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INTERNATIONAL ENERGY AGENCY

DEVELOPING GUIDANCE ON MONITORING AND PROJECT BOUNDARIES FOR GREENHOUSE GAS PROJECTS

INFORMATION PAPER

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FOREWORD

This document was prepared in May 2002 by the OECD Secretariat at the request of the Annex I Expert Group on the United Nations Framework Convention on Climate Change. The Annex I Expert Group oversees development of analytical papers for the purpose of providing useful and timely input to the climate change negotiations. These papers may also be useful to national policy makers and other decision-makers. In a collaborative effort, authors work with the Annex I Expert Group to develop these papers. However, the papers do not necessarily represent the views of the OECD or the IEA, nor are they intended to prejudge the views of countries participating in the Annex I Expert Group. Rather, they are Secretariat information papers intended to inform Member countries, as well as the UNFCCC audience.

The Annex I Parties or countries referred to in this document refer to those listed in Annex I to the UNFCCC (as amended at the 3rd Conference of the Parties in December 1997): Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, the European Union, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland, and United States of America. Where this document refers to "countries" or "governments" it is also intended to include "regional economic organisations", if appropriate.

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Comparing the greenhouse gas (GHG) emissions or uptake of a project to its baseline allows the mitigation effect of a project to be calculated. This mitigation effect corresponds to the maximum number of credits that a Joint Implementation (JI) or Clean Development Mechanism (CDM) project can generate.

The GHG emissions or uptake of a project is determined by monitoring its performance over time. The Marrakech Accords indicate that a project monitoring plan needs to be established as part of the JI/CDM project design document. Monitoring may also be needed at other times or for other purposes. For example, monitoring can be used to establish project baselines or to determine whether or not a project's initial crediting period can appropriately be extended.

This paper focuses on the monitoring needed to quantify the impact of a GHG mitigation project and on defining the boundaries of what needs to be monitored. Drawing on lessons from project monitoring experience and guidance to date, it identifies key questions whose answers set the ground rules for specific monitoring guidance for project types or categories. It also identifies other, more detailed, areas in which monitoring guidance would be useful.

Developing guidelines for GHG mitigation projects on baselines and monitoring are related and should be done in parallel. Monitoring guidance can encompass broad recommendations, such as what constitutes a "significant" emissions source, as well as detailed technical recommendations, such as where to locate meters or how to read them.

Some key questions need to be answered before detailed monitoring guidance can be set up:

- Should project developers have a choice of different possible monitoring methods?

- What flexibility should project developers have in defining the project boundary?

- How should any general cost/accuracy tradeoffs be accommodated?

The answers will influence the extent to which implementing monitoring guidance promotes consistency, transparency and predictability between different projects. The answers will also affect the time and cost associated with verifying a project's emission reductions.

This paper recommends allowing a choice of monitoring methods. This will give project developers some flexibility to use less complex, accurate or costly monitoring methods for less important emission sources. For some project types, standardised measurement and monitoring protocols may have already been set up.

Defining project boundaries is important – for both baselines and monitoring - as it affects both the numbers of credits that a project can generate and the potential significance of leakage from a project. However, the Marrakech Accords' definition of project boundary is not precise enough to ensure that different project developers will reach consistent and predictable decisions. Defining wide project boundaries and using simple monitoring methods for less important emission sources may be an appropriate balance between reducing the risk of leakage and limiting monitoring costs. Developing decision trees to guide project developers as to what to include in a project boundary, and how rigorous emission methodologies should be for each source, may also be appropriate.

There are costs associated with developing and carrying out a project monitoring plan. The costs associated with developing a monitoring plan are occurred up-front, and can be high (e.g. $20,000 for "first-of-a-kind" CERUPT and PCF projects). Some costs associated with monitoring a project's performance are likely to be incurred whether or not a project has been set up as a greenhouse gas mitigation project. However, some items that need to be monitored in order to assess the GHG benefits of a project (e.g. increase in underground biomass) would not normally be monitored unless the project was seeking to gain emissions credits. Thus, the importance of the JI/CDM-component of on-going monitoring costs also varies by project type. Project developers can be expected to prefer projects that are easy to monitor in order to keep total monitoring costs below a certain level, e.g. 8% of the total costs of a project.

The on-going costs of monitoring a project's performance can vary significantly by project type. In general, monitoring costs will increase with the number and variety of sources that need to be monitored; frequency of monitoring[1] and reporting; accuracy/confidence level that monitoring should achieve; and the complexity of monitoring methods. Ideally, project monitoring should provide an accurate picture (or, at the least, not a consistent over-estimation) of a project's GHG impacts. However, while monitoring can in theory be a more-or-less exact exercise, developing emission baselines is not. It may therefore be appropriate to consider possible trade-offs when developing monitoring guidance. This paper recommends that projects using less accurate monitoring methods, or lower monitoring/reporting frequencies for major emission sources should generate fewer credits than similar projects applying more rigorous or regular monitoring methods.

Simplifying the monitoring process to reduce monitoring costs may be particularly important for small-scale CDM projects that, by their very nature, are less able to bear high transaction costs. These simplifications could include the use of sample populations, reducing the frequency of monitoring/verification and calculating project benefits by using easy-to-monitor data, default emission factors and narrow project boundaries. For the most environmentally-friendly projects, such as electricity generation from wind or solar power, highly simplified monitoring could be limited to ensuring that the equipment installed continues to operate.

Once the ground rules for monitoring guidance have been defined, more specific guidelines are needed to outline e.g. exactly what should be monitored, when, how, and by whom. This specific guidance can benefit greatly from input and/or lessons from guidance developed elsewhere, e.g. for developing emissions inventories, monitoring GHG mitigation projects, or from national or international monitoring standards in particular sectors.

The Marrakech Accords indicate that a project's monitoring plan should include a description and justification of the project boundary, identification of data that needs to be collected, quality assurance/control procedures and a list of potential sources of leakage. These recommendations may need to be elaborated and expanded. For example, the monitoring plan should also indicate how often different parameters should be monitored and reported; who is responsible for monitoring and recording the different information; how the monitored information should be recorded, and what information is likely to be needed in order to verify credits. An outline of any training that project operators will need to carry out the GHG-related monitoring and reporting activities in the monitoring plan may also be needed.

Examining actual or recommended project boundaries for GHG mitigation projects shows that different guidance on what to include in the project boundary can differ markedly (for a particular project type). The need for transparency and consistency between different projects reinforces the value of detailed guidance on project boundaries.

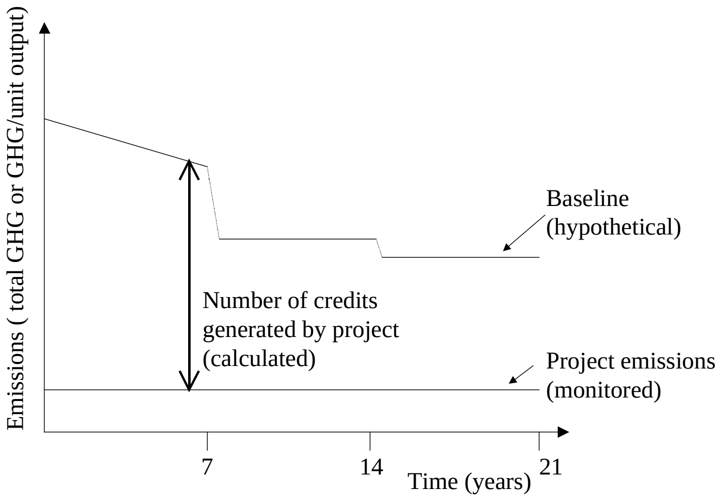
[1] Unless continuous emissions monitoring is used.

1. Introduction

One of the reasons for setting up a Joint Implementation (JI) or Clean Development Mechanism (CDM) project is to generate emission credits. These credits can be used by Annex I Parties to help meet their emission commitments under the Kyoto Protocol (KP). Domestic greenhouse gas (GHG) mitigation projects may also be set up and need to be monitored in the context of e.g. voluntary programmes to reduce emissions in particular sectors.

In order to determine the mitigation effects of such projects the emissions or uptake level of the project needs to be monitored and then compared to that of the project's baseline (Figure 1). For JI/CDM projects, the extent that emissions have been reduced below the baseline, or that removals have been increased above the baseline, corresponds to the maximum number of credits a project can generate[2].

Figure 1: **Baselines and monitoring for an emission reduction project**



Monitoring is defined here as the measurement or estimation of the greenhouse gas (GHG) impacts of a mitigation project.

The Marrakech Accords indicate that monitoring project performance is an essential part of the JI/CDM project cycle. While the Accords do lay out the role of some actors in monitoring, almost no other guidance is provided. However, if project developers and operators knew what the mandatory "monitoring plan" should consist of, what aspects of the project need to be monitored, how they should be monitored, when and by whom[3] it could reduce the time and costs associated with project development. Applying such monitoring guidance could therefore increase transparency, predictability and comparability of credit generation from projects. It could also increase the ease and reduce the costs of verifying emission reductions.

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[2] In practice, the number of credits obtained by project developers may not equal the number of credits generated by the project. Some CERs will be deducted from CDM projects in order to cover the administrative expenses and assist in meeting the costs of adaptation. In addition, some host countries may negotiate to keep a proportion of CERs and/or ERUs themselves.

[3] Similar information will also be needed to quantify the effects of any project-based reductions within a national credit programme.

While detailed guidance on what and how to monitor will vary by project category, some generic guidance on other aspects of project boundaries and monitoring should be drawn up. This paper seeks to clarify some of the relevant key issues. Drawing on lessons from project monitoring experience and guidance, it identifies key questions that need to be answered before any generic (or specific) project guidance on project monitoring and boundaries can be agreed, and makes recommendations on how to answer such questions. It also makes some recommendations as to what could be considered for inclusion in any monitoring guidance to be developed by the CDM's Executive Board.

1.1 Role of monitoring in a GHG mitigation project

There are several reasons to monitor particular aspects of JI/CDM projects, and the context in which projects are (or will be) operating. These include to:

- Monitor the GHG emissions/uptake of the project itself. This information is needed to establish the number of credits generated by the project (by comparing to the baseline);

- Pre-project monitoring in order to estimate an appropriate baseline for the project. This may or may not be needed depending on how the baseline for a project is being set up;

- Assess the wider environmental or other impacts of the project (e.g. the importance of carbon leakage and spillover). This information is needed to assess whether or not the number of credits generated by the project represents the actual mitigation effect of the project;

- Ensure (for forestry projects) that the GHG benefits of the project are not reversed, i.e. that if "permanent" credits are generated by LULUCF projects, the sequestration is also permanent[4];

- Draw lessons *ex post* from projects already implemented so as to provide feedback and insights on how well baselines and other rules in the project cycle are working;

- Determine whether or not the project's initial baseline can appropriately be extended for a second or third crediting period.

Thus, monitoring will need to be carried out at different points during the development and operation of a GHG mitigation project. Most obviously, monitoring will need to take place during the lifetime of a project in order to quantify the GHG impact of the project (see text box). Such monitoring is likely to need to be carried out on a regular basis, e.g. annually, in order to obtain a regular flow of emission credits. Monitoring outside the project boundary during the project's lifetime may also be necessary in order to assess the importance of leakage. Over time the findings of such an assessment could influence project design and any revisions/updates on rules for eligibility and baselines.

What information needs to be monitored, and who should be responsible for monitoring will differ depending on the reason for which monitoring is taking place. This paper focuses on the monitoring needed to quantify the GHG impact of the project itself. This paper also explores the project boundary issue in some depth.

[4] This aspect of monitoring forestry projects may or may not be needed depending on the crediting regime used. See Ellis 2001 for a more detailed discussion.

2. Key questions

The development of monitoring guidelines for JI and CDM projects is related to the development of recommendations on baselines and additionality. There are also strong links between monitoring guidance, and guidance on reporting and verification. Development of guidance for baselines, monitoring and reporting should be done in parallel. As for guidance on baseline-setting, monitoring guidance can range from very broad guidance, such as what constitutes a “significant” emissions source to detailed technical recommendations, such as where to locate meters, or how to read them.

Answers to some key questions will define the ground rules needed before detailed monitoring guidance can be set up. These questions centre around the level of variation in monitoring the performance of different projects that is compatible Marrakech Accords’ indication that general monitoring guidance will be set up in order to “promote consistency, transparency and predictability”. Answering these questions can help set the ground rules for any subsequent detailed monitoring guidance, and could significantly influence project monitoring costs. The main questions are:

- Should monitoring guidance allow choices in monitoring methods?
- How could any general cost/accuracy tradeoffs be accommodated?
- What flexibility should project developers have in defining the project boundary?
- Should guidance on project boundaries follow the same principles for emission reduction and sink enhancement projects?

2.1 Should monitoring guidance allow choices in monitoring methods?

The answer to this question is key to setting the ground rules for any detailed monitoring guidance. Many different possible methods could appropriately be used to monitor emissions or enhancements by a project. For example, carbon uptake by standing biomass (trees) in forestry projects can be estimated from timber inventory techniques (on-site measurements), modelled, estimated via the use of allometric equations or estimated by using a combination of these methods. These different methods can result in different estimates of a project’s emissions or enhancements, at different costs, and with different levels of accuracy and confidence.

Both the IPCC guidance on good practice in inventory calculation (IPCC 2000) and international guidance developed to determine the results of energy efficiency projects (IPMVP 2000) allows for a choice of monitoring methodology. For example, the IPCC inventory guidance often includes two or three different methodologies to calculate a particular emission, with more detailed methods being recommended for “key” emission sources.

- Despite potential differences in the results, there may be a number of reasons to leave project developers flexibility in the choice of monitoring methods. The Marrakech Accords allow a choice of baseline methodology. For example, these methodologies do not rule out the use of “absolute” baselines, which would require different elements to be monitored than if “rate-based” baselines were used. In order to ensure that baseline and monitoring guidance are compatible, a choice of monitoring methods will be needed.

- The relative importance of different gases and sources can vary enormously, depending on the characteristics of the individual greenhouse gas mitigation project. It may be cost-effective to allow project developers to use simplified methodologies to monitor sources that are not “key”.

- Different equipments and methods/techniques may be already in place in different countries. Recognising such differences and building on existing processes may be necessary.

Recommendations:

➔ Project developers should be allowed flexibility in the choice of monitoring methods they use. This will allow developers to use simplified methodologies to monitor minor sources.
➔ Once a particular method is used it should be applied consistently throughout the project lifetime.

2.2 How can possible cost/accuracy tradeoffs be accommodated?

Each part of the JI/CDM project cycle has associated transaction costs. Monitoring the performance and GHG impacts of a project can be an important component of a project's total transaction costs for some project types.

Developing a monitoring plan may also be costly, particularly for a “first-of-a-kind” project. For example, the Prototype Carbon Fund (PCF 2000) estimates that developing a first-of-a-kind baseline, monitoring and verification protocol (MVP) takes about 4-5 weeks and costs approximately $40,000. However, they also suggest that subsequent MVPs for similar project types will be much quicker and cheaper to set up. The monitoring and verification component of this accounts for approximately $20,000 (Heister, 2002). Costs for developing a first-of-a-kind CERUPT project are estimated at $20,000 (CDM Susac 2002), although these costs may halve for subsequent projects (Bode 2002). This level of transaction costs at a stage when the proposed project has not even been approved, is likely to inhibit project development, particularly for small projects. Establishing guidance on what should be included in a monitoring plan could help project developers significantly reduce the costs associated with setting up a monitoring plan.

The cost of monitoring aspects of a project that are relevant to generating emissions credits, and that would not normally be monitored for non-JI/CDM projects will therefore need to be kept low (e.g. 1-8% of the total project cost) in order to not inhibit project development.

The Marrakech Accords make it clear that resources will need to be devoted to project monitoring from a very early stage in project development, and certainly before the project has been approved as a JI/CDM project. The Accords also indicate that guidance on monitoring methodologies developed by the CDM Executive Board needs to “provide an accurate measure of actual reductions in anthropogenic emissions as a result of the project activity, taking into account the need for consistency and cost-effectiveness”. This implies that cost considerations may be taken into account when developing monitoring guidance. For example, it may be possible to choose to forego both the credits and the costs of monitoring of a particular emission source associated with an individual project[5].

However, this appears to contradict text relating to project boundaries earlier in the same decision which indicates that all “significant” sources that are “under the control” and “reasonably attributable” to a project need to be monitored. Such text limits the choice that participants in JI and CDM emission

[5] This may be most relevant for LULUCF projects, as some of the environmental benefit of these projects (e.g. increase in root or soil carbon) can be costly to quantify.

reduction projects have in deciding on any potential tradeoffs between the number of credits obtained and the cost of obtaining those credits.

How onerous project monitoring is likely to be for CDM projects is not yet clear, as it will depend on the definition of project boundaries as well as on the methods recommended to monitor particular sources of emissions or enhancements. Actual project monitoring costs can vary widely. For example, Ecosecurities (2000) estimate that transaction costs of JI projects will vary between $10,000 to $15,000/year. The Prototype Carbon Fund indicate that monitoring and verification costs are likely to account for approximately half of the total $200,000 - $400,000 transaction costs of the project (over the lifetime of the project)[6]. The IPMVP, which outlines rigorous methods to assess energy savings of energy efficiency projects estimates that this assessment should cost no more than 10% of the annual average savings being assessed. GEF energy efficiency projects (Birner 2001) set aside between 1-8% of a project's overall budget for monitoring and evaluation purposes. Theoretical case studies in Nabuurs et al. (1999) indicate that the costs of monitoring Kyoto forests in JI countries may vary from $11-18/hectare.

The costs of monitoring project performance will vary by type of project and project design, but are likely to increase with the:

- Number and variety of sources that need to be monitored;
- Frequency of monitoring and reporting;
- Accuracy/confidence level that monitoring should achieve; and the
- Complexity of monitoring methods.

The number and variety of sources that need to be monitored varies by project type. For example, there is only one main location for emission reductions in projects that involve emission reductions in single, point sources - such as large electricity-generation or industrial projects. Monitoring emissions on one site is likely to be easier and cheaper than monitoring projects that involve diffuse emissions reduction or uptake, such as in energy-efficiency or forestry projects (although monitoring these projects can also benefit from economies of scale, or sampling). Similarly, monitoring only CO_2 emissions from a project is likely to be easier and cheaper than monitoring CO_2, CH_4 and N_2O emissions.

Increased frequency of monitoring and reporting will also increase costs, although not necessarily significantly if what needs to be monitored for GHG purposes would have been monitored anyway. For example, grid-connected electricity generation projects are likely to keep track of their fuel consumption and electricity generation or output whether or not they are a JI/CDM project. However, information which may be needed to calculate the effect of energy efficiency projects, such as the amount of energy used for lighting, in which rooms, and for how long, are unlikely to be collected as a matter of course (unless set up as part of the project design). Similarly, soil and root carbon would not normally be estimated for forestry activities unless they were aiming to generate emission credits.

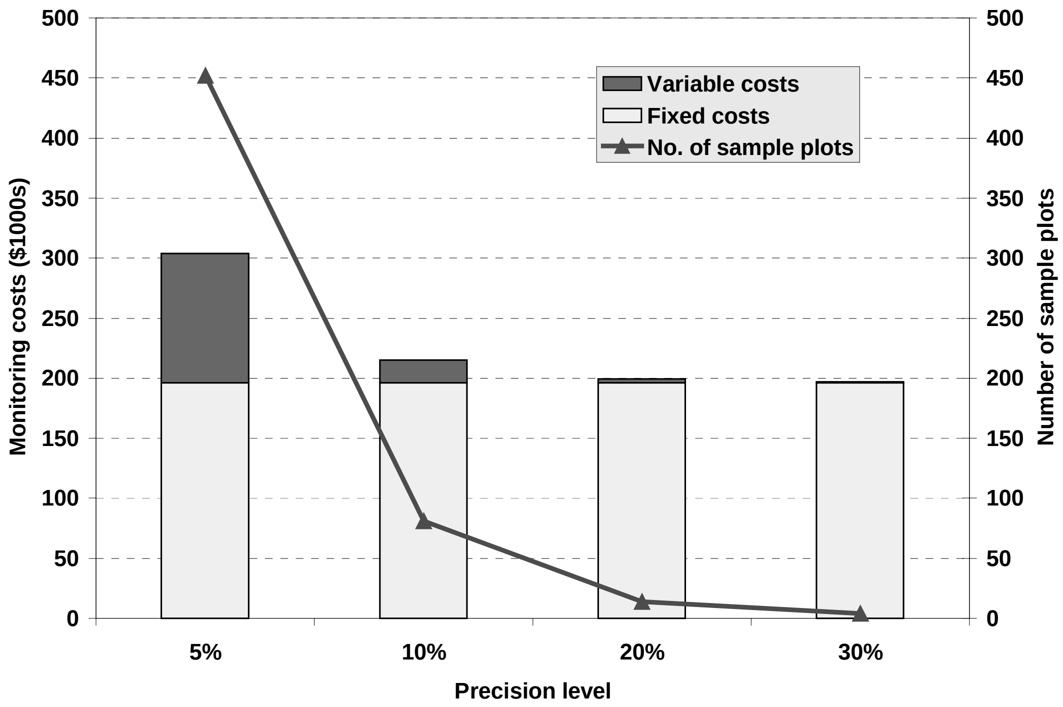
Any requirement to increase the accuracy or confidence level with which a project emissions or enhancement calculation is made could also increase the costs of project monitoring. This could mean increased fixed costs, for example if different equipment needed to be installed. It could also increase variable costs by increasing the numbers of forest sample plots or household appliance efficiency surveys

[6] This includes monitoring some aspects of a project that may not need to be monitored for CDM projects. For example, PCF projects monitor baseline parameters (such as GHG intensity of electricity displaced by a project) and sustainable development indicators.

that need undertaking, or one-off costs (e.g. if project-specific emission factors needed to be measured, rather than using default factors).

Many methods could be used to monitor the carbon sequestration in forestry projects. These include modelling, deriving estimates from equations and field measurements. These different techniques have different associated costs, and their applicability and/or feasibility may vary with project size. However, in order to verify the emission mitigation effect of a project, it is likely that field measurements ("ground-truthing") will play an important role in monitoring and/or verifying changes in carbon stocks from LULUCF projects. The number of sample plots and other field measurements used to monitor changes in carbon stocks has a large influence on the variable costs associated with project monitoring, although fixed costs may be more important (Powell 1999). The number of sample plots used also has an influence on the accuracy and confidence levels with which a project's mitigation effect can be calculated (Figure 2).

Figure 2: **Influence of number of sample plots on the monitoring cost and precision level for the Noel Kempff project**



Source: adapted from Powell (1999) and Kadyszewski (2001)

However, preliminary indications are that the cost of sequestering carbon in forests is low. Brown et. al. (2001) indicate that the cost of measuring and monitoring carbon in (large) forestry projects would be less than $0.5 per ton of carbon for precision levels of less than +/- 10% of the mean with 90% confidence. This means that monitoring costs for (large) LULUCF projects could be somewhat higher than for energy/industry projects and still be able to provide a low-cost sequestration potential.

The complexity of monitoring methods can also increase monitoring costs if it requires the use of more expensive equipment or of specially trained staff to carry out monitoring-related tasks, such as for forestry or energy efficiency projects.

In order to ensure that different projects produce CERs of equal "quality", guidance may need to specify the accuracy/confidence with which emission mitigation estimates need to be made. Alternatively, some sort of guidance or methodology could be set up that would allow a trade-off between rigour/accuracy of monitoring, and level of credit allocation. This type of approach has precedents, e.g. from the US EPA's Conservation Verification Protocols – where higher "credits" were given for energy savings estimated through direct monitoring than through using e.g. standard equations. This approach has also been recommended as a potential way of dealing with the varying uncertainty, related to different methods, of estimating the GHG mitigation effect of forestry projects (Hamburg 2000) and for energy projects (DNV 2001b).

Recommendations:

➔ Keep "incremental" monitoring costs for larger GHG mitigation or sequestration projects manageable by ensuring that the level of precision/confidence required for project monitoring data is comparable with that for baseline data.
➔ Explore the feasibility setting up guidance that would allow a trade-off between rigour/accuracy of monitoring a project's major emission impacts and the number of credits allocated.

2.3 Project boundaries: what flexibility should project developers have?

The Marrakech Accords require that each JI/CDM project "shall" include a "monitoring plan" as part of the project design document (see Annex A). Defining the boundaries of what needs to be monitored is a crucial step in setting up a plan to monitor the project's performance and is also needed when defining what the baseline for the project includes. In order to ensure that credits from projects credibly reflect GHG mitigation, parameters included in a project's baseline need to be monitored, and vice versa. This will ensure that the calculated emission benefit of the project compares emissions/uptake from the same sources.

How a project boundary is defined is important, because it influences the environmental credibility of credits generated by the project and the costs of monitoring (through the effect of project boundary definitions on the number of sources that need monitoring). For example, monitoring the emissions from a zero-emitting project such as stand-alone renewable electricity generating projects is a trivial exercise, if the project boundary is drawn around the project site. However, if the project boundary has been drawn to also include emissions associated with preparing the project site and transporting equipment to the project site, the complexity of monitoring operations increases.

The Marrakech Accords define project boundaries for emission reduction CDM projects as "encompass[ing] all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the CDM project activity"[7]. This definition therefore sets up a three-staged approach to defining project boundaries. Only emission sources that are significant and reasonably attributable and being "under the control" of the project participants need to be included in the project boundary. Thus, emission sources that are e.g. significant but not under the control of the project participants are not included in the project boundary. For example, an electricity supply project that increases electricity generation near centres of electricity demand may significantly reduce losses due to electricity transmission and distribution (T&D). However, T&D losses are likely to be

[7] The definition for JI is similarly worded, although it also includes reference to removals by sinks.

out of the control of the project participants, so reduction in T&D should not generate credits for most supply-side electricity projects (Kartha et. al. 2002[8]).

The key words describing project boundaries in the Marrakech Accord, i.e. “under the control” “significant” and “reasonably attributable” are not defined, although they are all open to interpretation. Thus, the guidance provided by the Marrakech Accords is not specific enough to ensure consistent and comparable decisions by project developers on determining what project boundaries for baselines and monitoring JI/CDM projects should be.

Determining project boundaries is not necessarily a simple task (see e.g. OECD/IEA 2000). Greenhouse gas mitigation projects can affect many different sources and gases. This impact can be direct or indirect and can occur on the project site or external to the project site. For example, a project’s fuel combustion, process emissions or sequestration are both on-site and direct. However, emissions associated with fuel transport to the project site, or electricity distribution from a project site are direct emissions, but occur off-site. Indirect on-site emissions could be caused by a change in operating characteristics of the project site (e.g. increased heating demand) or through preparation of the project site (e.g. flooding a site for hydro generation or deforestation on the project site). Indirect, off-site effects can also include the effect that a project has on fuel demand and/or prices, or the GHG emissions generated by producing materials or equipment used on a project site.

The relative significance of sources of emission or mitigation can vary greatly by project type and during the life of the project. For example, the relative importance of different carbon pools can change during the growth of a forest. Establishing guidance on how to set project boundaries would therefore greatly improve the comparability of different projects in the same sector.

2.3.1 Options to define “under the control” of the project participants

Project participants can control some, but not all, impacts of greenhouse gas mitigation projects. For example, they can control how much natural gas they use for power or heat production, but not the extent of leakage in the gas transmission and distribution network that supplies the project with gas. Similarly, distributors of energy efficiency appliances (e.g. energy efficient lightbulbs) can control how many appliances they distribute, but not necessarily how much they are used. In general, project participants should be able to control direct on-site emissions. However, they may or may not be able to control off-site or indirect emissions.

A standardised approach to defining “under the control” of project participants could be used. This definition could, for example, include either direct emissions only; or on-site emissions only; or all direct emissions as well as emissions associated with the use of imported steam, heat or electricity and transmission and distribution losses (for EE projects and distributed generation projects). Alternatively, “under the control” could be defined include any emission sources related to the project activity that can be financially controlled by the project participants (WBCSD/WRI 2001).

Developing a standard approach to defining project boundaries will simplify work of project developers, and will therefore reduce transaction costs. It will also simplify the review of projects and verification of emission reductions.

[8] This study recommends including T&D losses in the project boundary for distributed electricity generation projects (and energy efficiency projects).

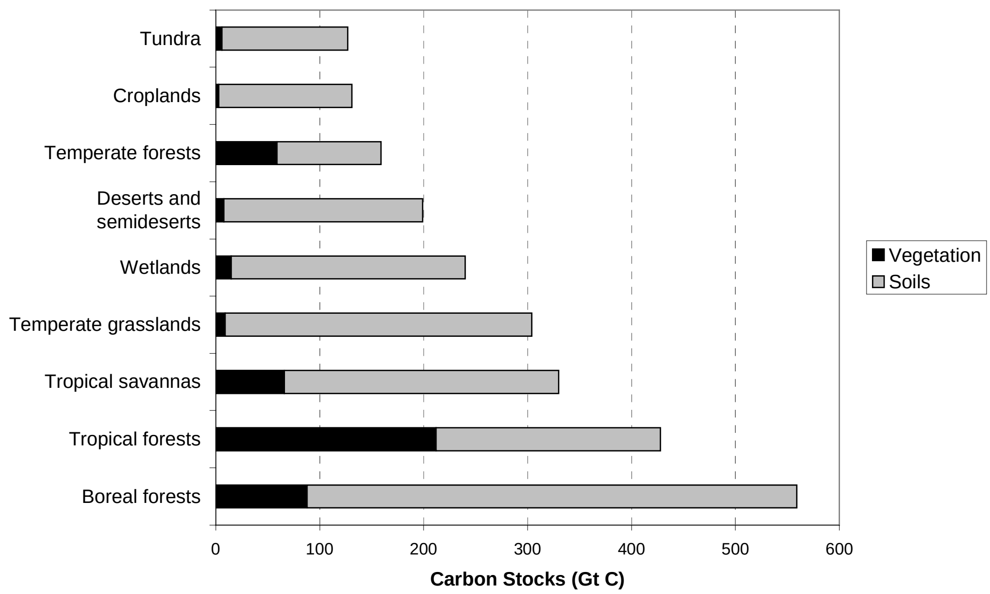
Recommendations:

➔ For most electricity/heat production projects, a definition of "under the control" that encompasses direct on-site emissions, as well as emissions associated with any heat, steam or electricity imported to the project site may be the most appropriate, as this includes a project's major sources, without requiring any confidential financial data[9].
➔ For energy efficiency and distributed generation projects, transmission and distribution losses should also be included (Kartha et. al. 2002).

2.3.2 Options to define "significant" emission or enhancement sources

The relative importance of different sources of emission or enhancements in a JI/CDM project can vary substantially between, but also within, project types. For example, the level of CH_4 and N_2O emissions from fuel combustion will depend on the fuel source and technology type. For LULUCF projects, the relative importance of different carbon pools can vary substantially according to the climate zone in which the project is taking place (Figure 3). Therefore, a particular source/sink could be significant for one afforestation project but not significant for another. This implies that prescribing what is a "significant" emissions/enhancement source cannot usefully be drawn up at the sector (or possibly even at a project category) level.

Figure 3: **Above and below-ground carbon stocks in different land types**



Source: Data from IPCC SR LULUCF, 2000.

There are three main options to establish a general definition of a "significant" source of emissions (or enhancement). These are:

- Absolute emission (or enhancement) levels;

[9] Some have suggested that a different definition should apply to JI projects, in order to exclude elements over which the host country has no control (such as the GHG-intensity of imported electricity or heat).

- Emission levels relative to the project's (or baseline's) total emission levels; or
- Emission levels relative to the largest single GWP-weighted GHG impact of a project.

Consistency and transparency between different projects in the same sector would be increased if the projects used similar project boundaries. Work on establishing specific guidance on project boundaries would thus be facilitated if the CDM EB could agree a general definition of, or formula to define, what constitutes a "significant" emissions source. Such a definition may, or may not, need to be differentiated by sector.

Alternatively, project developers could be responsible for identifying, quantifying and including all significant emission sources associated with their project in the project boundary. This would have the advantage of avoiding the need to agree a definition of "significant" for particular project types. If project developers know from the outset (as they do for CDM projects) that an independent third-party will review the emission benefits calculated from a particular project, it will not be in their interests to exclude significant emission sources. Thus, this approach would not necessarily lead to large inconsistencies between project boundaries chosen for different projects of the same type. (However, this approach may not be as transparent as one applying an agreed definition of significant).

Recommendations:

➔ If an internationally-agreed definition of "significant" emission levels is needed, the most appropriate approach may be to do so relative to the largest single estimated GWP-weighted GHG impact of a project, as it does not require either a subjective definition or quantification of all emission sources, even if very minor. The World Bank uses this approach when calculating the GHG impacts of their projects (WB 1998)[10].

➔ Alternatively, no concrete guidance of what constitutes "significant" could be drawn up. This would mean that developers of projects whose emission benefits will be verified by an independent third party would be responsible for including all significant sources in the project boundary.

2.3.3 Options to define "reasonably attributable" to the project

Individual greenhouse gas mitigation projects can have widespread impacts. However, not all impacts can be directly attributed to a particular project and/or easily monitored. Defining what is "reasonably attributable" to the JI/CDM project influences the extent of leakage or spillover from a project by deciding what is included or excluded from the project boundary. For example, it may be possible to attribute emissions caused by transport of a domestically-produced fuel to a project site to a particular JI/CDM project. It is also possible to estimate these emissions. If these emissions are excluded from the project boundary, the number of credits generated by the project may be overestimated. These emissions should therefore be included in the project boundary if they are "significant".

However, a project may have other effects on GHG emissions outside the geographical project boundary. For example, a greenhouse gas mitigation project involving a switch away from coal will reduce demand for coal from the project site. It could therefore in theory reduce coal prices (although it is unlikely that one fuel switching project would significantly reduce the price of an internationally-traded commodity), and

[10] The threshold used is to exclude any impact that is less than 10% of the largest individual GHG impact of the project.

increase coal demand elsewhere. However, whether this effect is significant depends on the relative size of the project compared to world/regional/local coal demand, as well as a host of other factors such as the cost and availability of coal and other fuels near the project site. Determining whether or not a project has impacts of this kind may be difficult, and quantifying such impacts would be even more so. Alternatively, it may be possible to quantify the GHG impacts of some indirect effects, such as the GHG intensity of materials used to construct the project. For example, emissions from concrete used to build the shaft of a wind turbine are “reasonably attributable” to the project using that wind turbine. However, counting such emissions – if they are judged as “significant” – within the project boundary would increase the complexity of GHG reporting both at the project site and at the site where the project materials are produced as these emissions may also be counted elsewhere.

Recommendation:

➔ For practical reasons, it may therefore be sensible to set limits around the definition of what “reasonably attributable” is. This would include both a geographical component (e.g. relating to impacts on or adjacent to the project site) as well as a project activity component (e.g. relating to the project’s main activity).

2.4 Should guidance on project boundaries be the same for emission reduction and sink enhancement projects?

In LULUCF projects, the proportion of carbon in pools that are significant (see Figure 3) and attributable to the project, but difficult and/or costly to measure can be large. While estimating above-ground carbon can be done with reasonable accuracy and cost, monitoring the carbon sequestered in soils, roots and necromass (dead biomass) is both costly and subject to considerable uncertainties (Hamburg 2000). Thus, including soil carbon, necromass - and to a lesser extent, roots - in project boundaries can significantly increase the cost of project monitoring. Of course, it will also increase the number of credits that a project can generate, although the relative importance of the different pools depends on the type of forest planted and in which area.

Recommendation:

➔ Project developers should be given more choice in the definition of project boundaries for LULUCF CDM projects than for energy or industry projects. This choice could allow project developers the possibility of foregoing emissions credits, and associated costs of monitoring particular parts of the project, for pools that they can demonstrate do not decrease as a result of the project. This choice could be crucial in limiting the level of monitoring costs for small-scale LULUCF projects (such as those involving plantations for bioenergy).

2.5 How can the monitoring burden be reduced?

Small CDM projects are – by definition – less able to absorb transaction costs, including those associated with project monitoring. Reducing the monitoring burden for small CDM projects would reduce the transaction costs associated with such projects and thus could help increase the number of such projects that are initiated.

The Marrakech Accords specifically include the possibility of developing simplified monitoring methodologies for small-scale projects. There are a number of ways by which this could be done, (in increasing order of simplification):

- Focussing monitoring efforts on larger emission sources or enhancements. This would imply that smaller projects could have a different definition of what a "significant" emission source (and therefore a different project boundary) to other project types.

- Using easy-to-monitor data, perhaps adjusted by using some sort of default values, rather than basing results on data that are more difficult or costly to monitor. Thus it may be important to define proxies that can be used or easily developed for data that is unavailable or costly. For example, rather than monitoring how much electricity is actually distributed by a particular project, a standardised/default factor could be applied to the project's electricity generation to account for T&D losses.

- The use of published, default, emission/conversion factors (rather than measured factors) may also be appropriate, even for non-CO_2 gases.

- It may also be worth exploring the use of sample populations, either for monitoring or verification purposes[11]. In such a situation, only a proportion of similar projects would be monitored and/or verified, and the GHG impact of the project estimated from the performance of the sample.

- The monitoring and/or verification frequency could be reduced for small projects. This could mean that small CDM projects are monitored sporadically, rather than yearly[12]. For example, projects could be monitored in years 1, 2 and 7, with emission benefits for years 3-6 inclusive estimated from the extrapolated data. (It will probably be advisable avoiding extrapolating project results from data from the first year of project operation, particularly when the project involves the use/operation of equipment of new technology types).

- Perhaps the simplest monitoring methodology may be to monitor only that the equipment installed in the project continues to be in working order and is being used. This approach would only be applicable to the most environmentally friendly projects, such as zero-emitting technologies that are not in common use in a particular region, Default factors would be used to estimate the output of such projects, rather than monitoring output directly. For small-scale renewable electricity projects based on intermittent energy resources, this may involve estimating a default load factor.

If many similar projects are undertaken in a region, it may be possible to group (or "bundle") monitoring activities together. This could reduce the costs of project monitoring substantially, although may increase the error associated with calculating emission reductions from a group of projects. "Bundling" of projects could be carried out for "small-scale" or other projects if the number of sample projects monitored should be statistically significant. A multi-project verification exercise carried out for 31 comparable Swedish AIJ projects (DNV 2001a and b) estimates that multi-project verification activities could be 50-70% cheaper than project-specific verification activities[13]. Case studies of greenhouse gas mitigation projects in India also indicated that bundling similar projects into groups 10 would "turn several types of small-scale projects into viable CDM projects" (Factorag 2001).

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[11] This approach would also usefully be applied to GHG mitigation projects that involve many diffuse sources: it would be impractical to monitor every light bulb installed in an energy-efficiency project or every tree planted in a forestry project.

[12] However, the disadvantages of monitoring sporadically are that capacities for monitoring will not be built up, so the quality of monitoring may suffer.

[13] However, no substantiating information for these figures was presented in the document itself, as this information was considered to be confidential.

Recommendations:

➔ The implications of these different simplification strategies should be assessed, and more detailed recommendations developed for each of the three types of small-scale projects eligible under the CDM.

➔ Projects should only be “bundled” together if they are technologically similar, located in similar regions, have comparable baselines and monitor/report similar project indicators (DNV 2001a).

3. Other areas in which guidance may be useful

International guidance provided on other issues could also be useful in increasing comparability and transparency between projects, and reducing transaction costs. These include tasks such as:

- What a monitoring plan should contain and how data should be recorded; and
- The relationship between the frequency of monitoring, reporting and crediting.

In addition, guidance may also be usefully prepared on:

- Simplifying or streamlining monitoring procedures for small-scale CDM projects.

3.1 What a monitoring plan should contain

The Marrakech Accords calls for a monitoring plan that collects and archives all data relevant to determining the project's baseline, monitoring its performance and determining the GHG benefits of the project (see Annex A). Guidance on developing this plan and on monitoring the performance of projects will need to be a practical "how-to" document designed for use by project developers and participants. Monitoring guidance can range from very broad guidance, such as what constitutes a "significant" emissions source to detailed technical recommendations, such as where to locate meters or how to read them.

The Marrakech Accords include guidance on what the monitoring plan for JI/CDM should include (see Annex A). Each of these points, such as "quality assurance and control procedures" could usefully be elaborated on in a monitoring plan or any specific monitoring guidance to be developed. Moreover, other information not mentioned in the Marrakech Accord outline of what a monitoring plan should include may also be needed in such guidance, e.g.:

- Information on pre-project (baseline) situation. This information will be needed by the Operational Entities in order to calculate the credits generated by a project.
- An outline of the organisational and management requirements for monitoring, such as in which language data should be recorded, archiving of monitoring data, who is responsible for monitoring project performance, and what (if any) training will be provided to ensure that this monitoring is carried out.
- An indication of monitoring frequency and reporting.
- Explanation of how emission reductions/enhancements due to the project were calculated by using the data monitored with the monitoring methods described (e.g. instructions on how to "translate" monitored project data to GHG emissions)
- What information is likely to be needed for verifying emission credits, for example fuel bills, documentation of system losses, indication of project context etc.

In addition, information on the sustainable development aspects of the project may need to be monitored in order to facilitate host country judgements on whether or not a project proposed or underway does contribute to their sustainable development. Monitoring plans written for PCF projects include specific indicators that projects need to meet to show that they are contributing to sustainable development.

3.2 Frequency of monitoring, reporting, and verifying information

Project developers will need guidance on how often to monitor, record, aggregate (e.g. averages across a given period) and report data. There may or may not be a significant difference between the frequency with which a project needs to be monitored, and the frequency with which monitored data needs to be recorded and reported. For example, an electricity project using continuous emissions monitors or monitoring hourly output will not need to report all data collected, but project participants will need guidance on how often to report data collected on a continuous or very frequent basis.

3.2.1 Monitoring and reporting frequency

The frequency of monitoring should be determined by answers to the following questions:

- What frequency of monitoring will give an accurate picture of project performance?
- With what frequency are credits from the project needed?

The frequency of monitoring that will give an accurate picture of project performance will vary by, and within, project type. For example, although re/afforestation projects increase below-ground carbon as well as above-ground carbon, increases in below-ground carbon can be both slow and gradual (depending on the species). Periodic (e.g. every 5y) monitoring of below-ground carbon will therefore give an accurate estimation of its accumulation in the years when it is monitored, as well as in the years between monitoring. It will therefore be most cost-efficient, while also remaining environmentally prudent, to monitor such information on a less than annual basis.

However, parameters in other project types that are inherently more variable will need to be monitored more frequently. For example, a project's level of output may need to be monitored more frequently than the characteristics of its raw materials or input fuel. An appropriate monitoring frequency may even vary within a project category. Energy efficiency projects that reduce a constant load by a constant amount may only needing limited (sporadic) monitoring, whereas a project reducing a variable demand by a variable amount would need more regular monitoring in order to determine accurately the energy saved by that particular project (IPMVP 2000).

3.2.2 Verification frequency

According to the Marrakech Accord, it is the operational entity that determines the emission reductions from CDM projects. The Accords also stipulate that operational entities (OE) need to submit an annual activity report to the Executive Board. Furthermore, credits can only be issued after the OE has submitted its verification and certification reports. These reports cover emission reductions "during the specified time period". However, the Accords do not indicate whether all projects need to be verified or certified annually.

It may therefore be possible for project participants of at least some project types to choose a less-than-annual (e.g. once every 2 or 3 years) verification schedule. This would mean that although the project would continue generating emission credits on a regular basis, credits may only be issued ever few years.

A less-than-annual verification process would not necessarily need to alter the monitoring and reporting schedule used within the project itself, although it would mean that project operators responsible for monitoring data would need to keep data over a longer period of time.

3.2.3 Frequency/cost trade-offs

There will be a trade-off between the time/cost of frequent monitoring and reporting, and the time/cost needed to verify a project's emissions/enhancements (Table 8). Verifiers will also need to have access to monitoring data, and may also wish or need to undertake limited monitoring themselves as part of an auditing procedure. Verification is an important exercise to ensure the environmental credibility of the credits generated. It can also highlight significant differences between estimated and audited emission reductions. For example, DNV (2001b) indicate that the reported mitigation effect of 31 projects was 746kt CO_2, but the audited (verified) mitigation effect for the same projects was 13% lower at 647 kt CO_2.

Less-than-annual verification should lower the fixed costs of verification (e.g. travel to project site), although it may increase the variable costs (e.g. of identifying data anomalies). A less frequent verification schedule would mean that project developers would receive emission credits (and associated revenue) in bunches, rather than yearly. Moreover, a delay between a project generating credits and a project developer receiving credits would normally be expected, because of the time needed for verification, certification and issuance of credits. Thus, the cost/ease of verification may also need to be considered when establishing guidance for the frequency of monitoring and reporting data, although such considerations should also take into account the cost differences in more frequent monitoring and reporting.

3.3 Areas for detailed/sectoral monitoring guidance

Specific monitoring guidance by project type/category, in addition to the ground rules for monitoring guidance described above, will facilitate the work of both the project developer and the project operator in determining what to monitor, how and when.

Specific guidance is likely to be needed on the key technical and organisational aspects of project monitoring, namely:

- Which sources/gases should be included in the project boundary (either a list, or a method by which to determine the project boundary);

- A detailed list of parameters that need monitoring, e.g. kWh distributed;

- Which monitoring method(s) and/or equipment should be used;

- Other reporting requirements, e.g. indicating the status of different data points (measured, monitored, derived, default value etc.);

- The frequency with which parameters relevant for the estimation of the project's emissions need to be monitored. This is likely to vary considerably for different parameters, and may also vary depending on different project types.

- When the project needs to be monitored. It is important for LULUCF projects that monitoring occurs at the same time of year. Consistency in timing of monitoring may also be important for projects estimating benefits on the basis of sample populations.

- An outline of the organisational requirements for monitoring, such as how, where and in which language data should be recorded. This is important because data may be recorded over a long time period, and may need to be accessed throughout the life of the project. It is also important that the data be recorded in such a form as to be easily accessible and understandable by a verifier. The allocation of monitoring responsibilities between the different project participants is also needed.

- Recommendations on reducing errors and uncertainties (including recommendations on how to generate a sample population and extrapolate emission reductions/sink enhancements from this population, the use of trained personnel to monitor different items) and recommendations on how to deal with errors/uncertainties (such as tradeoff with number of credits).

- How long a project should be monitored for. Depending on how crediting for LULUCF projects is set up, guidance may be needed on whether a LULUCF project needs monitoring past its crediting lifetime.

- How leakage, spillover and transboundary effects will be determined.

- Units in which to monitor and report. Specifying frequently commonly used units for reporting (such as volume units for natural gas) may reduce reporting errors (WRI/WBCSD 2001). Specifying common reporting units will facilitate verification.

In addition, it may be necessary to provide the project operators with some guidance or training in how to operate the monitoring and reporting system set up for the project (DNV 2001b). For example, information required to calculate emission reductions will need to be monitored on a calendar year basis, whereas other information the project operators may need to monitored or report for economic reasons may be on a financial year basis.

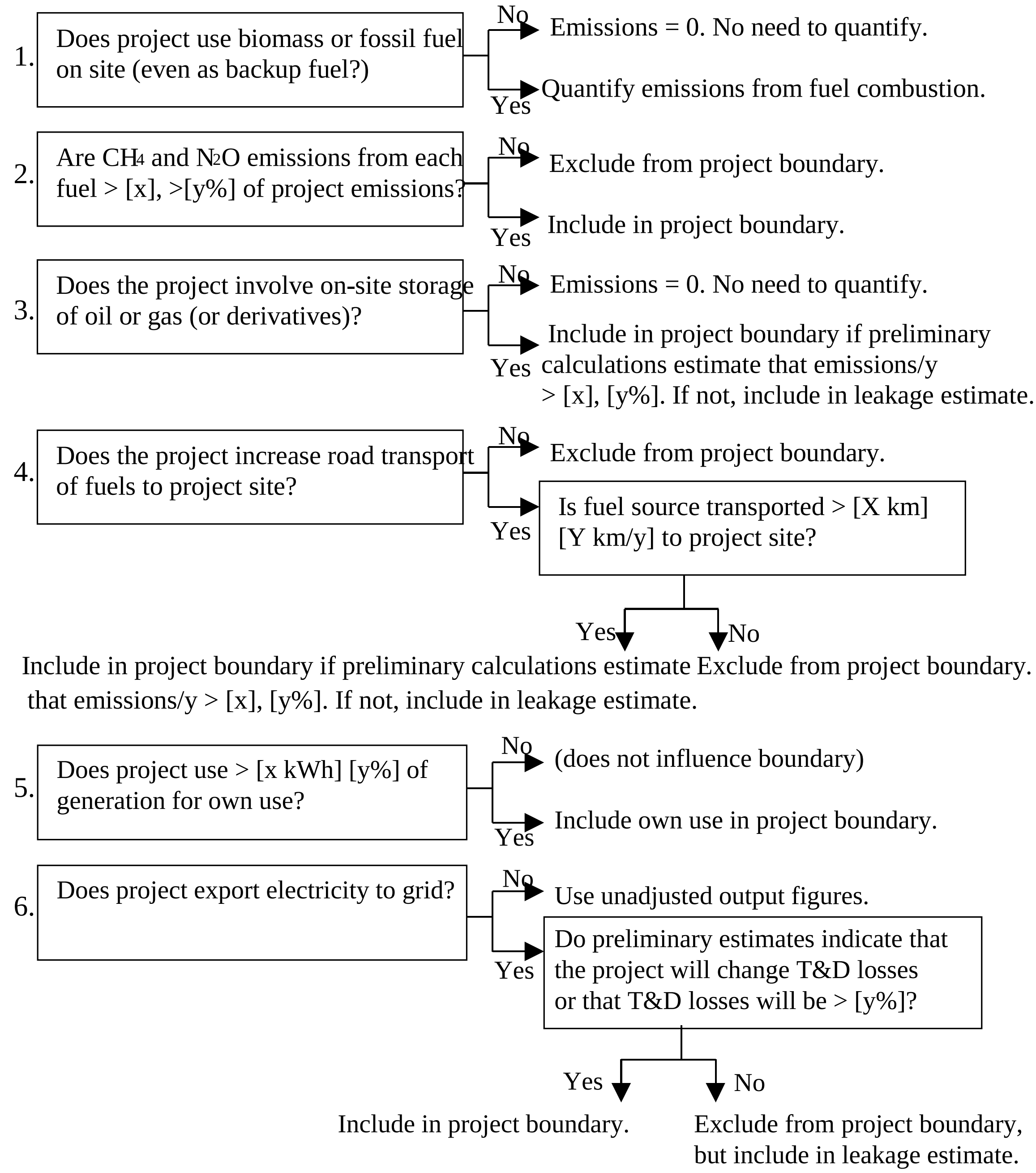
Since this guidance is technical, it may be most appropriate for it to be drawn up by experts, e.g. those serving on an advisory panel to the CDM EB. A useful starting point may be guidance for JI/CDM projects drawn up by the Japanese (WBG 2001) and Dutch governments (ERUPT and CERUPT, EZ 2001) and the work on monitoring energy efficiency and forestry projects drawn up by LBL (Vine and Sathaye 1999, Vine et al. 1999).

Other guidance can also provide useful input to development of detailed monitoring methods and guidance. For example, IPCC guidance (IPCC 1997 and 2000) outlines methodologies for determining emissions from different sources; develops decision trees to determine which the most appropriate method is; and lists detailed technical data (such as emission factors, conversion factors) that may be useful when calculating the emissions associated with a project. It also provides management/organisational guidance for the development of quality assurance/quality control (QA/QC) procedures. The IPMVP (IPMVP 2000) provides an overview of best practice techniques in determining the results of energy efficiency projects. National guidelines e.g. to determine the mitigation effects of voluntary actions by companies, have also been developed and may be relevant. In addition, much experience has been gained using the methodologies developed by Winrock (MacDicken 1997) to calculate changes in carbon stocks from forestry projects. ISO 14000 and 9000 may also provide useful input, as they make recommendations on the responsibilities and qualifications of the different team-members used in verification teams and on QA/QC procedures.

3.3.1 *Specific guidance recommendations*

Because the relative importance of different sources of emissions or enhancements in JI/CDM projects may vary by project type, it may be sensible to use decision trees in order to guide decisions on drawing up project boundaries. This would reduce the number of separate monitoring guidance documents that would need to be set up. An example of a decision tree for deciding the boundary of an electricity project is outlined in Figure 4.

Figure 4: **Example of a decision tree determination of project boundaries (electricity or heat generation project)**



3.3.2 Deciding which aspects of a project to monitor

Not all aspects of greenhouse gas mitigation projects will be monitored on a continuous basis. Therefore, project performance will need to be extrapolated from the use of indicators of project performance.

A definition of project boundaries (whether it appears in guidance on project monitoring or on baseline development) will help project developers assess what information does not need to be monitored. However, it may not be precise enough to define what exactly should be monitored. Thus, monitoring guidance will also need to recommend what indicators of project performance should be, and how they should be monitored.

As shown by Table 2 to 5, what needs to be monitored is determined by the project boundary and varies widely by project category. However, defining the project boundaries does not in itself completely define which indicators need to be monitored in order to measure project performance. For example, there is no agreement on what indicator should be used to define project output for an electricity/heat project. Even for an electricity generation project, for which monitoring should be relatively simple, there can be significant differences between electricity generated by a project, energy sent out to the grid (i.e. excluding own-use) and electricity received by the user (i.e. taking into account losses from transmission and distribution). Consistency, comparability and transparency will be increased if guidance is given on what "type" of electricity (generated, sent out, used) should be monitored. (This should be straightforward. For example, the baseline recommendations for GHG mitigation projects in the electric power sector in Kartha et. al. 2002 are based on generated electricity. Technical T&D losses are only taken into account for energy efficiency projects and distributed generation projects).

The use of decision trees may also be useful in determining the activities and parameters that need to be monitored to assess project performance, as well as outlining how (in which units) they should be monitored. This information is needed before the project is set up in order to allow cost-effective monitoring systems to be designed or located in the most appropriate locations. Defining the units in which project output should be monitored may be less obvious for projects in other sectors (e.g. industry), as the baseline could be expressed in terms of emissions/tons of intermediate product produced (rather than emissions/ton of final product) (OECD/IEA 2000).

Once it has been decided what aspects of a project need to be monitored, the next step is to assess how such monitoring should occur. In some cases, such as forestry or energy efficiency projects, more than one method could appropriately be used to monitor individual parameters of project performance. Project developers could choose among methods, and their choice might depend on the type of project, the required accuracy of estimate, as well as the funds available for monitoring.

Once the indicators of project performance have been monitored, they then need to be "translated" into a GHG emissions equivalent by using an emissions factor. This will be a more or less simple task depending on the type of project. For example, an electricity/heat production project will need to calculate the GHG produced by the input fuel to generate electricity. This is a trivial task for projects using zero-emitting fuels (if no other fossil fuel sources are included in the project boundary), and should be able to be done relatively easily for other project types by using the emission calculation methodologies developed by the IPCC. "Translating" carbon monitored in forestry projects to CO_2 is also a trivial process.

4. Lessons learned from experience in monitoring/verifying project performance

Some of the organisational lessons learned from monitoring greenhouse gas mitigation projects have already been incorporated into the CDM and JI project cycles as laid out in the Marrakech Accord. For example, the requirement that a monitoring plan needs to be set up at the project design stage should enable monitoring considerations to be included at an early stage in project planning. This should therefore facilitate the gathering of relevant data at little or no extra costs by e.g. ensuring that meters are placed at appropriate locations. Ensuring that emission reductions are verified by an independent third party should also increase confidence in the validity of issued emission reductions. Other lessons learned from monitoring greenhouse gas mitigation projects already underway, such as the importance of training project operators in monitoring and reporting climate-related impacts of the project (as distinct from the economic and/or physical output of the project) should also be incorporated.

There is already some experience with developing and/or applying monitoring plans for greenhouse gas mitigation projects. Some monitoring guidance has been developed at the sector and/or project category level specifically to monitor the performance of JI/CDM (or other climate mitigation) projects. This guidance has generally been drawn up by individual governments (e.g. EZ 2001, WGB 2001) or organisations (e.g. Vine and Sathaye 1999, Vine et. al. 1999, MacDicken 1997, Martinot 1998, DNV 1999a). The IPCC has also drawn up some very generic guidance for LULUCF projects (IPCC 2000).

Monitoring plans have also been established for a few AIJ projects (e.g. Ravindranath and Bhat 1997, Brown et. al. 1999), and the monitoring/verification process analysed for others (e.g. DNV 1999b, DNV 2001). However, many AIJ projects were not systematically monitored (e.g. DNV 2000), so experience with monitoring GHG mitigation projects is not as large as could be expected. A handful of Prototype Carbon Fund (PCF) projects, all of which have a monitoring plan, have also been developed (e.g. PCF 2001a and 2001b).

Existing monitoring plans and guidance documents can differ substantially on key issues, such as how to define project boundaries. This section summarises experience with and/or planning for project monitoring in the electricity, energy efficiency and forestry sectors, including on project boundaries, monitoring methods and cost. It then highlights differences between different available guidance documents, and raises questions and develops recommendations on monitoring guidance for JI/CDM projects in the electricity and forestry sectors.

4.1 Project boundaries

General guidance on project boundaries for GHG mitigation projects has been developed by a number of different organisations. These were all developed before the Marrakech Accords were agreed, and so of course could not take its definition of project boundary into account. While the guidance in the Marrakech Accords will supercede guidance previously developed for JI/CDM projects, it is interesting to note the variation found in different guidance documents (Table 1).

Table 1: **General recommendations on which impacts to include in the project boundary**

Guidance	Sectors covered	Definition of boundary
Marrakech Accords	All JI projects and emission reduction CDM projects	Boundary shall include all sources "under the control of the project participants that are significant and reasonably attributable" to the project.
OECD/IEA (2000)	Electricity generation, energy efficiency (lighting), cement, iron & steel, transport	Guidance varies by sector and project type, but generally suggests including major (but not all) direct on-site emissions, as well as emissions associated with electricity used in the project.
ERUPT (2001)	Fuel switch (in electricity, heat or CHP projects), CHP, landfill gas recovery, forestry	Direct on-site and off-site emissions that can be controlled or influenced by the project. In general, emissions related to activities one step downstream or upstream are also included.
WRI/ WBCSD (2001)	General	Direct GHG emissions from sources owned or controlled by the reporting company. Emissions from the generation of imported/purchased electricity, heat and steam.
WBG (2001)	Energy efficiency improvement in steelworks, refineries, fossil fuel power plant; natural gas CHP; reforestation	Include direct emissions (removals) from the project's main activity, as well as those not related to the project's main activity but that are not "small enough to be ignored". Include some indirect project impacts in project boundary.
World Bank (1998)	Several project types in the energy, transport, industry, and LULUCF sectors.	Guidance suggests excluding any impact that is less than 10% of the largest individual GHG impact of the project.

This difference in approach to defining project boundaries between different guidance documents can be illustrated by examining detailed recommendations on what to include and exclude in the project boundary for certain project types.

Table 2 outlines different recommendations for an electricity, CHP or heat supply-side project. The only aspect on which there is positive consensus is that CO_2 from the fossil fuels used to generate electricity/heat should be included in the project boundary. There also seems to be implicit agreement (as some guidance documents do not refer to these as possible sources) that emissions from site preparation and carbon embodied in construction materials should be excluded from the project boundary.

However, there are mixed opinions as to whether or not indirect emissions or non-CO_2 gases should be included in the project boundary. Whether or not these "other" sources are included may only make a few percentage points difference in the number of credits generated by a project, but could make monitoring significantly more expensive. These include CH_4 and N_2O from fossil fuel combustion, which together represent less than 1% of direct GHG emissions from the combustion of fossil fuels to generate electricity (OECD/IEA 2000). The different guidance documents are also not agreed on whether or not to include emissions associated with the transportation of fuels to the project site and of fuel storage on-site (although both sources are "reasonably attributable" to the project activity). In some cases, emission from transport of biomass or storage of natural gas could be significant, although data constraints may make them difficult to calculate.

Table 2: **Comparing project boundary recommendations (electricity/heat supply)**

Source	Included in boundary	Excluded from boundary	Project type
ERUPT (and CERUPT draft) (EZ 2001)	On-site combustion of fossil fuels, own use of electricity and heat	Combustion of fuels in back-up boiler	CHP
WBG (2001)	On-site combustion of fossil fuels, emissions from transportation and storage of fuels on project site	Mining and processing of fuels and construction materials. Operation of construction machinery, construction of infrastructure for heat supply, change of biomass caused by landcover change.	CHP (gas)
OECD/IEA (2000)	CO_2 and CH_4 emissions from on-site combustion of fuel for electricity generation	On-site emissions of N_2O, all off-site and indirect effects	Grid-connected elec. gen.
WB (1998)	CO_2 emissions from on-site combustion of fuel for electricity generation.	On-site emissions of CH_4 and N_2O. Losses from transmission and distribution.	Grid-connected CHP.
IGPO (2000)	CO_2, CH_4 and N_2O emissions from on-site combustion of fuel for electricity generation, own use of electricity/heat	All off-site and indirect effects	Electricity or heat projects

Table 3 indicates the project boundaries actually used in selected electricity/heat greenhouse gas mitigation projects (e.g. AIJ or PCF projects). These boundaries, unsurprisingly, also vary. PCF projects have very strict monitoring and reporting requirements in general. This is illustrated by the fact that one project excludes increased electricity use due to "development" (i.e. increase in electricity use over business-as-usual due to readily available electricity) from its project boundary. Another PCF project uses hourly dispatch data to assess the GHG-intensity of electricity displaced by the project. While such detailed methods increase the accuracy of estimating the climate mitigation effect of the project, they also increase the monitoring burden, both before and during the project. However, even different AIJ projects have different project boundaries. Although many AIJ projects in the electricity/heat sectors exclude CH_4 and/or N_2O, these sources are included for some projects.

Table 3: **Project boundary assumptions in selected climate mitigation projects (electricity/heat)**

Source	Included in boundary	Excluded from boundary	Project type
PCF (2001b)	Transport and combustion of petroleum fuels for electricity generation and lighting purposes to project area	Increased electricity use due to “development”. Non-CO_2 gases produced by combustion and transport.	Small elec gen project (hydro and diesel)
PCF (2001a)	Hourly net generation (local grid collects figures on hourly generation by source)		Run of river hydro (elec. gen.)
Jordan/E7 AIJ project (UNFCCC 2000)	CO_2 emissions from oil used for power generation, including own use.	CH_4 and N_2O emissions from fuel combustion, all off-site emissions	Fuel efficiency improvement
Poland/Netherlands AIJ project at Byczyna	CO_2, CH_4 and N_2O emissions from boiler fuel combustion	(All other emissions)	Fuel efficiency and fuel switch in heating system.
Martinsen et. al. (2001)	Physical boundary of the heat production facility.	Emissions from fuel production and transportation to project site.	Heat production (biofuels)

Table 4 outlines recommendations from different guidance documents on what to include in project boundaries for a reforestation project. There is greater consensus than for electricity/heat projects, but not complete agreement, on what to include in a project boundary. For a reforestation project, all guidance suggests including the carbon contained in above-ground biomass, and excluding emissions from e.g. transporting seedlings and wood products. However, there is disagreement on whether or not to monitor some significant carbon pools, such as soils and wood products, although whether soil carbon provides a "significant" contribution to GHG sequestration from a project depends on the soil type, previous land uses and the type of forest that is planted (Figure 3).

Table 4: **Comparing project boundary recommendations (reforestation project)**

Source	Included in boundary	Excluded from boundary
WBG (2001)	Above and below-ground biomass, litter accumulation, emissions from soil carbon, preparation of land for planting, fertiliser use, reversal of sequestration from fires, deforestation etc.	Fossil fuel combustion for raising and transporting seedlings, operating machinery, transporting wood products, land use on land adjacent to project.
ERUPT	Sink enhancement pools (which pools are not specified), fertiliser use, fossil-fuel-related emissions related to land preparation, nursery, planting,	(instructions unclear as to whether direct and indirect off-site emissions should be included)
Vine et. al. (1999)	All carbon pools, possibly C content of harvested wood products, “and can be expanded if warranted”, temporal boundaries	(Emissions related to land preparation and planting, fertiliser use not mentioned)
IPCC SRLULUCF* (2001)	Trees and wood products should be quantified and monitored. It is recommended that roots and soil carbon are also quantified and monitored. Dead biomass may need to be measured depending on project type.	Herbaceous biomass (vegetation) excluded from boundary. (Emissions related to land preparation and planting, fertiliser use not mentioned)
Hamburg (2000)	Living above-ground biomass, below-ground biomass (roots), soil carbon (if stock declines).	Soil carbon (if increased by project), necromass.
Tipper et. al. 2001	All carbon pools that increase for which credits are claimed, all carbon pools that decrease. May need to include non-CO_2 gases. May need to include fossil fuel emissions from e.g. irrigation.	Carbon pools that increase but for which credit not claimed.

*The suggested boundary here is for a re/afforestation project involving plantations (but not short-rotation energy plantations). The recommended boundary for other reforestation projects e.g. agroforestry projects is different.

Table 5 outlines different project boundaries actually used for different LULUCF projects. As for the electricity/heat example, there is agreement from all different guidance documents that the one major source of GHG mitigation from forestry projects (carbon contained in trees) should be included in the project boundary. The guidance documents that mention fertiliser use suggest including it in the project boundary (but most guidance documents do not mention fertiliser). However, there are different recommendations for almost every other aspect, including significant carbon pools such as roots, soil carbon, dead biomass or harvested wood products. How to deal with the possible reversal of carbon sequestration by fires, pests, etc. (the "permanence" issue) is also not included in all monitoring guidance documents. Few guidance documents indicate whether or not emissions associated with forestry projects (such fossil fuel emissions associated with land preparation and planting) should be included. There is also a wide difference in what is included in the project boundaries for individual (mainly AIJ) forestry projects.

Table 5: **Project boundary assumptions in selected climate mitigation projects (reforestation)**

Source	Included in boundary	Excluded from boundary
Ravindranath & Bhat (1997)	Standing tree biomass, litter, soil carbon, annual C uptake, wood extraction, wood end uses, soil and litter decomposition rates, root biomass accumulation	(Emissions related to land preparation and planting, fertiliser use not mentioned)
Brown et. al. 1999	Above-ground woody biomass (trees), below-ground biomass (roots), dead biomass (standing and lying) vegetation, litter	Soil carbon. (Emissions related to land preparation and planting, fertiliser use not mentioned)
Klinki AIJ (UNFCCC 1998)	Above and below-ground biomass	Soil carbon, emissions from harvesting.
Scolel Té project (IPCC 2001)	Trees, soil	All other carbon pools. (Emissions related to land preparation and planting, fertiliser use not mentioned)

4.2 Frequency of monitoring

There is only limited guidance available on how frequently to monitor different aspects of a project’s performance. As for the different guidance on project boundaries, guidance on monitoring frequency also diverges.

Table 6 outlines recommendations for the monitoring frequency of two forestry projects. The recommended monitoring frequency is quite different for important carbon pools, such as above-ground woody biomass and below-ground biomass (roots). Provided that the project site was not subject to disturbances, the monitoring frequency may not affect the total number of credits generated by a project, and may therefore be judged as unproblematic. However, the timing and frequency of monitoring may affect the years in which credits are allocated. For example, if biomass growth (and carbon accumulation) is extrapolated linearly between starting, mid and end-points, the growth of carbon stocks will be overestimated at the beginning of the project and underestimated towards the end. This slight front-loading of credits may make be the project more economically attractive (Ellis 2001).

Table 6: **Selected recommendations on frequency of monitoring activities for different carbon pools in LULUCF projects**

Parameter to be monitored	Suggested timing (y)	
	"Typical forestry mitigation project"*	Guaraqueçaba Climate Action Project, Brazil*
Soil carbon	Y_0, every 2/3 years, end of project	Years 1, 3, 5, 10, 15, 20, 30, 40
Above-ground woody biomass	Y_0, mid rotation, end rotation	Years 1, 3, 5, 10, 15, 20, 30, 40 Remote sensing will be used in years 25 and 35
Standing dead biomass	--	Years 1, 3, 5, 10, 15, 20, 30, 40
Litter/slash	Y_0, every 5 years	Years 1, 3, 5, 10, 15, 20, 30, 40
Annual C uptake	Annually or periodically	--
Extraction of wood	Annually, end of rotation	(not applicable to this project)
End-uses of wood	Annually, end of rotation	--
Soil/litter decomposition rates	Annually	Every 5 years
Root biomass	Y_0, end of rotation	Every 5 years
Rates of land-use change, socio-Economic indicators	--	Y_0, every 5 years

Source: Ravindranath & Bhat, 1997 (for a "typical forestry mitigation project"), Brown et. al. 1999, Brown & Delaney 1999 (for Guaraqueçaba Climate Action Project, Brazil)

Table 7 outlines the recommended monitoring frequency for a fuel-switch AIJ project. This table highlights the different frequency with which different parameters in one particular project should be monitored. While some aspects of the project (i.e. generation of electricity and heat) are monitored continuously, other aspects are monitored daily or yearly. Moreover, double copies of the project output are kept: in electronic form (continuously) and paper form (weekly). Recommendations on monitoring frequency from other electricity supply projects are different. For example, one PCF project (PCF 2001b) requires monthly output reports. Another (PCF 2001a) indicates that hourly output needs to be recorded. The mitigation effect of AIJ projects, when reported to the UNFCCC, are done so on an annual level (see e.g. UNFCCC 2001b), although these reports do not indicate the frequency of reporting compared to the frequency of monitoring.

Table 7: **Monitoring frequency and responsibilities for Quercus AIJ project**

Data	Recording frequency	Format (paper/ electronic)	Where kept	Responsible	Data records stored
Generated electricity	Continuous	Electronic	Boiler house	Boiler house manager	2 years
Generated electricity	Weekly	Paper	Head office	Boiler house operator	2 years
Generated heat	Continuous	Electronic	Boiler house	Boiler house manager	2 years
Generated heat	Weekly	Paper	Head office	Boiler house operator	2 years
Bio fuel consumption	Daily	Paper	Boiler house	Boiler house operator	2 years
NCV of bio fuel	Daily	Paper	Boiler house	Boiler house manager	2 years
Gas consumption	Daily	Paper	Boiler house	Boiler house operator	2 years
NCV of gas	Annually	Paper	Boiler house	Boiler house manager	2 years

Source: Martinsen et al. 2002

Monitoring guidance for LULUCF projects may also need to specify the length of time a project should be monitored for. This is because the guidelines for CDM projects agreed at COP7 do not cover LULUCF projects and because forestry projects sequester carbon over a long period of time. Moreover, since carbon sequestration may be reversed, projects may need to be monitored for a longer period than their crediting life to ensure that the credits generated by forestry projects represent real and long-term climate benefits.

5. Conclusions

Monitoring activities will need to be carried out at different times and for different purposes during the preparation and implementation of a greenhouse gas mitigation project. For example, pre-project monitoring may be needed to define a project's baseline and monitoring during the project will be needed to quantify a project’s greenhouse gas impacts (and therefore the number of credits it can generate). Monitoring may also be needed for other project-related functions such as assessing the importance of leakage or whether or not the crediting period for a project should be extended. This paper focuses on monitoring the performance of a greenhouse gas mitigation project and on defining the boundaries of what needs to be monitored.

The CDM's Executive Board has been tasked with setting up detailed guidance on monitoring, baselines, project boundaries, as well as other issues relevant for CDM projects. Readily available monitoring guidance will facilitate the task of JI/CDM project developers by giving clear instructions, and can therefore reduce the cost to project developers of establishing a monitoring plan (this is also true for domestic GHG mitigation projects). Clear monitoring guidance can also facilitate verification of emission reductions.

The Marrakech Accords indicate that the monitoring plan for a JI/CDM project has to be set up as part of the project design document. Thus, monitoring-related costs will occur up-front (even before a project has been registered) as well as during a project’s operation. The costs associated with developing a monitoring or monitoring/verification plan can be significant, e.g. $20,000 for a “first-of-a-kind” project. The on-going costs of monitoring project performance can also be significant, but vary by project type and design.

Developing a project’s baseline and monitoring requirements are closely linked. For example, all parameters included in a project’s baseline will also need to be included in the definition of a project boundary, and monitored during the project’s crediting period. Therefore, developing guidelines for project monitoring and baselines may need to be carried out in parallel in order to ensure consistency. For example, if a particular emissions source is excluded from a project's baseline, monitoring reductions in emissions from this source should not generate emission credits. Developing monitoring guidelines will also influence (or be influenced by) any guidelines on how to report and/or verify the impacts of greenhouse gas mitigation projects.

Monitoring guidance can range from very broad guidance, such as what constitutes a “significant” emissions source to detailed technical recommendations, such as where to locate meters or how to read them. Thus, project developers would benefit both from “ground rules” as well as specific methodological, management or organisational guidance.

Some key questions need answering before the ground rules for any detailed (e.g. sectoral or project-category) monitoring guidance can be established. The answers to these questions are inter-linked and begin to establish the ground rules for project monitoring guidance. These questions need to be addressed rapidly in order to allow monitoring plans, and therefore JI/CDM projects, to move ahead. The answers will influence the time and cost associated with developing, applying and verifying monitoring guidance. These are:

- Whether monitoring guidance should allow for a choice of monitoring methods. Given that different methods can be used to calculate emission baselines, that particular emissions can be ably monitored by different methods, and that some flexibility to use less complex monitoring methods could reduce monitoring costs, this paper recommends that a choice of monitoring methodologies should be allowed.

- Whether individual project developers should have some flexibility in deciding the project boundary. How the project boundary is defined affects which sources of emissions and enhancements are accounted for, and therefore the importance (or not) of leakage. The project boundary therefore also affects which emission sources/sinks are included in a project's baseline. In order to promote consistency and comparability between different projects of a similar nature, it may be appropriate to require similar projects to have comparable project boundaries. This paper recommends encouraging consistent project boundaries either by further clarifying the definition of project boundary outlined in the Marrakech Accord, or by devolving the responsibility to define what is "significant" "reasonably attributable", and "under the control" to the project developers and verifiers[14].

- Whether any general cost/accuracy tradeoffs should be recommended. This paper recommends that "incremental" monitoring costs for larger GHG mitigation or sequestration projects be kept manageable by ensuring that a very high level of precision/confidence is not required for project monitoring data if there are significant uncertainties in a project's baseline level or data. It also recommends that simpler monitoring methods should be allowed in return for a conservative estimation of credits generated from the project.

- How monitoring procedures for small-scale projects could be simplified. Simplifications could include reducing the frequency of monitoring/verification; and calculating project benefits by using easy-to-monitor data, default emission factors and narrow project boundaries. For the most environmentally-friendly projects, such as renewable-based electricity generation, highly simplified monitoring could be limited to ensuring that the equipment installed continues to operate.

Once the "ground rules" have been set, more specific guidance will be needed by project category or type. This type of guidance includes:

- What a monitoring plan should contain. The Marrakech Accords outline some parameters that are needed in a monitoring plan, but a complete list needs to be drawn up.

- How frequently projects should be monitored and the relationship between the frequency of monitoring and the frequency of reporting and verification. This is important because the frequency of monitoring, reporting and verification influence the transaction costs of the project.

A project's monitoring plan may need to contain items in addition to those identified in the Marrakech Accord. These include "technical" data such as a detailed list of all sources of emissions and enhancements included in the project boundary; monitoring methods chosen for different sources and gases; methods on how to assess or address errors and uncertainties; information on the pre-project situation, and an indication of monitoring frequency and reporting. In addition, the monitoring plan will also need to include an outline of organisational/management requirements for monitoring (e.g. where and how data should be stored); who is responsible for monitoring what; and what information is likely to be needed for verifying credits.

Some experience with developing monitoring plans and monitoring greenhouse gas mitigation projects exists. For example, some emission reduction and sink enhancement AIJ projects have been monitored, although many AIJ projects have not been monitored regularly. In addition, detailed and extensive monitoring and verification plans have been drawn up for each Prototype Carbon Fund project. Various governments and organisations have also drawn up guidelines of varying levels of detail on how to monitor

[14] It will not be in the interests of the project developers to omit significant emission sources from the project boundary if they know that independent verifiers will subsequently examine their boundary choices and can withhold or delay credit issuance if they are in disagreement.

greenhouse gas mitigation projects. This experience, and the lessons learned from it, will be useful input to any detailed, methodological monitoring guidance that is drawn up for CDM and JI projects.

Moreover, detailed guidance relevant to monitoring the benefits of greenhouse gas mitigation projects has also been drawn up for other purposes. This includes the IPCC guidance on good practice in inventory calculations, the International Performance Measurement and Verification Protocol for energy efficiency projects and the WRI/WBCSD Greenhouse Gas Protocol, developed for corporate accounting. In addition to these international standards, national or regional standards for measuring and monitoring have also been developed for some project types. Using such standards to measure and monitor the impact of JI/CDM projects should be encouraged, as it should increase transparency of monitoring, and decrease the costs of developing monitoring plans.

Comparisons of the detailed guidance on project monitoring drawn up by different bodies, shows that different organisations give different recommendations on what to monitor, and when. (Not all guidance recommends methods of how to monitor particular parameters). Differences in project boundary recommendations reflect the implicit decisions by different guidance developers of what is or is not a significant emissions/enhancement source that can be monitored cost-effectively. For example, for electricity/heat supply projects, the only aspect on which there is positive consensus on project boundaries from the different guidance documents is that CO_2 from the fossil fuels used to generate electricity/heat should be included (which is where the bulk of the emissions come from). Different recommendations are made for whether or not to include e.g. direct on-site emissions of CH_4 and N_2O and direct off-site emissions arising from the transport of fuels to the project site. Similarly, recommendations on boundaries for forestry projects do not agree whether soil carbon, roots and dead biomass (all of which can comprise a significant proportion of total carbon stock on a project site) should be monitored.

Decision trees could be a useful means for project developers to decide whether or not to include particular emission sources in the project boundary and what appropriate indicators of project performance are. Using such decision trees would increase comparability and consistency between projects, as well as facilitating the verification process (and therefore reducing its cost).

The frequency with which a project is monitored can influence the accuracy of emission mitigation estimates as well as the frequency with which project operators receive emission credits. However, there is little guidance on appropriate monitoring frequencies for different project types, and little consistency between what guidance there is. Moreover, a distinction is needed in any guidance between the frequency with which a particular parameter is monitored, and the frequency with which it is reported.

Less frequent monitoring and reporting (e.g. less than once per year) may be appropriate for some project types, such as LULUCF projects, as changes in carbon stocks may be slow, gradual, and follow a well-known pattern. More frequent monitoring and reporting (e.g. monthly or weekly) may be appropriate for certain parameters in other projects, such as energy production or efficiency projects, where the performance is more variable throughout a year. Given that CERs are only issued after verification, and that there will be a time delay between verification and issuance, it is likely that project operators may wish to verify projects annually - at least towards the end of a commitment period. However, because less frequent verification should lower total verification costs, project developers may also wish to have the option of not verifying projects annually.

The costs of monitoring project performance will vary by type of project. For example, the time and cost involved in calculating the GHG impacts of wind-powered electricity could be trivial (depending on project boundary assumptions), but that for estimating carbon uptake by a forest is not. In general, monitoring costs will increase with the number of sources that need to be monitored; frequency of monitoring and reporting; accuracy/confidence level that monitoring should achieve; and the complexity of monitoring methods.

Ideally, project monitoring should provide an accurate picture of the GHG impacts of a project. However, the credits generated by a project are calculated by comparing the project's performance (which can be measured more or less accurately) with the project baseline (which is by definition a hypothetical scenario). It may therefore be appropriate to make some trade-offs to ensure that monitoring costs are kept to a reasonable level, e.g. under 8% of a project's total cost. Implications of possible actions to reduce monitoring costs are indicated in Table 8.

Table 8: **Implications of possible actions to reduce monitoring costs**

Type of trade-off to reduce monitoring costs	Effect of trade-off on:			
	Number of credits	Risk of leakage	Accuracy of emissions/ enhancement estimate	Verification costs
Narrower project boundary	Lower or Higher	Higher	Reduced for project as whole but unchanged for sources actually monitored	Reduced
Reduced frequency (i.e. less than annual) monitoring	None (in theory)*	Low	Reduced (for extrapolated points), unchanged for other points.	Increased**
Lower accuracy/ confidence	None (in theory)*	Higher	Reduced	Increased
Simpler methods taking into account conservative assumptions and parameters	None (in theory)*	Unknown	Reduced	Reduced

In practice, it could be decided to reduce/discount the number of credits awarded to projects using simpler monitoring methods, and/or lower accuracy/confidence levels and/or reduced monitoring frequency.

** Because it is more difficult to verify data where data series are not complete.

Trade-offs may sensibly be made at a different point for different project types. However, perhaps the easiest means to address trade-offs is to use simple monitoring methods and conservative assumptions to make sure that the number of credits generated by a project are not over-estimated. The implications of different trade-offs should be taken into account when making decisions on the ground rules that guide the development of monitoring guidance.

6. Annex A: Marrakech Accord provisions on the project cycle and project monitoring

6.1 CDM project cycle

The Marrakech Accords lays out a number of specific steps that projects need to fulfil in order to become CDM projects and generate emissions credits. These steps are:

- Validation of project activity, which includes 30 days for stakeholders comment
- Registration of project activity, including a determination that the project is additional and that the baseline is appropriate. The registration becomes final eight weeks after date of receipt of request for registration.
- Monitoring projects throughout their crediting life, according to the monitoring plan. This is a condition for verification, certification and issuance of CERs.
- Verification of a project's baseline, emissions and credits. An independent reviewer should undertake this verification periodically, and *ex post.* Verification is also required for JI projects.
- Certification, which occurs on receipt of the verification report.
- Request for issuance of credits.
- Issuance of credits, which occurs after a 15 day delay.

6.2 Excerpts from Decision 17/CP.7

The following text is taken from Decision 17/CP.7 of the Marrakech Accords (UNFCCC 2001).

52. The project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

Monitoring

53. Project participants shall include, as part of the project design document, a monitoring plan that provides for:

(a) The collection and archiving of all relevant data necessary for estimating or measuring anthropogenic emissions by sources of greenhouse gases occurring within the project boundary during the crediting period;

(b) The collection and archiving of all relevant data necessary for determining the baseline …

(c) The identification of all potential sources of, and the collection and archiving of data on, increased anthropogenic emissions by sources of greenhouse gases outside the project boundary that are significant and reasonably attributable to the project activity during the crediting period;

….

(e) Quality assurance and control procedures for the monitoring process;

(f) Procedures for the periodic calculation of the reductions of anthropogenic emissions by sources by the proposed CDM project activity, and for leakage effects;

(g) Documentation of all steps […] above.

…

54. For small-scale CDM project activities …. Project participants may use simplified modalities and procedures for small-scale projects.

…

58. The implementation of the registered monitoring plan and its revisions, as applicable, shall be a condition for verification, certification and the issuance of CERs.

59. Subsequent to the monitoring and reporting of reductions in anthropogenic emissions, CERs resulting from a CDM project activity during a specified time period shall be calculated, applying the registered methodology, by subtracting the actual anthropogenic emissions by sources from baseline emissions and adjusting for leakage.

Appendix B: Project design document

2. …. [a] project design document which shall include the following:

(h) Monitoring plan:
- (i) Identification of data needs and data quality with regard to accuracy, comparability, completeness and validity;
- (ii) Methodologies to be used for data collection and monitoring including quality assurance and quality control provisions for monitoring, collecting, and reporting;
- (iii) …

(j) Calculations:
- (i) Description of formulae used to calculate and estimate anthropogenic emissions by sources of greenhouse gases of the CDM project activity within the project boundary;
- (ii) Description of formulae used to calculate and to project leakage, defined as: the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the CDM project activity boundary, and that is measurable and attributable to the CDM project activity;
- (iii) …

Appendix C: Terms of reference for establishing guidelines on baselines and monitoring methodologies

The executive board, drawing on experts … shall develop and recommend to the COP/MOP, *inter alia:*

(a) General guidance on methodologies relating to baselines and monitoring consistent with the principles set out in those modalities and procedures in order to:

…

(ii) Promote consistency, transparency and predictability;
(iii) Provide rigour to ensure that net reductions in anthropogenic emissions are real and measurable, and an accurate reflection of what has occurred within the project boundary

…

(b) Specific guidance in the following areas:

…

(iii) Monitoring methodologies that provide an accurate measure of actual reductions in anthropogenic emissions as a result of the project activity, taking into account the need for consistency and cost-effectiveness;
(iv) Decision trees and other methodological tools….
…
(vi) Determination of project boundaries including accounting for all greenhouse gases that should be included as a part of the baseline, and monitoring.

7. References

Birner, Sabrina, personal communication (21.2.2002)

Bode, Jan-Willem, 2002, personal communication (22.2.2002)

Bode, Jan-Willem, R. H. Ravindranath, H. I. Somashekhar, 2001 - draft, *Baseline Development for Bioenergy Projects: Case Studies from South India*

Brown, Sandra, Miguel Calmon, Matt Delaney, 1999, *Carbon Inventory and Monitoring Plan for the Guaraqueçaba Climate Action Project, Brazil,* Prepared by Winrock International for The Nature Conservancy

Brown, Sandra, and Matt Delaney, 2001, *Guaraqueçaba Climate Action Project: 2000 Findings and Status Report,* Prepared by Winrock International for The Nature Conservancy

Brown, Sandra, Ian Swingland, Robin Hanbury-Tenison, Ghillean Prance, Norman Myers, 2001, *Carbon Sinks for Abating Climate Change: Can they work?,* http://www2.essex.ac.uk/ces/ResearchProgrammes/CESOccasionalPapers/ListOccPapers.htm

CDM Susac, 2002, *How-to guide to Monitoring and Verification Protocol*, http://cdmsusac.energyprojects.net/

DNV (Det Norske Veritas), 1999a, *Illumex Draft Model Monitoring and Verification Protocol,* Report 99-3288 prepared for the World Bank

DNV, 1999b, *Illumex Verification Report,* Report 99-3258 prepared for the World Bank

DNV, 2000, *Slovakian-Norwegian JI projects verification report,* prepared for the Norwegian Ministry of Environment, report number 2000-3461

DNV, 2001a, *Multi-Project Verification of Swedish AIJ Projects: Verification Results and Documentation,* Report ER 10:2001 prepared for the Swedish National Energy Administration

DNV, 2001b, *Multi-Project Verification of Swedish AIJ Projects: Methodology and Lessons Learned,* Report ER 9:2001 prepared for the Swedish National Energy Administration

EcoSecurities Ltd, 2000, *Financing and Financing Mechanisms for Joint Implementation (JI) Projects in the Electricity Sector*, November 2000, UK.EcoSecurities Ltd.

Ellis, Jane, 2001, *Forestry Projects: Permanence, Credit Accounting and Lifetime,* OECD and IEA Information Paper COM/ENV/EPOC/IEA/SLT(2001)11, http://www.oecd.org/pdf/M00023000/M00023450.pdf

EZ (Ministry of Economic Affairs, the Netherlands), 2001, *Operational Guidelines for Baseline Studies, Validation, Monitoring and Verification of Joint Implementation Projects,* http://www.carboncredits.nl/

Factorag, 2001, *Small-scale CDM Projects: Opportunities and Obstacles,* http://www.factorag.ch/pdf%20files/SUT%20Small-scale%20CDM%20Projects_Vol1_5-11-01.pdf

Hamburg, Steven P, 2000, *Simple rules for measuring changes in cecosystem carbon in forestry-offset projects*, Mitigation and Adaptation Strategies for Global Change, **5**: 25-37, 2000.

Heister, Johannes, personal communication, 5.4.2002

IGPO (International Greenhouse Partnerships Office), 2000, *Workbook on Electricity and Heat Generation from Renewables*, Prepared by Energy Strategies Pty Ltd and George Wilkenfield & Associates, http://www.isr.gov.au/resources/energy_greenhouse/igp

IPCC, 2000, *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*

IPCC/OECD/IEA, 1997, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*

IPCC, 2000, Special Report on *Land-Use, Land-Use Change and Forestry*, http://www.ipcc.ch/

IPMVP, 2000, *International Performance Measurement and Verification Protocol Volume I*, http://www.ipmvp.org/info/downloads_2000.html

Kadyszewski, John, 2001, presentation at COP7 side event *Forestry Projects: How to Credit and Monitor*, http://www.iisd.ca/climate/cop7/enbots/nov5.html

Kartha, Sivan and Michael Lazarus, with Martina Bosi, 2002, *Practical Baseline Recommendations for Greenhouse Gas Mitigation Projects in the Electric Power Sector*, OECD and IEA Information Paper

Loreti, Christopher, Scot Foster, Jane Obbagy, 2001, *An Overview of Greenhouse Gas Emissions Verification Issues*, Prepared for the Pew Center on Global Climate Change, http://www.pewclimate.org/projects/emissions_verification.cfm

MacDicken, K.G., 1997, *A Guide to Monitoring Carbon Storage in Forestry and Agroforestry Projects*, Winrock International, http://www.winrock.org/

Martinot, Eric, 1998, *Monitoring and Evaluation of Market Development in World Bank-GEF Climate Change Projects: Framework and Guidelines*, World Bank, paper number 066.

Martinsen, Thomas, Hans Jacob Mydske, Andy Yager, Milan Oravec, Ján Ilavský, 2002, *Implementation of the AIJ projects Fuel Switch in Boilers in the Slovak Republic*, Report prepared for the Norwegian Pollution Control Authority

Nabuurs, G. J, A.J. Dolman, E. Verkaik, A. P. Whitmore, W. P. Daamen, O. Oenema, P. Kabat, G. M. J. Mohren, 1999, *Resolving Issues on Terrestrial Biospheric Sinks in the Kyoto Protocol*, Dutch National Research Programme on Global Air Pollution and Climate Change, Report no. 410 200 030 (1999)

OECD/IEA, 2000, *Emission Baselines: Estimating the Unknown*, Paris

PCF (Prototype Carbon Fund), 2001a, *Chile: Chacabuquito 26MW Run-of-River Hydro Project: Monitoring and Verification Protocol,* http://www.prototypecarbonfund.org/router.cfm?show=Discuss.cfm

PCF (Prototype Carbon Fund), 2001b, *Uganda: West Nile Electrification Project Monitoring and Verification Protocol,* http://www.prototypecarbonfund.org/

PCF, 2000, *Learning from the Implementation of the Prototype Carbon Fund,* PCF Occasional Papers Number 1

Powell, M. 1999, *Effect of Inventory Precision and Variance on the Estimated Number of Sample Plots and Inventory Variable Cost: The Noel Kempff Mercado Climate Action Project*. Paper prepared for the World Bank, Winrock International, 38 Winrock Dr., Morrilton, Arkansas 72110, USA.

Ravindranath, N. H., and P. R. Bhat, 1997, *Monitoring of carbon abatement in forestry projects - Case study of Western Ghat project*, Mitigation and Adaptation Strategies for Global Change, **2**, 217-230

Richard Tipper, William McGhee, Jane Ellis, Ben H. de Jong, Augustine Hellier, 2001, *An Initial View on Methodologies for Emission Baselines: Forestry Case Study (*internal OECD/IEA consultation paper)

UNEP/OECD/IEA, 2001, *Baseline methodologies: Possibilities for Standardised Baselines for JI and the CDM,* Document COM/ENV/EPOC/IEA/SLT(2001)15 http://www.oecd.org/pdf/M00007000/M00007696.pdf

UNFCCC, 2001, The Marrakech Accords and the Marrakech Declaration

UNFCCC, 2001b, *Activities Implemented Jointly Under the AIJ Pilot Phase: Balvi (II), District heating renovation project*; http://unfccc.int/program/aij/aijact01/Sweden/lvaswe-04-01.html

UNFCCC, 2001c, *Activities Implemented Jointly Under the AIJ Pilot Phase: Reduction of Atmospheric Pollution through modernisation of HEAT Supply system in the Town of ByCzyna*, http://unfccc.int/program/aij/aijact01/polnld-01-01.html

UNFCCC, 2000, *Activities Implemented Jointly Under the AIJ Pilot Phase: Improving Thermal Power Plant Efficiency,* http://unfccc.int/program/aij/aijact01/Jorduitfrcn-01.html

UNFCCC, 1998, *Activities Implemented Jointly Under the AIJ Pilot Phase: Klinki forestry project*

USDOE, 1994, *Sector-specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992: Forestry Sector,* http://www.eia.doe.gov/oiaf/1605/guidelins.html

Vine, Edward and Jayant Sathaye, 1999, *Guidelines for the Monitoring, Evaluation, Reporting, Verification, and Certification of Energy-Efficiency Projects for Climate Change Mitigation*, Report LBNL-41543

Vine, Edward, Jayant Sathaye and Willy Makundi, 1999, *Guidelines for the Monitoring, Evaluation, Reporting, Verification, and Certification of Forestry Projects for Climate Change Mitigation*, Report LBNL-41877

WB (World Bank), 1998, *Greenhouse Gas Assessment Handbook,* http://wbln0018.worldbank.org/essd/kb.nsf/ab34a7716339450985256666007c9ca9/901594d74185a58885256761007cbefd

WBCSD/WRI, 2001, *The Greenhouse Gas Protocol: a corporate accounting and reporting standard,* http://www.wbcsd.org

WGB (Working Group on Baseline for CDM/JI Project), 2001, *Technical Procedures for CDM/JI Projects at the Planning Stage* **-** Interim Report to the Ministry of the Environment, Government of Japan

Willems, Stéphane, 2000, *Key Features of Domestic Monitoring Systems under the Kyoto Protocol*, OECD and IEA Information Paper COM/ENV/EPOC/IEA/SLT/(2000)4, http://www.oecd.org/env/cc/

8. Glossary

AIJ	Activities Implemented Jointly
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
COP	Conference of the Parties
EB	The Executive Board of the Clean Development Mechanism
ERUs	Emission Reduction Units
GHG	Greenhouse gas
GWP	Global warming potential
IPMVP	International Performance Measurement and Verification Protocol
JI	Joint Implementation
LULUCF	Land-use, Land-use change and forestry
Necromass	Dead biomass (lying or standing)
OE	Operational Entity
PCF	Prototype Carbon Fund
QA/QC	Quality assurance and quality control procedures.
Spillover	Spillover refers to positive side-effects of the project (i.e. increased emission reductions or sequestration) that are not included in the project boundary and that do not generate emission credits.