1. Introduction

Because of concerns with the growing threat of global climate change from increasing concentrations of greenhouse gases in the atmosphere, more than 176 countries (as of Oct. 7, 1998) have become Parties to the U.N. Framework Convention on Climate Change (FCCC) (UNEP/WMO 1992). The FCCC was entered into force on March 21, 1994, and the Parties to the FCCC adopted the Kyoto Protocol for continuing the implementation of the FCCC in December 1997 (UNFCCC 1997). The Protocol requires developed countries to reduce their aggregate emissions by at least 5.2% below 1990 levels by the 2008-2012 time period.

The Kyoto Protocol requires Annex I (developed) countries to report anthropogenic emissions by sources, and removals by sinks, of greenhouse gases at the national level (Article 5).[1] For example, countries would have to set national systems for estimating emissions accurately, achieving compliance with emissions targets, and ensuring enforcement for meeting emissions targets. Annual reports on measurement, compliance and enforcement efforts at the national level would be required and made available to the public.

The Kyoto Protocol includes two project-based mechanisms for activities across countries. Article 6 of the Protocol allows for joint implementation projects between Annex I countries: i.e., project-level trading of emissions reductions ("transferable emission reduction units") can occur among countries with GHG emission reduction commitments under the Protocol. Article 12 of the Protocol provides for a "Clean Development Mechanism" (CDM) that allows legal entities in the developed world to enter into cooperative projects to reduce emissions in the developing world for the benefit of both parties. Developed countries will be able to use "certified emissions reductions" from project activities in developing countries to contribute to their compliance with GHG targets. Projects undertaken by developed countries will not only reduce greenhouse gas (GHG) emissions or sequester carbon, but may also result in non-GHG benefits and costs (i.e., other environmental and socioeconomic benefits and costs). The key provisions of the Kyoto Protocol remain to be developed in more detail as negotiations clarify the existing text of the Protocol.[2]

[1] GHG sources include emissions from fossil fuel combustion, industry, decomposing and oxidized biomass, soil carbon loss, and methane from agricultural activities, livestock, landfills and anaerobic decomposition of phytomass. GHG sinks include storage in the atmosphere, ocean uptake, and uptake by growing vegetation (IPCC 1996; Andrasko et al. 1996).

[2] While this report focuses on the Kyoto Protocol, it should also be useful for projects undertaken before the Protocol goes into effect: e.g., in the U.S., the President's Climate Change Proposal contains a program that rewards organizations, by providing credits or incentives (e.g., a credit against a company's emissions or a tax credit), for taking early actions to reduce greenhouse gases

1.1. Overview of Project Tasks

Forestry projects to be undertaken within the Clean Development Mechanism or under joint implementation will likely involve several tasks (Fig. 1.). The guidelines contained in this report are primarily targeted to the tasks that occur during the implementation of a project (see section numbers in Fig. 1). The project design and development phase will incorporate many of the information needs required for completing the later tasks (see Section 3). We expect that there will be different types of arrangements for implementing these projects: e.g., (1) a project developer might implement the project with his/her own money; (2) a developer might borrow money from a financial institution to implement the project; (3) a developer might work with a third party who would be responsible for many project activities; etc. While the flow of funds might change as a result of these different arrangements, the guidelines presented in this report should be relevant to all parties, independent of the arrangement.

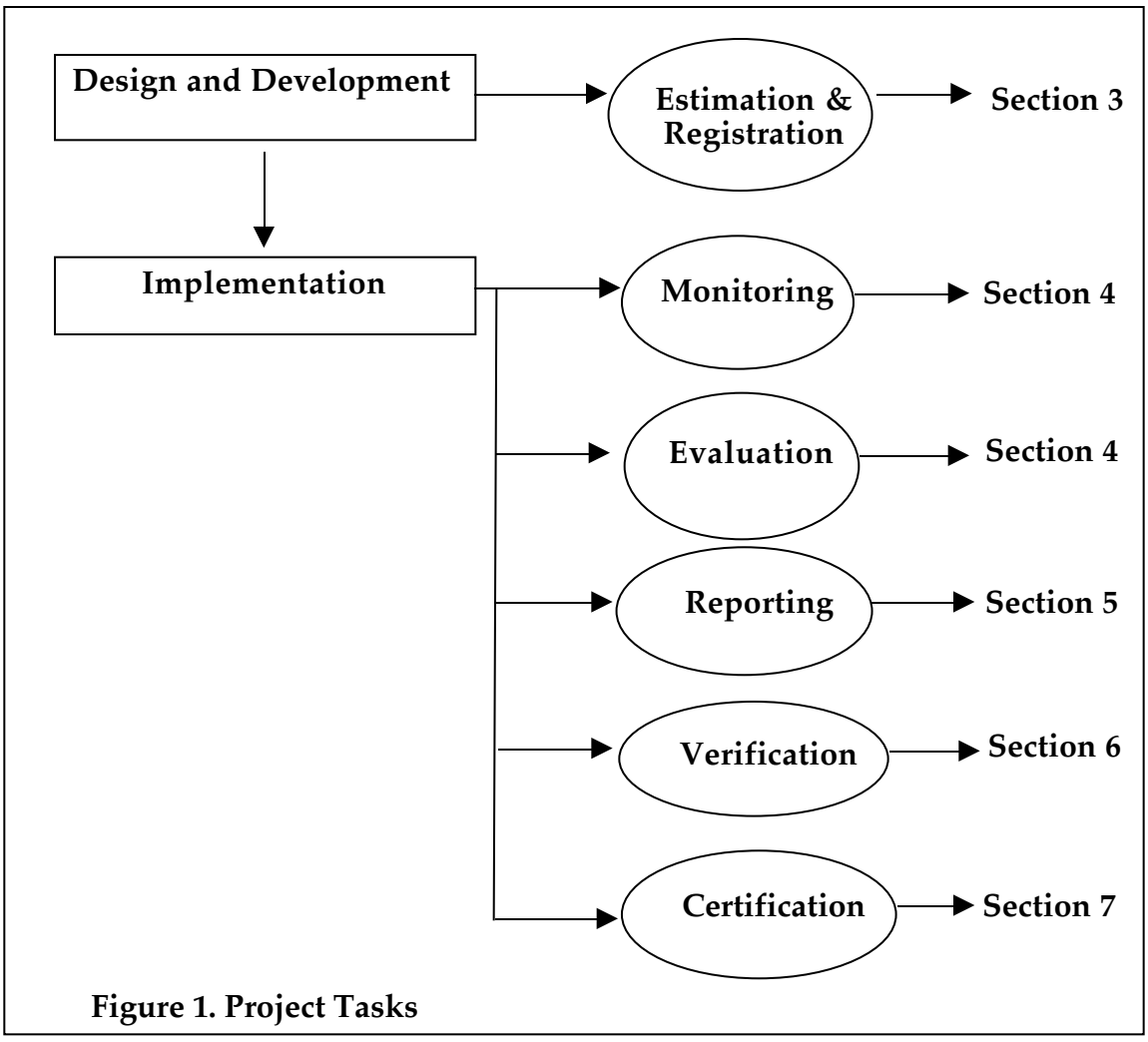


Figure 1. Project Tasks

before the international agreements from the Kyoto Protocol would take effect. The proposal is now commonly referred to as a "credit for early action" program (USGAO 1998).

In Figure 1, we differentiate "registration" from "certification" (see Section 7). Certification refers to certifying whether the measured GHG reductions actually occurred. This definition reflects the language in the Kyoto Protocol regarding the Clean Development Mechanism and "certified emission reductions." In contrast, when a host country approves a project for implementation, the project is "registered" (see UNFCCC 1998b).[1] For a project to be approved, each country will rely on project approval criteria that they developed: e.g., (1) the project funding sources must be additional to traditional project development funding source; (2) the project must be consistent with the host country's national priorities (including sustainable development); (3) confirmation of local stakeholder involvement; (4) confirmation that adequate local capacity exists or will be developed; (5) potential for long-term climate change mitigation; (6) baseline and project scenarios; and (7) the inclusion of a monitoring protocol (see Watt et al. 1995).

A country may also use different administrative or legal requirements for registering projects. For example, the project proposal (containing construction and operation plans, proposed monitoring and evaluation of carbon sequestration, and estimated carbon sequestration) might have to be reviewed and assessed by independent reviewers (see Section 3).[2] After this initial review, the project participants would have an opportunity to make adjustments to the project design and make appropriate adjustments to the expected carbon sequestration. The reviewers would then approve the project, and the project would be registered.[3] Individuals or organizations voicing concerns about the project would have an opportunity to appeal the approval of the project, if desired.

1.2. Conceptual Framework

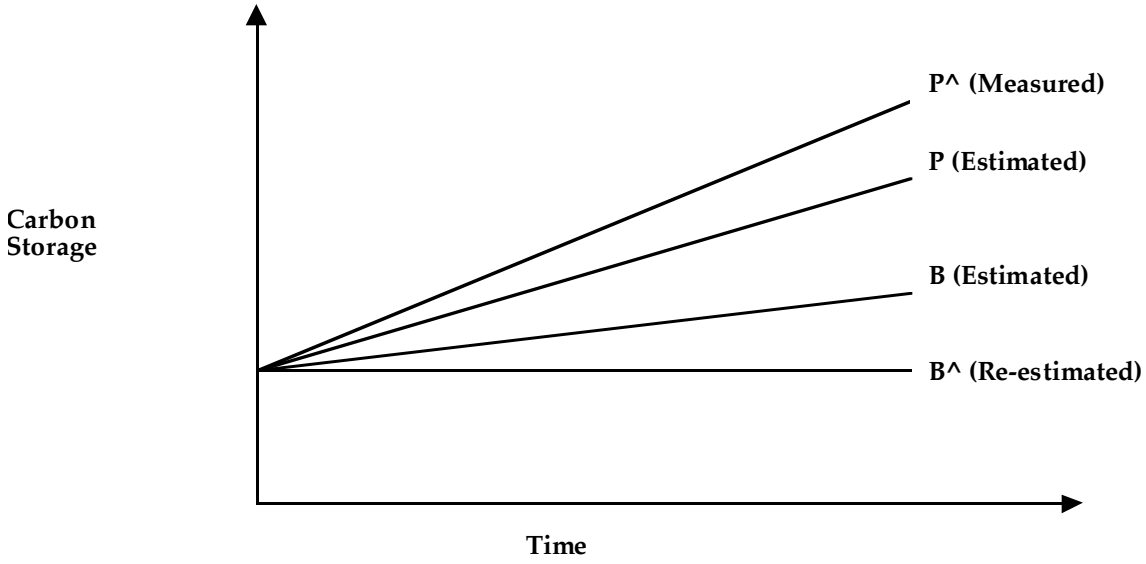
The analysis of changes in carbon stock occurs when a project is being designed and during the implementation of a forestry project. In the design stage, the first step is estimating the baseline (i.e., what would have happened to the carbon stock if the project had not been implemented) (see Section 3.2) and the project impacts. Once these have been estimated, then the net change in carbon stock is simply the difference between the estimated project impacts and the baseline (P-B, in Fig.

[1] In contrast to our interpretation, others believe certification occurs at the project approval stage, prior to implementation. We disagree, since certification can only occur after carbon sequestration has been measured.

[2] The term carbon sequestration describes the process of carbon uptake and storage. This refers to carbon dioxide uptake through photosynthesis and storage of carbon in vegetation, soils, and wood products.

[3] Under this approach, the independent reviewers could be the same people who verify the project during project implementation (personal communication from Johannes Heister, The World Bank, Jan. 12, 1999).

2). After a project has started to be implemented, the baseline can be re-estimated and the project impacts will be calculated based on monitoring and evaluation methods (Section 4). The net changes will be the difference between the measured project impacts and the re-estimated baseline (P^-B^, in Fig. 2). The example in Fig. 2 illustrates a case where measured carbon storage is greater than estimated as a result of a forestry project. On the other hand, carbon storage in the re-estimated baseline is lower than what had been estimated at the project design stage. In this case, the calculated net change in carbon storage is larger than what was first estimated. It is also possible that either P^ may be less than P and B^ may be more than B, or both might occur, making the net carbon storage less than estimated.



B: Estimated carbon stock without project (baseline)
P: Estimated carbon stock with project
P-B: Estimated net (additional) change in carbon stock

B^: Re-estimated carbon stock without project (baseline) (after monitoring and evaluation)
P^: Measured carbon stock with project (after monitoring and evaluation)
P^-B^: Measured net (additional) change in carbon stock (after monitoring and evaluation)

Figure 2. Example of Carbon Storage Over Time

1.3. Purpose of MERVC Guidelines

Monitoring, evaluating, reporting, verifying, and certifying (MERVC) guidelines are needed for joint implementation and CDM projects in order to accurately determine their impact on GHG and other attributes (see Box 1) (Vine and Sathaye 1997). The estimation of project impacts is not the focus of the guidelines in this report; however, these guidelines do discuss many of the issues involved in estimation, since they are of utmost concern in the activities that occur after a project is implemented. Furthermore, the findings based on measurement and evaluation are often compared with the estimated impacts of a project.

Under joint implementation, the reduction in emissions by sources, or an enhancement of removals by sinks, must be "additional" to any that would otherwise occur, entailing project evaluation (Article 6) (see Section 3). And the "emission reduction units" from these projects can be used to meet Annex I Party's commitment under Article 3 of the Kyoto Protocol, necessitating all MERVC activities to be conducted. Similarly, under the Clean Development Mechanism, emission reductions must not only be additional, but certified, real and measurable, again requiring the performance of all MERVC activities (Article 12).

Implementation of standardized guidelines is intended to: (1) increase the reliability of data for estimating GHG impacts; (2) provide real-time data so programs and plans can be revised mid-course; (3) introduce consistency and transparency across project types, sectors, and reporters; (4) enhance the credibility of the projects with stakeholders; (5) reduce costs by providing an international, industry consensus approach and methodologies; and (6) reduce financing costs, allowing project bundling and pooled project financing.

These guidelines are important management tools for all parties involved in carbon mitigation in land-use sectors. There will be different approaches ("models") in how the monitoring, evaluation, reporting, verification, and certification of forestry projects will be conducted: e.g., a project developer might decide to conduct monitoring and evaluation, or might decide to contract out one or more of these functions. Verification and certification must be implemented by third parties (Article 12). Similarly, some projects might include a portfolio of projects. Despite the diversity of responsibilities and project types, the Lawrence Berkeley National Laboratory's (LBNL's) MERVC guidelines are designed to be relevant for all models and project approaches.

Box 1

Definitions

Estimation: refers to making a judgement on the likely or approximate stock of carbon, GHG emissions, and socioeconomic and environmental benefits and costs in the with- and without-project (baseline) scenarios. Estimation can occur throughout the lifetime of the project, but plays a central role during the project design stage when the project proposal is being developed.

Monitoring: refers to the measurement of carbon stocks, GHG emissions, and socioeconomic and environmental benefits and costs that occur as a result of a project. Monitoring does *not* involve the calculation of GHG reductions nor does it involve comparisons with previous baseline measurements. For example, monitoring could involve the number of hectares preserved by a forestry project. The objectives of monitoring are to inform interested parties about the performance of a project, to adjust project development, to identify measures that can improve project quality, to make the project more cost-effective, to improve planning and measuring processes, and to be part of a learning process for all participants (De Jong et al. 1997). Monitoring is often conducted internally, by the project developers.

Evaluation: refers to both impact and process evaluations of a particular project, typically entailing a more in-depth and rigorous analysis of a project compared to monitoring emissions. Project evaluation usually involves comparisons requiring information from outside the project in time, area, or population (De Jong et al. 1997). The calculation of GHG reductions is conducted at this stage. Project evaluation would include GHG impacts and non-GHG impacts (i.e., environmental, economic, and social impacts), and the re-estimation of the baseline, leakage, positive project spillover, etc., which were estimated during the project design stage (see Section 3). Evaluation organizes and analyzes the information collected by the monitoring procedures, compares this information with information collected in other ways, and presents the resulting analysis of the overall performance of a project. Project evaluations will be used to determine the official level of GHG emissions reductions that should be assigned to the project. The focus of evaluation is on projects that have been implemented for a period of time, not on proposals (i.e., project development and assessment). While it is true that similar activities may be conducted during the project design stage (e.g., estimating a baseline, leakage, or spillover), this type of analysis is estimation and not the type of evaluation that is described in this report and which is based on the collection of data.

Reporting refers to *measured* GHG and non-GHG impacts of a project (in some cases, organizations may report on their *estimated* impacts, prior to project implementation, but this is not the focus of this paper). Reporting occurs throughout the MERVC process (e.g., periodic reporting of monitored results and a final report once the project has ended).

Verification refers to establishing whether the measured GHG reductions actually occurred, similar to an accounting audit performed by an objective, accredited party not directly involved with the project. Verification can occur without certification.

Certification refers to certifying whether the measured GHG reductions actually occurred. Certification is expected to be the outcome of a verification process. The value-added function of certification is in the transfer of liability/responsibility to the certifier.

LBNL's MERVC guidelines will help project participants determine how effective their project has been in curbing GHG emissions, and they will help planners and policy makers in determining the potential impacts for different types of projects, and for improvements in project design and implementation. Finally, by providing a basis for more reliable sequestered carbon and a common approach to the measurement and evaluation of forestry projects, widespread adoption of the MERVC guidelines will make these projects more reliable and profitable.

In the longer term, MERVC guidelines will be a necessary element of any international carbon trading system, as proposed in the Kyoto Protocol. A country could generate carbon credits by implementing projects that result in a net reduction in emissions. The validation of such projects will require MERVC guidelines that are acceptable to all parties. These guidelines will lead to verified findings, conducted on an ex-post facto basis (i.e., actual as opposed to predicted (ex-ante) project performance).

LBNL's MERVC guidelines have been reviewed by project developers (working on projects in Russia, Eastern Europe, Africa and Latin America) as well as experts in the monitoring and evaluation of forestry projects. The practitioners reviewed the report for accuracy and assessed whether data were available for completing the forms presented at the end of this report. Based on their feedback, we believe LBNL's MERVC guidelines can be used by project developers, evaluators, and verifiers. We hope that international entities can also use our guidelines as a model for developing official MERVC-type guidelines.

1.4. Target Audience

These guidelines are primarily for developers, evaluators, verifiers, and certifiers of forestry projects. This document can also be used by anyone involved with the design and development of joint implementation and Clean Development Mechanism projects, such as: forest management companies, development banks, finance firms, consultants, government agency employees and contractors, city and municipal managers, researchers, and nonprofit organizations.

1.5. Scope

LBNL's MERVC guidelines are targeted to forestry projects.[1] The guidelines can be used for assessing the impacts for a single project, or for a group of projects (e.g., in a program, where there are many participants). These guidelines occupy an intermediate position between a previous report that provided an overview of MERVC issues (Vine and Sathaye 1997) and a procedural handbook that describes the information and requirements for specific measurement and evaluation methods that may be employed for measuring carbon sequestration.

LBNL's MERVC guidelines address several key issues, such as: (1) uncertainty and risk; (2) the frequency and duration of monitoring and evaluation; (3) methods for estimating gross and net changes in the carbon stock; and (4) verification and certification of changes in the carbon stock (Vine and Sathaye 1997). We provide a Monitoring and Evaluation Reporting Form and a Verification Reporting Form at the end of this report to facilitate the review of forestry projects.

LBNL's MERVC guidelines also:

- Address the needs of participants in forestry projects, including financiers, investors, developers, and technical consultants.
- Discuss procedures, with varying levels of accuracy and cost, for evaluating and verifying (1) baseline and project installation conditions, and (2) long-term change in carbon stock.
- Apply MERVC procedures to a variety of projects.
- Provide procedures that (1) are consistently applicable to similar projects throughout all geographic regions, and (2) are internationally accepted, impartial and reliable.

These guidelines reflect the following principles: MERVC activities should be consistent, technically sound, readily verifiable, objective, simple, relevant, transparent, and cost-effective. Sometimes, tradeoffs need to be made for some of these criteria: e.g., simplicity versus technical soundness. Because of concerns about high costs in responding to MERVC guidelines, these guidelines are designed to be not too burdensome. Nevertheless, adequate funding and expertise are necessary for carrying out these activities.

While we have provided checklists for evaluating environmental and socioeconomic impacts, we believe that other existing guidelines are better suited for addressing these impacts (Section 8). The

[1] A similar set of guidelines has been prepared for energy-efficiency projects (Vine and Sathaye 1999).

checklists are included to remind project developers and evaluators about the importance of these impacts and the need to examine them during the evaluation of forestry projects.

We assume that the monitoring, evaluation and reporting activities will be undertaken by project implementors, but that verification and certification will be conducted by an outside third party experienced in verification (see Sections 6 and 7). We do not address which organization is the primary recipient of the information collected in MERVC activities: e.g., a national government, the FCCC Secretariat, or the CDM Executive Board. Nor do we address how this information will be used by these entities: e.g., granting full carbon credits, partial credits, or zero credits, based on the evaluation and verification reports. We expect these issues to be addressed by international bodies in the coming years.

Finally, the Kyoto Protocol contains emission targets, differentiated by country, for an aggregate of six major greenhouse gases (measured in carbon equivalents): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). LBNL's MERVC guidelines only examine issues dealing with CO_2.

1.6. Relationship to Other Programs/Documents

In a previous paper, we reviewed existing guidelines and protocols related to GHG reductions (Vine and Sathaye 1997). We concluded that while one or more of these documents addressed many of the issues that need to be covered in MERVC guidelines, none of them provided the type of detailed, standardized guidelines needed for addressing all of the issues in this report. Nevertheless, as noted below, LBNL's MERVC guidelines are indebted to the information and guidance contained in these documents.

1.6.1. World Bank's monitoring and evaluation guidelines. The World Bank prepared monitoring and evaluation guidelines for the Global Environment Facility (GEF), a multilateral funding program created to support projects that yield global environmental benefits but would not otherwise be implemented because of inadequate economic or financial returns to project investors (World Bank 1994a). The GEF supports four types of projects: biodiversity preservation, pollution reduction of international waters, GHG emission reduction and, to a limited extent, the control of ozone-depleting substances. LBNL's MERVC guidelines have incorporated several aspects of the World Bank guidelines.

1.6.2. Winrock's carbon monitoring guidelines. The Winrock International Institute for Agricultural Development published a guide to monitoring carbon sequestration in forestry and agroforestry projects (MacDicken 1998). The guide describes a system of cost-effective methods for monitoring and verifying, on a commercial basis, the accumulation of carbon in forest plantations, managed natural forests and agroforestry land uses. This system is based on accepted principles and practices of forest inventory, soil science and ecological surveys. Winrock's monitoring system assesses changes in four main carbon pools: above-ground biomass, below-ground biomass, soils, and standing litter crop. It aims to assess the net difference in each pool for project and non-project (or pre-project) areas over a specified period of time. LBNL's MERVC guidelines have extensively used Winrock's guidelines for carbon monitoring in forestry projects.

1.6.3. SGS Forestry's Carbon Offset Verification Service. SGS Forestry's Carbon Offset Verification Service is the first international third-party verification service of forestry-based carbon offset projects (EcoSecurities 1998). The service consists of a formal analysis of project concept and design, and an independent quantification and verification of projected and achieved savings in carbon stock derived from the project. SGS Forestry's methodology covers the following components: (1) suitability assessment of project design, to determine whether the project fulfills SGS Forestry's carbon offset project eligibility criteria; (2) assessment of the project's scientific methodology, focusing on data quality and statistical analysis; (3) verification of projections of net carbon flows derived from the project by quantifying carbon flows of with- and without-project (baseline) scenarios, using SGS Forestry's Carbon Quantification Model; and (4) a surveillance program for assessment of project development and verification of achieved offsets. The SGS service is designed to provide a greater confidence for carbon offset projects, regulation and transactions, by being an impartial third-party with a uniform evaluation methodology. LBNL's MERVC guidelines have extensively used SGS Forestry's guidelines for carbon monitoring in forestry projects.

1.6.4. USIJI's Project Proposal Guidelines. The U.S. Initiative on Joint Implementation (USIJI) prepared project proposal guidelines for organizations seeking funding from investors to reduce GHG emissions (USIJI 1996). The guidelines request information on the proposed project, including the identification of all GHG sources and sinks included in the emissions baseline as well as those affected by the proposed project, and net impacts. The guidelines also ask for additional information, such as the estimates of GHG emissions and sequestration, including methodologies, type of data used, calculations, assumptions, references and key uncertainties affecting the emissions estimates. The estimates include the baseline estimate of emissions or sequestration of GHG without measures and the estimate of emissions or sequestration of GHG with measures. LBNL's MERVC guidelines have incorporated many aspects of the USIJI's guidelines.

1.6.5. DOE's Voluntary Reporting of Greenhouse Gases. The U.S. Department of Energy (DOE) prepared guidelines and forms for the voluntary reporting of greenhouse gases (USDOE 1994a and 1994b). The guidelines and forms can be used by corporations, government agencies, households and voluntary organizations to report to the DOE's Energy Information Administration on actions taken that have reduced or avoided emissions of greenhouse gases. The documents offer guidance on recording historic and current GHG emissions, emissions reductions, and carbon sequestration. The supporting documents (USDOE 1994b) contain limited examples of project analysis for the following sectors: electricity supply, residential and commercial buildings, industrial, transportation, forestry, and agriculture. Companies are allowed discretion in determining the basis from which their emissions reductions are estimated and can self-certify that their claims are accurate. LBNL's MERVC guidelines have incorporated aspects of DOE's guidelines.

1.6.6. Face Foundation. The Face Foundation in the Netherlands has worked on joint implementation projects in the forestry sector for many years and has used satellite imagery for evaluating these projects (Face Foundation 1997). The Face Foundation was set up by Sep (the Dutch Electricity Generating Board) to fund projects to sequester some of the carbon dioxide emitted into the atmosphere by the burning of fossil fuels when generating electricity in the Netherlands. Face stands for Forests Absorbing Carbon dioxide Emissions. Remote sensing is one of the monitoring methods used in LBNL's MERVC guidelines.

1.6.7. Forest Stewardship Council's Principles and Criteria for Forest Management. The Forest Stewardship Council (FSC) is an international body that accredits certification organizations in order to guarantee the authenticity of their claims (Forest Stewardship Council 1996). In all cases, the process of certification is initiated voluntarily by forest owners and managers who request the services of a certification organization. The FSC's "Principles and Criteria for Forest Management" apply to all tropical, temperate and boreal forests, and more detailed standards may be prepared at national and local levels. The Principles and Criteria are to be incorporated into the evaluation systems and standards of all certification organizations seeking accreditation by the FSC. LBNL's MERVC guidelines have incorporated many of the basic principles of the FSC's Principles and Criteria (including Principle #8: Monitoring and Assessment).

1.6.8. University of Edinburgh's provisional guidelines and standards. The University of Edinburgh's Institute of Ecology and Resource Management has developed provisional guidelines and standards for assessing carbon offset projects (University of Edinburgh 1998). These guidelines are based on the experience of a community forestry and carbon sequestration project in Chiapas, Mexico, and overlap with the forestry standards of the Forest Stewardship Council (see Section 1.6.7). LBNL's MERVC

guidelines reflect the basic principles of these guidelines: verifiable, viable, and socially and environmentally responsible.