at privileged location hinders project at disadvantaged location
-0.5 = project at location on average hinders project at disadvantaged location
0 = project location economically privileged
0.5 = economically on average
1 = project location economically disadvantaged

Conclusions and Way Forward
A qualitative definition is possible as well. In a qualitative scale, the different conditions of a region could be described verbally, or a combination of the parameters shown above could be used.

Alternatively, a host country could issue a list with regions of special preference.
In the application on South Africa, data for these parameters were frequently available on provincial level only. Therefore, this indicator should be developed country-specific according to the data abundance.

---

$^{31}$ GGP: gross geographical product.
10. **Criterion: Microeconomic Efficiency**

(Contribution to the attractiveness of investments)

**Description of Criterion**

“The project has a high internal rate of return”

**Indicator:**

IRR of project including CER at a price of 40 Rand.

**Measurement of Indicator:**

The expected IRR during the 10 years after project implementation is calculated and compared with the baseline project.

**Maximum values of scale:**

Minimum utility (-1) are projects with a negative IRR. Medium utility (0) are projects that have an IRR around the real discount rate. Maximum is derived with a linear extrapolation.

**Definition of utility function:**

linear

<table>
<thead>
<tr>
<th>Scale</th>
<th>Value of unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>0%</td>
</tr>
<tr>
<td>-0.5</td>
<td>5%</td>
</tr>
<tr>
<td>0</td>
<td>10%</td>
</tr>
<tr>
<td>0.5</td>
<td>15%</td>
</tr>
<tr>
<td>1</td>
<td>20%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit Microeconomic Efficiency (ME): Internal Rate of Return (IRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score (utility)</td>
</tr>
<tr>
<td>-1</td>
</tr>
<tr>
<td>-0.5</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>
11. Criterion: Employment Generation

Description of Criterion
“the project creates jobs”

Indicator:
Additional Man-month per GHG Reduction

Measurement of Indicator:
The number of man-year of labour is counted and compared to the baseline project. The 10 years after project implementation are therefore considered. The absolute change in man-year created is normalized with the amount of CER created.

Maximum values of scale:
At a CER price of 40 Rand, a 1000CER project can maximally sustain 5 salaries of 8000 Rand. Maximum utility means that the CER revenues are used to employ people with good salaries.

Definition of utility function:
linear

Scale

<table>
<thead>
<tr>
<th>Score (utility)</th>
<th>Value of unit</th>
<th>Unit Employment Generation (EG): $\frac{(JP - JB)}{CER_p} = EG$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>-5</td>
<td>$\frac{(JP - JB)}{CER_p}$</td>
</tr>
<tr>
<td>-0.5</td>
<td>-2.5</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Conclusions and Way Forward:
There are several advantages in defining “employment generation” quantitatively. A calculation showing that no jobs are lost directly due to the project seems to be indispensable. However, several factors are thereby excluded and could form “sustainability leakages”. In particular, the indicator does not say anything about the salaries. Simply re-defining the indicator into $ for salaries per turnover (see criterion 3: equal distribution) is no solution, as a shift towards fewer, highly paid salaries is just not what most participants might have had in mind.

With the words of one participant, who stated that “a job is only a job if it makes for a living”, one could in the future define the indicator as JP=total amount of man-month paid with sector-specific appropriate salaries created by the project…
12. **Criterion: Sustainable Technology Transfer**

(Technical innovation for the country)

**Description of Criterion**

“The project applies innovative, locally manageable technology.”

**Indicator:**

Qualitative indicator

**Measurement of Indicator:**

The applied technology, its planned implementation, supply of spare parts, and expected maintenance is examined. It is estimated, whether the applied technology is an innovation for the country, and whether the applied technology can be locally maintained.

**Scale**

-1 = transferred technology is not maintainable and manageable over the long term

-0.5 = external skills must be imported with the transferred technology

0 = no technology transfer is involved

0.5 = local skills can be developed with the assistance of external expertise

1 = potential capacity exists locally to maintain and manage the implemented technology
Appendix 2: Existing sets of SD criteria and indicators

1. SSN Sustainable Development Indicators

   Indicator 1 – Contribution to the mitigation of Global Climate Change
   Global environmental benefits will be measured by the net reduction of GHG emissions measured in CO$_2$ equivalent according to the IPCC GWP for a one hundred-year horizon.
   Vector: 0 = No change in GHG emission level compared with the baseline.  
           3+ = Total avoidance of the GHG emissions predicted. 
   The main difficulty with quantifying this indicator is estimating the leakage (see below). Complete leakage accounting is required within the host country and sometimes abroad, for example, in those projects that aim to conserve indigenous forests. 

   Indicator 2 – Contribution to local environmental sustainability
   Local environmental impacts will be assessed by the percentage change in the emissions of the most significant local pollutant (oxides of sulphur, nitrogen, carbon and other atmospheric wastes; radioactive waste, VOC, TSP or any solid or liquid waste). A weighted average percentage change may be used when more than one pollutant is considered to be relevant.
   Vector: 0 = No change in emission level of the selected pollutant.  
           3+ = Total avoidance of emissions of the local pollutant. 
           3- = Emissions of the local pollutant are doubled. 
   Subjectivity is an unavoidable weakness of this indicator, given the necessary selection of sample pollutants for monitoring. 

   Indicator 3 – Contribution to net employment generation
   Net employment generation will be taken as an indicator of social sustainability, measured by the number of additional jobs created by the CDM project in comparison with the baseline.
   Vector: 0 = No change in employment level compared with baseline.  
           +3 = Doubled number of jobs. 
           -3 = Elimination of all jobs predicted in the baseline. 
   This indicator is problematic in that it doesn't register a qualitative value for employment, such as whether the resultant jobs are highly or poorly qualified, temporary or permanent, secure or 'flexible'. Figures are also subject to inflation depending on whether direct and indirect jobs are counted. 

   Indicator 4 – Contribution to the sustainability of the balance of payments
   Net foreign currency savings may result through a reduction of, for example, fossil fuel imports as a result of CDM projects. Any impact this has on the balance of payments of the recipient country may be compared with the baseline.
   Vector: 0 = No change in foreign currency expenditure compared with baseline.  
           +3 = Total avoidance of foreign currency expenditures. 
           -3 = Doubled net foreign currency expenditures. 
   A major difficulty here is that estimates of future prices of imported goods and services replaced by the project can be quite uncertain (e.g. international oil prices).
Indicator 5 – Contribution to macroeconomic sustainability
The alleviation of the burden on public savings will be measured by the reduction of direct
government (national, provincial and local) investments (including budgets of state enterprises)
made possible by the foreign private investment in the CDM project in comparison with the
baseline.
Vector: 0 = No change in public investments compared to the baseline.
+3 = Total avoidance of public investments.
-3 = Doubled public investments compared to baseline.
The challenge here is to calculate the saving of public financial resources net of subsidies and to
ascertain the additionality of the foreign private investment.

Indicator 6 – Cost Effectiveness
Cost reductions implied by the CDM project in comparison with the baseline will measure the
contribution to increased microeconomic sustainability. The value of this indicator will only be
positive in the case of "win-win" ("no-regrets") projects.
Vector: 0 = No change in costs compared to the baseline.
+3 = Total avoidance of costs compared to the baseline.
-3 = Doubled costs compared to baseline.

Indicator 7 – Contribution to technological self-reliance
As the amount of expenditure on technology changes between the host and foreign investors, a
decrease of foreign currency investment may indicate an increase of technological sustainability.
When CDM projects lead to a reduction of foreign expenditure via a greater contribution of
domestically produced equipment, royalty payments and license fees, imported technical
assistance should decrease in comparison with the baseline.
Vector: 3 = No change in foreign currency expenditures with technology compared to the
baseline.
+3 = Total avoidance of foreign currency expenditures.
-3 = Doubled foreign currency expenditures with technology.

Indicator 8 – Contribution to the sustainable use of natural resources
CDM projects should lead to a reduction in the depletion of non-renewable natural resources
either through the adoption of technologies with higher energy efficiency or through an increased
deployment of renewable resources, such as the replacement of fossil fuels with solar or wind
energy.
In both cases, CDM projects will contribute to a more sustainable use of natural resources.
Vector: 0 = No change in non-renewable natural resource use.
+3 = Avoidance of all non-renewable natural resources.
-3 = Doubled use of non-renewable natural resources.

2. Johannesburg Climate Legacy
Assessment Criteria in terms of sustainable development:
Economic Criteria
• Contribute to job creation and economic development
• Access to essential services (energy, water, health, education, access to facilities / transport)
Environmental Criteria
• Reduce local environmental impacts
• Contribute to the sustainable and more efficient use of non-renewable natural resources
Social Criteria
• The upliftment and empowerment of disadvantaged sectors
• Additional non-direct socio-economic benefits (health, education, environment, alternative income generating activities, access)

3. Factor / Dasag: Small-Scale CDM Projects

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Indicators</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combating Poverty</td>
<td>Net employment generation</td>
<td>man-year / year</td>
</tr>
<tr>
<td>Equal Distribution</td>
<td>Ration of income for poor women compared to total income generated by the project</td>
<td>%</td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microeconomic Efficiency</td>
<td>IRR</td>
<td>%</td>
</tr>
<tr>
<td>Contribution to balance of payments</td>
<td>Net foreign currency required / MW installed capacity</td>
<td>USD / MW</td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saving of resources</td>
<td>Fossil fuels used</td>
<td>t/year</td>
</tr>
<tr>
<td>Pressure release on local environment</td>
<td>SO2 emissions</td>
<td>tonnes</td>
</tr>
</tbody>
</table>

4. PCFPlus
In his Report “Applying Sustainable Development Criteria to CDM Projects”, Selmuel Huq proposes to count the number of “sustainability categories” (social, environmental, economic) in which the project has a significant benefit.

Scale Sign Indicator
-1 Negative Project has negative sustainable development impacts in terms of undermining other environmental and social development (ESD) policies and/or causing environmental/social impacts from the CDM project baseline
0 Neutral: Sound CDM project but no difference from baseline in any discernable way in environmental/social or policy terms
1 Positive: One additional significant benefit, e.g. One of social, local environmental, health, poverty, community participation or economic/welfare gains
2 Positive: Two or more additional benefits in two categories
3 Positive: Significant benefits in three or more categories, i.e. all of social, local environmental, health, community participation and welfare/employment

5. SUSAC-Project Zambia

Economic
1. Reducing the burden on imports of energy on a macro-level
2. Increased investment in a priority sector of the economy
3. Contributing to competitiveness at a microlevel, like industry
4. Positive effects on the trade balance
5. Improved local economy (effects on GDP)
6. Reduction of energy intensity at a microlevel
7. Increasing share in the contribution of renewable energy to the energy supply mix of a macro-level
8. Increase of sustainable energy deployment
9. Increase of energy productivity

Environment
1. Global environmental measures should result in the reduction of greenhouse gases emissions (CO₂, CH₄, N₂O), as per convention (baseline development, additionality calculation)

2. Local environmental efforts should result in reduction of local impacting emissions (the pollutants O₂, NOₓ, CO, NMVOC) (reduced air pollution, reduced water pollution, conservation of bio-diversity, reduced soil erosion caused by deforestation)

**Social**
1. Increased local employment
2. More equitable distribution of resources (reduction of wealth disparities)
3. Increase in percentage of rural and periurban population with access to power supply
4. Affordability
5. Capacity building (e.g. transfer of technical skills)
6. Health impacts

### 6. Country Study South Africa

<table>
<thead>
<tr>
<th></th>
<th>Quantitative</th>
<th>qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Reducing GHG emissions</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>2. Local environmental impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil conservation and biodiversity</td>
<td></td>
<td>?</td>
</tr>
<tr>
<td>Water resources and biodiversity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air quality: non-greenhouse gas emissions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leakage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Cost-effectiveness</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>4. Macroeconomic impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact on trade balance</td>
<td></td>
<td>?</td>
</tr>
<tr>
<td>Impact on inflation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emissions return on initial investment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact on international competitiveness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact on GDP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Social impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social equity and poverty alleviation</td>
<td></td>
<td>?</td>
</tr>
<tr>
<td>Job creation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Institutional and administrative capacity</td>
<td></td>
<td>?</td>
</tr>
<tr>
<td>7 Technological feasibility</td>
<td></td>
<td>?</td>
</tr>
</tbody>
</table>

**Further considered sets and approaches**

**Helio International**

http://www.helio-international.org/Helio/anglais/climate/climate.html

Sustainability Criteria for energy projects should include the following aspects:

**Economic:** The project should result in increased energy sufficiency, reducing the burden on imports of energy for the project area.

**Social:** The project should result in increased local employment and increased equity in the distribution of resources.

**Environmental:** The project should result in a reduction in local emissions, including oxides of sulphur, nitrogen and suspended particulates.

**Technical:** The project should result in increased energy productivity or a greater proportion of renewable energy in the energy supply mix.

**NSS for Indonesia**

SD indicators (ranked after priority), see also SARCS
1. No adverse environmental impact  
2. Environmentally sound technology transfer  
3. Stakeholder participation  
4. Socio-economic consideration  
5. Improved capacity building  
6. Local economic benefits  
7. Community development program  
8. The market openness of CER to Annex 1 countries  
9. Increased employment  
10. Equitable distribution of benefits  
11. Respect of ulayat’s right (land tenure)  
12. Use of implementable technology  
13. No net increase in external debt burden  
14. Increase in foreign currency reserves

Appendix 3: Contacted Stakeholders in South Africa

**Government**
Department of Environmental Affairs & Tourism – Shirley Moroka  
Department of Trade and Industry – Xolile Witwa, Tsenge Demane  
Department of Foreign Affairs – Ruud Henk  
City of Cape Town – Craig Haskins

**NGO**
Southsouthnorth (SSN) – Steve Thorne, Stephan Raubenheimer, Barry Kantor  
Sustainable Energy and Climate Change Partnership (SECCP) – Richard Worthington  
South Africa Climate Action Network (SA-CAN) – Mamashoabathe  
Minerals and Energy Policy Center (MEPC) – Shomenthree Moody, Malebabo Sakoane  
Globe Southern Africa – Richard Sherman  
Sustainable Energy Africa (SEA) – Wendy Engel

**Consultancies**
Resource Recovery Systems - Neil Rein  
Palmer Development Group - Michael Goldblatt  
Price Waterhouse Coopers (PWC) – Harmke Immink  
KPMG – Stirling Habbitts  
Common Ground - Jonathan Hengst

**University**
University of Pretoria (UP) - Alan Brent, Dumisani Manzini  
CSIR – Dr. Alex Morrission  
University of Cape Town, Energy & Development Research Center (EDRC) – Randall Spalding-Fetcher, Harald Winkler, Alexandra Hofmänner
Appendix 4: Results from e-discussion on CDM-connect / investigation on Climate-L

CDM-Connect: In July we moderated a discussion on the internet platform CDM-Connect. Over 100 participants joined the list. Unfortunately, most of them did not actively participate. The summary of session 1 is attached below.
Session 1: July 15 to July 19 SD criteria for CDM projects
Session 2: July 29 to August 2 SD indicators for CDM projects

Climate-L: In June 2002 we put a question on the mailing list Climate-L regarding existing sets of sustainability criteria / indicators. We got about 30 meaningful answers that served – together with other sources – as the basis for our set of sustainability criteria. These answers are attached below.

CDM-Connect: e-discussion – Summary of Session 1

Dear Participants:
In the first session of this discussion "sustainable development assessment of CDM projects", we discussed a tentative set of SD criteria.
Please find here a brief summary of the first discussion round.

General Aspects on the implementation of SD criteria:

Does the establishment of SD criteria bring benefits to host countries? Several participants argued against a set of SD criteria. Concerns were expressed that of a race towards the bottom might happen, once countries define their criteria. Others expected a never ending and fruitless discussion about the definition of criteria.
On the other hand, several participants stressed the necessity of having a set at hand.
Some had made direct experiences with negative impacts of projects. Someone argued that there is a market for sustainable CDM existing. One participant asked for standards not only in the planning, but as well in the monitoring process.

How should the criteria and the implementation methodology be defined?

All participants agreed that SD criteria must be simple to apply and not and not to cumbersome. SD criteria will be more powerful if concentrated on a small core set.
Several methodologies were suggested to select and apply criteria. The selection of criteria is a very subjective process. Therefore the approach to only define a set of criteria, but also to weight or rank them according to local preferences, was widely supported. To do this, participants suggested several kinds of multi-criteria assessments and cost-benefit/effectiveness analysis.
Which SD criteria shall be selected?

Most participants agreed to stick to the traditional division of sustainability into the three goals of social, environmental and economic development, and to define criteria for each one of these dimensions. Though, one participant argued that such a list of traditional development goals would not capture the multiple dimensions of sustainable development, and he presented a very different way to access this concept. All these approaches can still be downloaded at our hosting platform CDM-connect. (www.cdm-connect.org)

Social Criteria:
“Distribution” criteria are difficult to apply, as the impact on distribution might be different to what it seems in the first place. On the other hand, gender and racial equity is high on the list of priorities in a country like South Africa.

“Stakeholder participation” as such is not yet a target.

Environmental Criteria:
They tend to be too broad. To measure environmental impacts, Life Cycle Analysis has been recommended.

Economic Criteria:
The utility of a macroeconomic criterion like “macroeconomic stability” or (more specific) “trade balance” was heavily disputed. As any foreign investments, CDM projects will have a negative impact on the trade balance, which is not a disadvantage, if the capital inflow is productive and long-term. If foreign exchange earnings are extremely important for the macroeconomic stability of a country, “export potential” would be the more appropriate criterion.

On the other hand, economic stability inside the country (“benefits for the local economy”) should be considered when assessing CDM projects.

Best regards

Renat Heuberger
Swiss Federal Institute of Technology

Investigation on the mailing list Climate-L

1. I am working at national office on clean development and climate change from Nicaragua. Our experience is very limited but very rich in different issues> socio economical scenarios, impacts, vulnerability studies, guidelines for preparing mitigation projects and other interesting issues. We are able to participate in the preparation of this indicators on Sustainable Development on CDM projects according with ours experiences. Best regards.

2. I haven't done any work on this myself, but you will see that the PCF projects include SD indices in the monitoring and verification protocols.

These are available for each project on the web.

3. GFA Terra Systems is a consulting company in the field of Natural Resource Management. We develop, monitor, validate etc. Carbon reduction projects. We are FSC (Forest Stewardship Council) accredited (only German company) and design our forestry sink projects in this way, i.e. according to this sustainable certification standard, which even exceeds the standard demanded by the Kyoto Protocol.
Current discussion often refers to FSC as basis for the further development of a certification standard for CO2 sink projects.

4. We as climate change project team in Armenia evaluate the importance of sustainability of the project results, as well as the catalytic role of CDM projects for increasing the interest to climate change issues in developing countries consider that indicators will be very helpful for evaluation and monitoring of the project results. In project reporting format there is questions concerning creation of conditions and base for contributing to the sustainable development but without clear indicators.

5. Helio International
http://www.helio-international.org/anglais/climate/index.html
and the SSN project
www.southsouthnorth.org
have proposed a detailed set of indicators.

6. I do not have information directly available to you, but I would be interested in the result of your study. I work on international climate policy at the Energy research Centre of the Netherlands (ECN). We focus on advice on project development, like baselines, procedures and capacity building, and we are about to start a study on energy transition and development trajectories. CDM plays a role in this, and therefore sustainability indicators as well.

For information, you could check out the Worldbank, or UNDP or UNEP, these organisations finance projects that should have a degree of sustainability (e.g. via GEF). There are also people arguing that if a CDM project is in coherence with the sustainability/sustainable development policy of the CDM host country, it is fine, and no objective standard needs to be applied.

7. We are trying to do the same thing.
Fortunately, we have several sets of indicators of SD at national level. The problem for us is how to expand it at project level.

8. An interesting, important question.
You might peruse:
Duncan Austin & Paul Faeth, How Much Sustainable Development Can We Expect from the Clean Development Mechanism? (World Resources Institute 1999)
Also, see
http://www.tyndall.ac.uk/publications/fact_sheets/it1_13.shtml
http://cdmsusac.energyprojects.net/Links/country-docs/Zambia-doc_on_sustainable_development.pdf

9. At this moment I am in the process to stimulate the 14 countries that participate in our Promotion of Renewable Energy, Energy Efficiency, and Climate Change program (PREGA) to establish on short terms a national CDM authority. One of the tasks is to develop SDIs. Apart from generic SDIs also CDM SDI should be developed. Until now I am not familiar of the fact if any country has elaborated CDM SDIs. As guideline I use e.g. the NSS SDIs for Indonesia and some SDIs used in other environmental projects. Chapter 4 of the NSS study is on SDIs. Maybe
other countries have developed similar SDIs. Contact NSS (Peter Kalas from CH!! is project manager).
START’s South Asia Regional Committee has recently supported regional/national sustainability indicators (under considerations of global environmental change. Information is available on our website <www.start.org>. While these projects do not explicitly address CDM-issues under Kyoto protocol, we are hopeful that our work will contribute to national plans.

10. Although I am not aware of any published work on this subject, I have given this problem some thought and you might also want to contact Neil Sampson, who I believe has also given it some thought. In my opinion, there are a lot of indicators that could or should be looked at, depending on the project and local circumstances, including:
Access to potable water (distance)
Agricultural productivity per hectare
Diversity of agricultural products
Groundwater levels
Access to electricity
Net in or out migration
Rate of incidence key diseases
Access to education (distances and years completed)
Diversity of sources of income
Income level

A project should be evaluated over time to see what happens to a set of indicators such as those listed. If they change in the wrong direction, it is an indication that the project is not sustainable and needs to be altered to address the problems it is causing.

11. I am working with the City of Cape Town to develop indicators by which to identify Projects to select to reduce Greenhouse Gas Emissions in the Municipality of Cape Town. This is the next step after completion of a Greenhouse Gas Inventory for the City of Cape Town which I am in the process of completing as part of the International Council for Local Environmental Initiatives (ICLEI) Cities for Climate Change Campaign.

12. Two of the projects which are being considered are part of South South North’s CDM Pilot Projects here in South Africa. For more information visit their website at www.southsouthnorth.org.

13. We are working on these indicators currently and hope to complete it in the next 2 weeks or so. I have attached two documents which have assisted me in providing a framework.

14. I do not have anything to contribute, however, I am interested in what you find out. I hope you can distribute your report to the Climate Change list; if not, please send me your report when completed.

15. I would recommend the South South North Project (Brasil, South Africa, Bangladesh, Indonesia) you may have already read www.SouthSouthNorth.org lead by E. Lèbre La Rovere who is very close to the Brasilian Gvt (Hello, member of CAN France is associated with this initiative) and the work of Steve Thorne and E. Lèbre la Rovere on criterias on SD in 1999. A look at the report or a mail to them will give you the bibliography
- You may found things on www.cdm-connect.org from the WBCSD and archives of a discussions on this themes. There were works conducted by DNV for the project Ilumex in Mexico 1999 (cf AIJ World Bank Site). You may have a look to www.ceruleanconsultants.com that claim to be an expert (I do not know them sufficiently)
16. I have done some work with this idea. See attached... Hope this offers some food for thought...
   Neil Sampson

17. You should contact steve thorne of South South North in South Africa they have done a lot of work in this area his address is sjthorne@mweb.co.za

18. La experiencia es acumulada en diferentes proyectos que he venido administrando (previamente decírle que trabaje en industrias durante 12 años antes de trabajar en proyectos). A comienzos del 2000 maneje un proyecto de la UE referido a medianas y pequeñas empresas peruanas exportadoras, paralelamente todo el 2000 y 2001 administré el programa VERANTWORTLICHES HANDELN aca en el Peru y que se maneja en 47 países de mundo (en alemania lo administra la VDI)mediante el cual preparaba permanentes reportes de INDICADORES GLOBALES (los mismos utilizados por el Banco Mundial referido al desarrollo sustentable)Desde comienzos de este año desarrollo un proyecto para mediar indicadores de 6 empresas peruanas en el tema ambiental para la GTZ.

19. We have been working in the field of sustainability indicators since 1994 and have an active interest in indicators related to various aspects of climate change, including indicators related to CDMs. It's an area that I find relatively unexplored, but where some of the experience gained with indicators in the non-CDM context would probably apply. There is a limit to this, and, for example, I would not expect a direct applicability of indicator sets developed in other contexts. In our work we found that developing 'sustainability indicators' in any context, project, organization or locale, requires a critical process. I suspect CDM projects would not be an exception; although they share some common goals, CDMs come in many different forms and are applied in many different contexts where apart from being multi-dimensional, sustainability can have very different meanings. We have experience with conceptualizing, developing and applying process templates to these different contexts ranging from local communities to the national and international level.

Most of our work that is relevant in this context was on the local or organizational scale, less on projects per se. However, many of the ideas apply.

I attach a report dealing with the process of indicator selection in the urban community setting. There is a process diagram towards the end that may be of interest. We applied a similar process template for developing an indicator set for the 1997 Manitoba sustainable development report.

With regard to tools, we have developed the dashboard of sustainability, a visual display of structured indicator sets. At the moment the dashboard is filled up with country data, but as a model it has much broader applicability.

http://www.iisd.org/cgsdi/dashboard_dsply.htm

In the CDM context I think one of the challenges is to find alignment between the overall sustainability issues of a given country (the broader context) and the objectives of a given project that may have a multitude of minor and a few major impacts. As usual, attribution of overall trends to a given project will be always a challenge, as will be to find practical ways to monitor, document (hopefully in an auditable way), and assess impacts, the difference between what was promised and what actually happened, and its implications. The emphasis is on practical, as in extreme cases a project could end up spending more on monitoring and assessment than delivery, which obviously should be avoided.

20. I do not know how good is your Spanish, but Alejandro Inbach and several other people have developed good indicators for projects. Please let me know if you are interested in getting his e-mail.
21. My answer for both questions are "No".

22. You will find attached the example of how Brazil selected CDM projects using a special matrix of HELIO-SSN indicators.

23. We are not working directly with indicators of sustainable development, however, we are using with the Indicators of Sustainable Forestry developed through the Montreal Process to describe forest conditions. Since sustainable development is a much broader topic, I doubt our work will be of particular interest to you. However, if you are interested you can access our First Approximation Report from our website, and I would be happy to answer any specific questions about the material.
http://www.odf.state.or.us/default.htm
<http://www.odf.state.or.us/default.htm>

24. I am replying to your recent enquiry to WEC regarding sustainability indicators. We have not developed our own set of indicators for project evaluation however if you look at the chapter on indicators in the online version of our recent publication "Living in One World" you will find references to a number of indicators which have been developed by other organisations.

25. This is very interesting. I am working with the Canadian International Development Agency on a similar initiative, although, getting the agency up to speed with the CDM has been all consuming of late. The sustainable development aspects of the CDM are definitely of interest to us and to our projects and I expect we will be focussing more specifically on these issues in the near future.

26. I imagine you have seen the S. Huq report on this issue on the PCF website (it has just recently been posted) and that you are familiar with the South South North projects that are developing SD indicators

27. I do have experience with indicators at the project level (and indeed with the UK Round Table for Sustainable Development). So far, the best approach that I have encountered is that of INSEAD, where Prof Robert Ayres has done some very interesting work on the thermodynamic approach to sustainable development, which I think offers a great deal of promise.

I think that this is suitable for applying at a project level. There is also the work of the Balaton Group (of which I am a member) on sustainability, which was published by Dana Meadows a few years back. In general, my view is that we need to be very careful not to overdefine measures too early. There are strong conceptual reasons for this and I generally prefer a learning/try them out approach to sustainability indicators. But having said that, the thermodynamic approach is strong.

Forum for the Future’s 5 capitals (human, natural, social, manufactured, financial) model also provides an interesting approach. And I am a supporter of Manfred Max-Neef’s work on human needs in addressing the measurement of social and human ‘capital’.

28. We have written a report on how to select sustainable indicators. I send you a copy. It is in French.

29. On these sustainability indicators for projects under the Clean Development Mechanism of the Kyoto Protocol, you can also contact:
-Maryse Labriet (GERAD, Québec): labriet@crt.umontreal.ca
-Salifou Seini-Modi (INRS, Québec): seinimodi@inrs-ener.uquebec.ca
-Dieudonné Goudou (IPCC Niger): kandadj@intnet.ne
30. I have worked on a couple of projects which involved development of indicators or framework for the development of indicators. The two projects that I would like to mention in this regard are:

"Guidelines for the Project Progress Review for India Ecodevelopment Project - Phase I, 1996-97; Funded By GEF & World Bank; Client: WWF India."

In this project a framework was developed for identifying indicators to monitor the performance of project implementation including monitoring the achievement of project goals. Based on this framework, a computerized project performance monitoring system was also developed.

"Sectoral Level Environmental Analysis (SLEA) and Environmental Management Plan for Transportation Strategy of Mumbai Metropolitan Regional Development Authority; 1996 - 97."

In this project indicators were developed to enable comparison of various transportation strategies for the region.

"Institutional Strengthening & Collection of Env. Statistics in Selected DMCs, 1995; (Asian Development Bank)"

In this project also a framework for compiling environmental statistics was first developed and based on this framework a number of indicators were identified.

31. I would like to express my willingness to work with your institute on the "sustainable development indicators", if possible. I propose to work from my home and coordinate with your institution through e-mail / internet. I have considerable amount of literature on the subject available with me and have access to various libraries in N. Delhi.

Currently I am working as an independent consultant. should you be interested in my proposal, I would send you my detailed biodata.

32. Hi Silvi
How was your Brazilian class ? I am sure you did a great job.
What about Lauro's WTO position ? Has he finally got it ? I really DO HOPE SO !

As I am optimistic that he will get it, I think of you both moving to Switzerland. See the e mail below. You may want to answer them from the work you have done on sinks. This may be an Institute where to find a position where relocating in Switzerland !

Cheers
Odile

Appendix 5: Questionnaire for Criteria Weighting
Sustainable development criteria for South Africa:
Invitation to participate in a national survey

The perceived impact of development projects are value driven, which is determined by the personal views of project evaluators. To assist government officials to objectively assess potential future projects, a profile of South African government and industry opinions is required to determine a value scale of sustainable development criteria in the South African context. Although this decision-support tool will primarily be developed and used to evaluate potentially eligible Clean Development Mechanism\(^{32}\) projects, the value scale will be useful for other decision purposes as well. Sustainable development sub-criteria are categorised into the three main pillars of sustainability, i.e. social, environmental and economic criteria, and are shown in the figure below. A description of the sub-criteria is available at the end of this document. Your contribution to assist the national government ensures that investments into South Africa are evaluated in a fair, transparent and representative manner. It must be noted, however, that the CDM secretariat of the national government is not obliged to approve potentially eligible projects based on the results of this survey solely.

**Questionnaire – Instructions:**

- The aim is to weight assessment criteria in order to evaluate CDM project proposals with regard to sustainable development in South Africa.
- To which aspects of sustainable development should the project contribute mostly? Place your weights accordingly.
- There is no right or false solution, it is all about your personal preferences and how YOU weight the different aspects of sustainable development.
- As it is by definition an integral part of each CDM, we do for this assessment NOT focus on greenhouse gas emissions (GHG) but evaluate the local SD aspects.

---

\(^{32}\) The Clean Development Mechanism (CDM) was created as part of the Kyoto Protocol in 1997 to lower the overall cost of reducing greenhouse gas (GHG) emissions released to the atmosphere, and to support sustainable development initiatives within developing countries. For more information visit the following website: [http://unfccc.int/cdm/](http://unfccc.int/cdm/)

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Questionnaire – Instructions (continued):

Which development targets are important? Not all aspects of sustainable development are equally relevant in the specific context of a country or a region. In the following questionnaire, you can indicate your preferences.

Understanding the criteria
Make sure that you understand clearly the meaning of a criterion, and the way it is going to be measured. Most criteria are defined as rather generic targets. If your weighting requires a comment, please feel free to do so.

Direct Weighting
The process of direct weighting is straight forward.
1. You have a total of 100 points to allocate.
2. Distribute the 100 points on the criteria. The more important a criteria is, the more points you give.
3. After having allocated the 100 points, indicate on a scale from 1 to 5 your level of certainty (how certain did you feel when allocating the points?) 1 = very certain; 5 = very uncertain.

<table>
<thead>
<tr>
<th>Direct Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>Criterion 1</td>
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<tr>
<td>Criterion 2</td>
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<tr>
<td>Criterion 3</td>
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<tr>
<td>Criterion 4</td>
</tr>
</tbody>
</table>

AHP (Analytic Hierarchy Process)
1. Go through the questions line by line. In each line you are asked to compare the relative importance of two criteria.
2. Check the box that best expresses your preference: from 1 (equally important) to 9 (extremely more important)
3. For each pair-wise comparison, indicate on a scale from 1 to 5 your level of certainty (how certain did you feel when allocating the points?) 1 = very certain; 5 = very uncertain.

<table>
<thead>
<tr>
<th>AHP</th>
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</thead>
<tbody>
<tr>
<td>Criterion A</td>
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<tr>
<td>Criterion B</td>
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<td>9</td>
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<tr>
<td>Criterion A</td>
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<td>Criterion B</td>
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<tr>
<td>Criterion 1</td>
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<tr>
<td>Criterion 1</td>
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<tr>
<td>Criterion 2</td>
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<tr>
<td>Criterion 3</td>
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</tbody>
</table>
### Please indicate your area of economic activity

<table>
<thead>
<tr>
<th>Area of Economic Activity</th>
<th>Government (please specify)</th>
<th>NGO (please specify)</th>
<th>Agriculture and related industries</th>
<th>Trading; repair of equipment; hotels and restaurants</th>
<th>Mining and quarrying</th>
<th>Manufacturing/process industry</th>
<th>Transport, storage, communication</th>
<th>Electricity, gas and water supply</th>
<th>Financial services</th>
<th>Construction industry</th>
<th>Community, social, personal services</th>
<th>Other (please specify)</th>
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<tbody>
<tr>
<td><strong>International</strong></td>
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<td><strong>National</strong></td>
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<tr>
<td><strong>Regional</strong></td>
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<tr>
<td><strong>Local</strong></td>
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<td><strong>Other, please specify</strong></td>
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</table>

### Which description would suit your company best (please tick)

<table>
<thead>
<tr>
<th>Description</th>
<th>International</th>
<th>National</th>
<th>Regional</th>
<th>Local</th>
<th>Other, please specify</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>National</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td></td>
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<td></td>
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<tr>
<td>Local</td>
<td></td>
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</tbody>
</table>

### Please indicate your location (please tick)

<table>
<thead>
<tr>
<th>Location</th>
<th>Gauteng</th>
<th>Eastern Cape</th>
<th>North West province</th>
<th>Western Cape</th>
<th>Free State</th>
<th>Northern Cape</th>
<th>KwaZulu Natal</th>
<th>Northern Province</th>
<th>Mpumalanga</th>
</tr>
</thead>
</table>

### Please indicate your age

<table>
<thead>
<tr>
<th>Age</th>
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</table>

### Please indicate your gender

<table>
<thead>
<tr>
<th>Gender</th>
<th></th>
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</table>

### Please indicate your awareness on the following issues (please tick)

| Issue                                                                 | Never heard about it | I read something about it | I know broadly what it entails | I follow the progress and development | No | Someone else in my organisation will take care of it | Thinking about participating or submitting a project | Actively involved in making it happen in South Africa | I do not know | No, it looks like exploitation | It would be good if certain industries | Yes, South Africa will benefit | I have never heard about it | No it is just a marketing exercise | The impact on project choices will be small | Very relevant as it will ensure that companies are well managed | Do you currently have an environmental management system/programme in place? | No | Yes |
|------------------------------------------------------------------------|----------------------|---------------------------|--------------------------------|--------------------------------------|-----|----------------------------------------------------|-------------------------------------------------|-------------------------------------------------|----------------|-----------------------------|-----------------------------|--------------------------------|-----------------------------|---------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------|--------|------|

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Thank you for filling out the questionnaire. We would like to ask you a couple of additional questions:

<table>
<thead>
<tr>
<th>Which Criteria (aspects of sustainable development) are missing? Please specify.</th>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>Which Criteria (aspects of sustainable development) would you drop? Please specify.</th>
</tr>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>Is weighting of criteria an appropriate way to map the preferences in sustainable development of a country? Do you have other suggestions?</th>
</tr>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Other general comments:</th>
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</table>
Sustainable Development Assessment of CDM Projects - ETH Zurich, Energy & Climate

## AHP

<table>
<thead>
<tr>
<th>Mitigation more important</th>
<th>SD more important</th>
<th>Level of uncertainty in decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Mitigation on Climate Change</td>
<td>extremely more important</td>
<td>very strongly more important</td>
</tr>
<tr>
<td>Contribution to Sustainable Development</td>
<td>1= certain</td>
<td>3= strongly uncertain</td>
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</tbody>
</table>

## Direct Weights

<table>
<thead>
<tr>
<th>Criteria</th>
<th>1st</th>
<th>2nd</th>
</tr>
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<tbody>
<tr>
<td>Social Development</td>
<td></td>
<td></td>
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<tr>
<td>Economic Development</td>
<td></td>
<td></td>
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<tr>
<td>Environmental Development</td>
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</tbody>
</table>

Distribute 100 points among the 3 targets. The more points, the more important is the target.

## Comments on your weighting

Level of uncertainty (see below)

## AHP

<table>
<thead>
<tr>
<th>Criterion A more important</th>
<th>Criterion B more important</th>
<th>Level of uncertainty in decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Criterion A</td>
<td>extremely more important</td>
<td>very strongly more important</td>
</tr>
<tr>
<td>Criterion B</td>
<td>1= certain</td>
<td>3= strongly uncertain</td>
</tr>
</tbody>
</table>

Social Development: “The project has positive effects on social development”
Environmental Development: “The project has positive effects on environmental development”
Economic Development: “The project has positive effects on sustainable economic development”
### Social Development

#### Direct Weights

<table>
<thead>
<tr>
<th>Criteria</th>
<th>1st</th>
<th>2nd</th>
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<tbody>
<tr>
<td>Stakeholder Participation</td>
<td></td>
<td></td>
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<tr>
<td>Improved service availability</td>
<td></td>
<td></td>
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<tr>
<td>Equal distribution</td>
<td></td>
<td></td>
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<tr>
<td>Capacity development</td>
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</tbody>
</table>

Distribute 100 points among the 4 criteria. The more points, the more important is the criterion.

#### Level of uncertainty (see below)

<table>
<thead>
<tr>
<th>Criterion A more important</th>
<th>Criterion B more important</th>
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<tbody>
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</table>

#### Comments on your weighting

Social Development

Distribute 100 points among the 4 criteria. The more points, the more important is the criterion.

<table>
<thead>
<tr>
<th>Level of uncertainty (1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1= certain</td>
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<tr>
<td>3= strongly uncertain</td>
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<tr>
<td>5= extremely uncertain</td>
</tr>
</tbody>
</table>

**Equal Distribution:** “the share of project return, which benefits people below poverty line, increases”

**Stakeholder Participation:** “stakeholders can participate in the project development.”

**Improved Service Availability:** “The project contributes to improved availability of essential services (water, energy, telephone,...)”

**Equal Distribution:** “the share of project return, which benefits people below poverty line, increases”

**Capacity Development:** “the project generates opportunities for capacity development”
### Direct Weights

<table>
<thead>
<tr>
<th>Criteria</th>
<th>1st</th>
<th>2nd</th>
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</thead>
<tbody>
<tr>
<td>Regional Economy</td>
<td></td>
<td></td>
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<tr>
<td>Microeconomic efficiency</td>
<td></td>
<td></td>
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<tr>
<td>Employment generation</td>
<td></td>
<td></td>
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<tr>
<td>Technology Transfer</td>
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</tbody>
</table>

- **Regional Economy**: "the project contributes to value generation in a disadvantaged region"
- **Microeconomic Efficiency**: "The internal rate of return of the project increases"
- **Employment Generation**: "the project creates jobs"
- **Sustainable Technology Transfer**: "The project applies innovative, locally manageable technology."

### Comments on your weighting

Distribute 100 points among the 4 criteria. The more points, the more important is the criterion. Level of uncertainty (see below)

### AHP

<table>
<thead>
<tr>
<th>Criterion A more important</th>
<th>Criterion B more important</th>
</tr>
</thead>
</table>

- **Criterion A more important**
  - Employment generation
  - Microeconomic efficiency
  - Technology Transfer

- **Criterion B more important**
  - Regional Economy

Level of uncertainty in decision

1= certain
3= strongly uncertain
5= extremely uncertain

---

**Level of uncertainty**

- **1**: Certain
- **3**: Strongly uncertain
- **5**: Extremely uncertain

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### Direct Weights

<table>
<thead>
<tr>
<th>Criteria</th>
<th>1st</th>
<th>2nd</th>
<th>Level of uncertainty (see below)</th>
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<tbody>
<tr>
<td>Mineral / Energy Resources</td>
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<td>Air Quality</td>
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<td>Water Quality</td>
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<tr>
<td>Land Resource</td>
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### AHP

<table>
<thead>
<tr>
<th>Criterion A more important</th>
<th>Criterion B more important</th>
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</thead>
<tbody>
<tr>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Air Quality</td>
<td>Water Quality</td>
</tr>
<tr>
<td>Air Quality</td>
<td>Mineral / Energy Resources</td>
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<tr>
<td>Air Quality</td>
<td>Land Resource</td>
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<tr>
<td>Water Quality</td>
<td>Mineral / Energy Resources</td>
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<tr>
<td>Water Quality</td>
<td>Land Resource</td>
</tr>
<tr>
<td>Land Resource</td>
<td>Mineral / Energy Resources</td>
</tr>
</tbody>
</table>

Mineral / energy resources: “the project contributes to decreasing pressure on fossil fuels / mineral resources”
Air Quality: “the project contributes to decreasing pressure on the regional air quality”
Water Quality: “the project contributes to decreasing pressure on the regional fresh water quality”
Land Resource: “the project contributes to decreasing pressure on the regional land resource”
Appendix 6: Detailed Project Descriptions