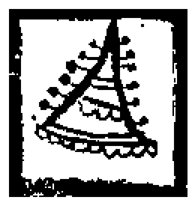
THE CLEAN DEVELOPMENT MECHANISM AND VILLAGE-BASED FOREST RESTORATION

A CASE STUDY FROM ADILABAD DISTRICT, ANDHRA PRADESH, INDIA



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Funding Provided By

DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE (DFAIT), CANADA

COMMUNITY FORESTRY INTERNATIONAL, INC.

Supporting Sustainable Management & Restoration of the World's Forests

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Community Forestry International (CFI) assists rural communities to regenerate forests by helping policy makers, development agencies, NGOs, and professional foresters develop the legal instruments, human resource capacities, and negotiation processes and methods to support resident resource managers. Community forest management contributes to livelihood security and poverty alleviation that, in turn, leads to sustainable development. CFI enables community forest management strategies to become an integral part of stabilizing forest management world-wide. CFI strategies are implemented through four interrelated thematic program areas. These include 1) Regional and National Policy Dialogues, 2) Mediation Processes and Methods for Enhancing Tenure Security, 3) Participatory Research & Field Programs, and 4) Communication. The program components are designed to engage national policy makers, professional practitioners, and communities to facilitate learning, reduce conflicts, and ultimately create management agreements that result in more equitable, sustainable forest

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EXECUTIVE SUMMARY

Global climate change trends are causing worldwide concern. For over a decade, international dialogues, held under the United Nations Framework Convention on Climate Change (UNFCCC), have sought to craft mechanisms and procedures to reduce the emissions of, and to sequester, greenhouse gases (ghg). This report presents the findings of a project organized by Community Forestry International (CFI), with support from the Government of Canada, to explore the feasibility of financing community-based forest carbon projects in central India that would fulfill the criteria of the Clean Development Mechanism (CDM) as a source of Certified Emission Reductions (CERs). The project evaluated a series of potential sites in Adilabad District, Andhra Pradesh to assess their eligibility in terms of the emerging CDM forest project parameters. In selected areas, social and ecological appraisals were carried out to assess institutional capacities for CDM project implementation, as well as to evaluate vegetation conditions and the potential for carbon sequestration under a variety of CDM scenarios. This paper also presents techniques for vegetative sampling for establishing carbon baselines, estimating carbon additionality, and creating CDM project scenarios for community-based afforestation and reforestation projects.

This research project found that Adilabad District, with its heavily forest-dependent communities and degrading forest ecosystems, would be a good candidate for CDM investments in reforestation and afforestation projects. Rural communities, especially those with homogenous tribal populations, expressed strong interests in forest restoration, yet they require financial assistance to mobilize labor for protection and management activities. Project research demonstrated that degraded teak and dry deciduous forests, even when reduced to scrub cover, will regenerate vigorously if coppice shoots and seedlings are protected and low-cost silvicultural operations are performed. The project's ecological appraisal determined that incremental soil and above-ground carbon sequestration rates for degraded teak sites were 5 to 7 metric tons of carbon per hectare per year (mtC/ha/year) and approximately 6 mtC/ha/year for mixed forests. Even at the currently low forest carbon market rates of $3 to $8 per ton, CER sales from Adilabad forests could finance community-based reforestation activities and provide an attractive financial incentive to low income households.

On October 28th, 2002, the findings of this study were presented at the VIIIth Conference of Parties to the Climate Change Agreement. A CFM project scenario for community-forest restoration in central India was included in the presentation and is available in Appendix III of this report. During a side event organized by the Centre for International Forestry Research (CIFOR) the research team stressed the need to develop CDM project guidelines based on field experience and empirical research, rather than allowing these procedures to be crafted by solely by negotiators with limited understanding of prevailing field realities.

Financing the transaction costs incurred for 3rd party monitoring, and project validation, registration, and certification remain a concern bearing on the viability of future community participation in forest carbon projects. While this project team found that many rural communities in Adilabad are motivated to reforest degraded areas, and that the district's degraded forest ecosystems have the potential to sequester substantial quantities of carbon, the immense physical and cultural distance between rural Adilabad and the world of international agreements and carbon trading impose severe limitations on prospects that projects linking these two worlds can be created. Unless the designers of CDM project frameworks make them more accessible to the rural poor, it is likely that Adilabad's rural communities, as well as countless others in the developing world, will be denied participation.

-Mark Poffenberger

ACKNOWLEDGEMENTS

In 1999, Community Forestry International (CFI) initiated a new research program to explore creative approaches to financing community forest management. The program began in central India in an effort to work with indigenous tribes and other forest-dependent peoples engaged in regenerating degraded forest ecosystems in their locale. Much of the findings generated by this project flowed from the information provided by the communities themselves. We are especially grateful to the communities in Kerimeri and Indaram forest beats, as well as to the people of Behroonguda village in Jannaram forest division of Adilabad district, for assisting the research team and generously giving their time to help us better understand their views on forest restoration.

Special thanks are also due to the Andhra Pradesh Forest Department including S.K.Das, S.D. Mukherjee, K. Suba Rao, Ramesh Kalaghatgi, and Babu Rao. We are also grateful to the Integrated Development Agency (ITDA), especially Navin Mittal and B. Nagnath. In New Delhi, we benefited from the advice of Dr. V.K. Bahuguna, Deputy Director General of the Indian Forest Service and Dr. T.P. Singh of the Tata Energy Research Institute. Thanks also to Mr. Rajan Khawaja, Chairman and Managing Director of Singareni Colleries, Ltd. for the support he gave to the study in Indaram Beat.

The project would not have been possible without the financial assistance of the Climate Change Division of the Department of Foreign Affairs and International Trade (DFAIT) of the Government of Canada. We have appreciated the support of David Drake, Sushma Gera, Tara Preston, and Pamela O'Donnell.

This project is deeply indebted to a committed field research team that conducted the ecological and social appraisal components in through Adilabad's hot summer months of May and June. Dr. N.H. Ravindranath and Indu K. Murthy of the Centre for Ecological Sciences, Bangalore were responsible for overall design of the ecological appraisal components of the study. The CES team working with community members collected the field data in 14 locations and conducted the soil and vegetation analyses. The socio-economic fieldwork and analysis was completed by Dr. Urmila Pingle, whose commitment to capturing community experiences and aspirations was demonstrated by her hard work. In Santa Barbara, Alex Tuttle, a graduate student at the Donald Bren School of Environmental Science & Management, University of California at Santa Barbara, researched climate change documents to prepare a summary of the steps to project development. We are grateful to Dr. Kathryn Smith-Hanssen for her excellent editorial and layout support, and Kevin Kolb for his fine cartography.

-Mark Poffenberger and Emmanuel D'Silva

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Introduction

Worldwide anxiety over global warming trends, increasingly indicated by an expanding body of scientific research, has triggered the international climate change dialogue that led to the Kyoto Protocol. Since the approval of that international agreement in 1990, formal discussions have been conducted through the United Nations Framework Convention on Climate Change (UNFCCC) to formulate and formalize a Clean Development Mechanism (CDM) to address the underlying causes of global warming. Sequestering carbon, a major greenhouse gas stored in oceans, soils, and forests, is one mitigation strategy that could be financed through the CDM.

This report describes the findings of a research project in central India that attempted to assess the feasibility of financing community-based forest restoration through the CDM. Part I describes some of the steps involved in bringing a CDM project from concept and need, to implementation and financing, as well as emerging issues regarding the definitions of eligible CDM forestry projects. Part II and Part III describe selected social environments in Adilabad District, Andhra Pradesh, where CDM could be implemented, as well as some of the human and institutional capacities and constraints future CDM projects could face. Part IV reports on the project's vegetation studies, examining current carbon stocks and a series of CDM scenarios for Adilabad's forests.

Over the past decade, some 68,000 Indian villages have mobilized their own meager resources and dedicated labor to protect degrading forest ecosystems in order to ensure their own environmental needs and those of future generations. The national and state governments have recently passed participatory forest policies to extend new rights and responsibilities to forest-dependent peoples to support their efforts to restore their environment. Bilateral and donor agencies have also invested over $500 million in support of community forest restoration. It is hoped that the CDM might provide a long-term source of financing to support the engagement of rural Indian communities in forest restoration activities.

While government and external funding have facilitated the expansion of community forestry in India, the scale of the task is daunting. Funding from government and donor-sponsored projects cover only a small proportion of the growing number of communities involved in resources stewardship. Thousands of hamlets have initiated forest protection, motivated by environmental and economic concerns, frequently without outside financial incentives. These communities are among the poorest in the world and could benefit from technical and capital support in sustaining and developing these resources. In the medium and long term, rural India will need to establish more sustainable financing systems for managing its natural resources. One promising option is the development of systems for environmental services payments, including funds paid to community management groups for water, bio-diesel production, biodiversity conservation, carbon sequestration, and others. This study focuses on potential opportunities to finance community forestry based upon emerging international agreements and mechanisms to facilitate trading in carbon offset payments.

A fundamental question the research team sought to address was, "Is it realistic to presume that Indian villagers will be able to work through the CDM to secure carbon-offset payments under the conditions and terms currently being formulated by the Conference of Parties to the UNFCCC?" In order to answer that question, the research team set themselves a series of tasks:

- Design procedures for developing forest carbon projects according to CDM guidelines
- Identify the steps required to prepare a CDM project as currently indicated by the Conference of Parties (COP) through the 7^{th} meeting
- Develop and test methodologies for social, institutional, and vegetation appraisals required for project development
- Assess the transaction costs incurred during the project development process
- Evaluate project contexts in terms of compatibility between field situations and CDM criteria

CDM Criteria of Eligibility for Forest Carbon Projects

In assessing the feasibility of identifying and developing CDM forest carbon projects in rural India the team analyzed current COP documents and accords to better understand the proposed criteria for inclusion or qualification for projects. While some criteria are still under development, recent meetings by the Conference of Parties (COP/MOP) of the United Nations Framework Convention on Climate Change (UNFCCC) have further clarified the types of land use, land-use change, and forestry (LULUCF) projects that are eligible under Article 12 of the Kyoto Protocol (Clean Development Mechanism (CDM). This section attempts to provide guidance regarding the types of forest projects that can be developed given the recent decisions by COP 7. Eligibility definitions are presented below.

- Afforestation: the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.
- Reforestation: the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989. The direct human-induced conversion of non-forested land to forested land through planting of natural seed sources, on land that was forested but that has been converted to non-forested land. For the

first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

- Forest: a minimum area of land of 0.05-1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10-30 percent with trees with the potential to reach a minimum height of 2-5 meters at maturity *in sit*u. A forest may consist either of closed forest formations which have yet to reach a crown density of 10-30 percent or tree height of 2-5 meters are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forests.

The Marrakech Accords, the latest COP document, states that forest-related projects under the CDM will be limited to afforestation and reforestation. There are several words within the definitions of "forests," "afforestation," and "reforestation" that are unclear in their meaning and potentially limiting future project sites. It is likely that many of the proposed projects will entail the reforestation of degraded forest land, therefore it must be clear that these potential projects would be eligible under the present definitions. Under the definition of forests it is stated that, "young natural stands and all plantations which have yet to reach a crown density of 10-30 percent or tree height of 2-5 meters" are considered forests. This could be problematic unless "young natural stands" are strictly defined. By defining forests to include "areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest," much ambiguity is added to the meaning of a forest. The key appears to be in the word "expected," since many areas falling under this category would face continued degradation unless a reforestation program were put in place. At the very least, an effective system of forest area "closure" would be needed to halt further loss of biomass and carbon storage, although closure alone would not justify inclusion into the CDM program under the current definitions.

Another issue relates to the definition of "reforestation." The Marrakech Accords state that reforestation has to occur "on land that was forested but that has been converted to non-forested land." Does conversion imply an intentional transfer of forestland to agriculture, for example, or does conversion also encompass general degradation of a forested area to a denuded landscape void of the characteristics of a forest as described above? These are questions that will hopefully be clarified in future COP meetings as the CDM becomes further operationalized. Given the limited scope of these terms and definitions, communities already engaged in forest protection and regeneration will likely be excluded from CDM-sourced support, as will degrading forests with more than 10 to 30 percent canopy closure. Young secondary forests with less than 10 percent canopy closure might also be excluded if they are expected to regenerate naturally.

The permanence of these definitions is under question as well. As of the COP 7 meeting in Marrakech, these were the latest definitions for forest, afforestation, and reforestation. However, the Marrakech Accords stated that the definitions applied to Article 3, paragraphs 3 and 4. The document did not expressly state whether the same definitions applied when the terms forests, afforestation, and reforestation were referenced while discussing Article 12 and the CDM. What is known is that the COP 7 requested the Subsidiary Body for Scientific and Technological Advice (SBSTA) to "develop definitions and modalities for including afforestation and reforestation project activities under Article 12 in the first commitment period, taking into account the issues of non-permanence, additionality, leakage, uncertainties and socio-economic and environmental impacts, including impacts on biodiversity and natural ecosystems." [1] The research team is concerned that emerging eligibility restrictions have significantly limited the contexts and parameters under which an Indian CDM forest project can be certified. As they are currently being defined, many of the conditions of eligibility being articulated through the COP will exclude a large proportion of India's forests where community forest restoration is already underway or could be carried-out in the future.

Establishing Carbon Baselines

In order to prove that a project is achieving reductions in atmospheric carbon levels additional to what would otherwise occur if no project were implemented, a baseline must be established. As defined at COP 7, the baseline for a CDM project is "the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity." [2] Clearly this definition applies to technology-based projects rather than forest-related projects. In the case of forests, a baseline would be a reference scenario against which a change in greenhouse gas removal by sinks is measured.

Rather than applying the definition specifically to forest-related projects, the COP 7 meeting instead invited the Intergovernmental Panel on Climate Change (IPCC) to "elaborate methods to estimate, measure, monitor, and report changes in carbon stocks and anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from land use, land-use change and forestry activities under Article 3, paragraphs 3 and 4, and Articles 6 and 12 of the Kyoto Protocol." [3] The executive board at COP 7 was charged with, *inter alia*, approving new methodologies related to baselines and monitoring plans, but it was not emphasized when this will or should occur. Approaches for measuring baselines were outlined in the COP 7 document, but only as they applied to technology-based CDM projects.

[1] Marrakesh Accords, pg. 70
[2] Ibid, pg. 83

One option for establishing a baseline, as mentioned in the IPCC report on LULUCF (2001), is to establish control plots within the project area that continue the current management regime or are not subject to active human management. This would satisfy the requirement of "direct human-induced conversion" set forth in the definitions of afforestation and reforestation. Simply measuring carbon levels before the project began and at different intervals during the project's lifetime may not satisfy that requirement, given the fact that some of the changes seen in the project area may not be specifically attributable to direct human intervention. As of the date in which the IPCC report was written, no standard method for determining baseline and additionality existed. [4]

Steps for Developing Community-based Forest Carbon Projects

As part of its effort to evaluate the feasibility of developing a community forest carbon project eligible for financing through the CDM, the research team attempted to isolate discrete steps or activities that would be required under emerging guidelines. The project identified a sequence of ten actions that would be involved in developing a project proposal are described in Figure 1. This project focused on exploring approaches to implement Steps 3, 4, and 5.

Step 1: Ratify Kyoto Protocol

In order for any private or public entity to develop a project for inclusion in the Clean Development Mechanism (CDM) under the Kyoto Protocol, the country involved must be a recognized Party to the Kyoto Protocol. In other words, the country must have signed and ratified (or approved, accepted, or acceded to) the treaty. Once this is done, the country must have designated what is called a "National Authority" for the CDM program to oversee all projects within the country. The project team has been monitoring the national approval process to determine if India would become a party to the protocol and be an acceptable site for CDM project financing.

Step 2: Meet Project Requirements of the CDM

For the first commitment period (2008 through 2012) the only types of land use projects that are eligible for inclusion in the CDM are afforestation and reforestation. Currently there are no explicit definitions for afforestation and reforestation found in Article 12 of the treaty. However, the treaty does include definitions for those two activities, as well as a definition of a "forest", in Article 3.[5]

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[3] Ibid, pg. 119
[4] IPCC, Pg. 304
[5] Please refer to the working paper, "Guidelines and Procedures for Developing Forest Carbon Projects under the Clean Development Mechanism" for a discussion of the questions and problems that arise from the language used in these definitions.

While formal definitions for these activities as they relate to the CDM are not anticipated until COP 9, it is likely that they will be similar to those that exist for these activities and land uses in Article 3.

Following these emerging definitions for eligibility, the project team made several preliminary visits to Adilabad District to seek sites that might fit the preliminary criteria for afforestation and reforestation. The team found that while much of the degrading forest land in the district fell outside the eligibility definitions outlined above, acceptable patches of deforested land areas were identified, though smaller in size and more fragmented than the team had anticipated.

Step 3: Evaluate Project Sites

After determining what the technical requirements are for an eligible CDM forestry project, the next step is to investigate potential sites for a proposed project and decide whether or not those sites meet the CDM requirements. Methods for doing this vary. Historical aerial photos or remote sensing data can be used to determine the forest history of a parcel of land to evaluate whether or not it would be eligible for afforestation or reforestation. If these resources are unavailable, project designers will likely have to rely on past studies, reports, and personal accounts to determine whether or not the site is a "forest" under the emerging Kyoto definition. The research team drew on oral histories and Andhra Forest Department records to evaluate forest cover status prior to January 1, 1990. Field level forestry staff and villagers could easily recollect forest cover twelve years earlier, and this reporting was substantiated by forest department documents kept at the Range and Divisional level.

Step 4: Assess Sequestration Rates

Some projects will have a greater potential for sequestering carbon than others. It is appropriate to conduct a preliminary assessment of the sequestration rates of the types of trees in question to determine what amount of carbon credits could potentially be accrued. Methods for assessing the sequestration potential of the vegetation that will be propagated vary. The experiences of the Adilabad project are reported in Part IV.

Step 5: Determine Level of Social Support

One of the requirements for CDM projects is to contribute to the sustainable development of the host country. In India, rural communities will manage many CDM forest carbon projects. Their buy-in and support of the proposed project is critical for project success. There are a variety of methods for evaluating the level of social support for the project within affected communities. The team evaluated project site suitability in terms of community interest and capacity to organize a protection and forest restoration project. Methods used included in-depth interviews with community leaders, community discussion groups, and assessments by local development works. This is reported in Part III.

Step 6: Draft Project Proposal

Information gleaned from steps 3 through 5 will help determine where to proceed with a project. Once an eligible sites and interested participating communities have been located, a project proposal can be drafted. This can later be used as a basis for attracting partners or institutional support. In the Adilabad case, suitable degraded forest sites were found in Indaram beat, Mancherial Division for reforestation activities. In Kerimeri Beat in Azifabad Division, some small, fragmented plots of forest land converted to agriculture over 50 years were identified for possible afforestation projects. Local coal mining companies have expressed interest in collaborating with projects, as have some international funding sources. International NGOs have expressed interests in purchasing carbon-offset credits, in part due to the community capacity building orientation of the proposed project. CDM projects are currently under development for the area.

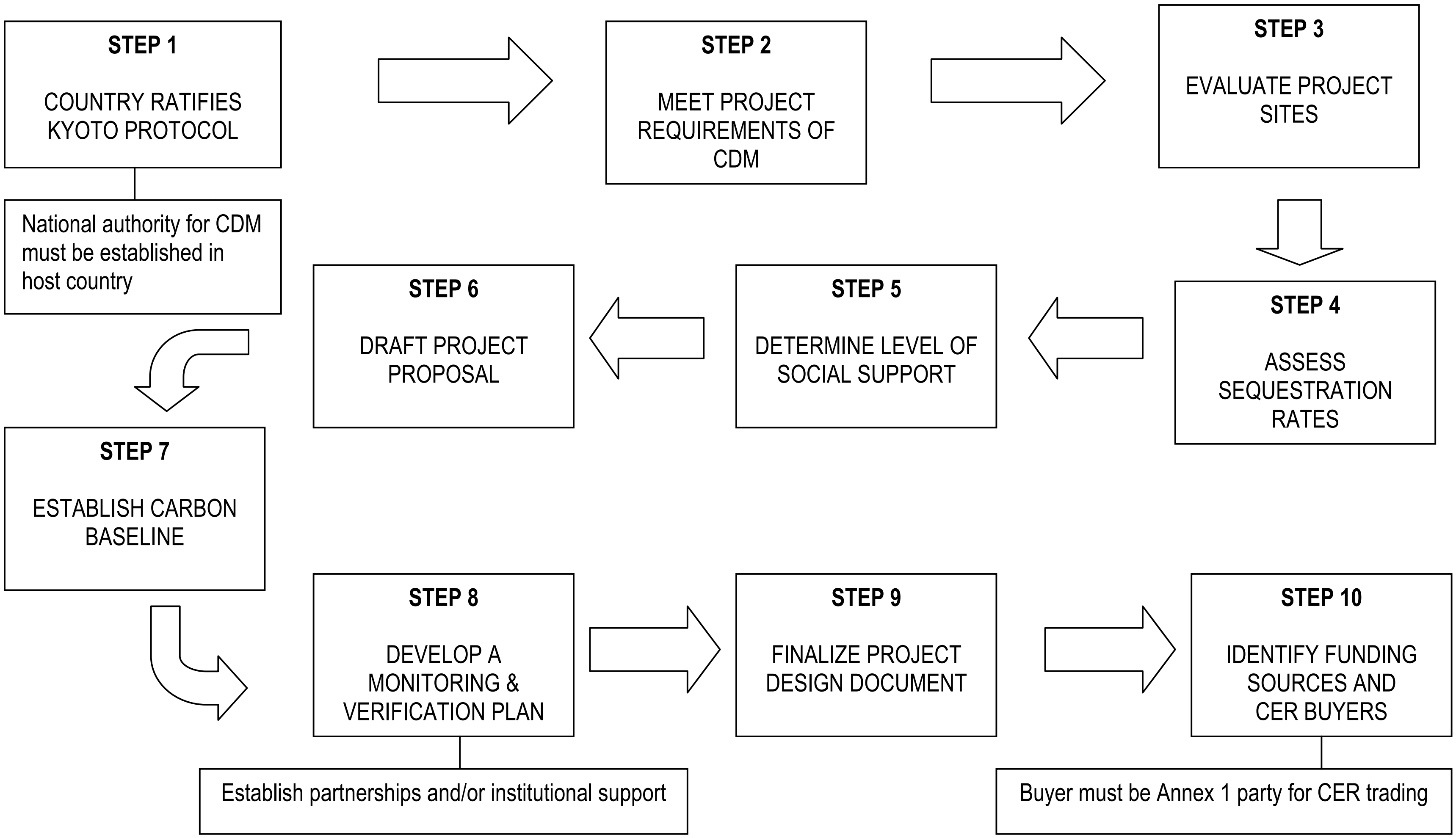
Step 7: Establish Carbon Baseline

One of the biggest challenges facing a proposed project is determining the baseline against which future carbon sequestration will be measured. Acceptable methodologies for establishing baselines in forestry projects have yet to be formalized by the treaty negotiations. The baselines are expected to be formalized by COP 9. Several options exist for establishing a baseline to demonstrate additionality. The project research team utilized a methodology that relied on establishing a baseline and then creating a series of CDM scenarios from which sequestration rate estimates could be developed. These methods and the team findings are presented in Part IV.

Step 8: Develop a Monitoring and Verification Plan

A monitoring plan must also be established before a project can be submitted for CDM registration. For most projects, the community surrounding the project site could oversee the monitoring program. Such a monitoring program should include a framework for third-party verification. Before CERs can be certified, a designated Operational Entity (the third party) must verify that the reported activities and carbon removals are actually taking place. Again, several methods exist for monitoring sequestration over time. The Adilabad project team would train community participants in routine vegetation sampling techniques and secure a local research institution or university to conduct third party verification

FIGURE 1: TEN STEPS TO DEVELOPING A CDM PROJECT



Step 9: Finalize Project Design Document

Once all of this has been completed, the information needs to be combined and the official Project Design Document[6] needs to be completed. The format for the design document is still in a draft form and should be finalized at the next meeting of the CDM Executive Board.

Step 10: Identify Funding Sources and CER Buyers

It is not clear at what point in the process that the project applicant needs to bring in a buyer for the Certified Emission Reductions (CERs). This seems to be a logical point at which a potential buyer would be confident enough with the project to commit to buying the CERs, assuming that CERs get issued by the CDM Executive Board. What is known is that the buyer must be eligible as an Annex 1 Party under the treaty and the Annex 1 country can only use CERs to supplement domestic emission reduction activities. Currently, no more than 5 percent of an Annex 1 country's emission reduction target can be achieved through the purchase of carbon credits.

Validation and Registration of CDM Project Activity

Once the Project Design Document is completed, it can be sent to a Designated Operational Entity (OE) for validation before a request for registration would be considered by the Executive Board of the CDM (see Figures 2). Registered CDM projects would then be subject to ongoing monitoring with periodic verification. These activities could result in certification and the issuance of Certified Emission Reduction Units (CERs) and the transfer of outset payments to the seller (see Figure 3). The steps identified are still under development by the COP. The prospects for rural Indian community groups processing their forest regeneration projects through this maze of approvals seems distant at best. Evaluating the feasibility of potential project approval, including the process illustrated in Figures 2 and 3, is beyond the scope of this study.

Summary

Part I provided readers with an understanding of the sequence of activities a proposed community-based CDM forest carbon project may be required to develop (see Figure 1). The research team attempted to follow these guidelines in developing methodologies for implementing Steps 3 through 5 in Adilabad District. These methods were later field tested in sample communities in the area. Part II will provide a discussion of the social, institutional, and environmental context in Adilabad District and study communities. Part III summarizes information that was collected during the field trials, assessing both the nature and effectiveness of the methods, as well as the suitability of the study villages for participation in future CDM projects. Part IV reviews the forest contexts in which CDM project sites were sought, and describes the vegetation sampling framework, baseline and CDM scenarios that emerged from the ecological appraisal. Part V summarizes the findings from the study. And presents some recommendations for CDM strategies.

[6] Please refer to the working paper entitled "Guidelines and Procedures for Developing Forest Carbon Projects under the Clean Development Mechanism" for a list of the information that needs to be included in the Project Design Document as it stands today.

FIGURE 2: VALIDATION & REGISTRATION OF A CDM PROJECT

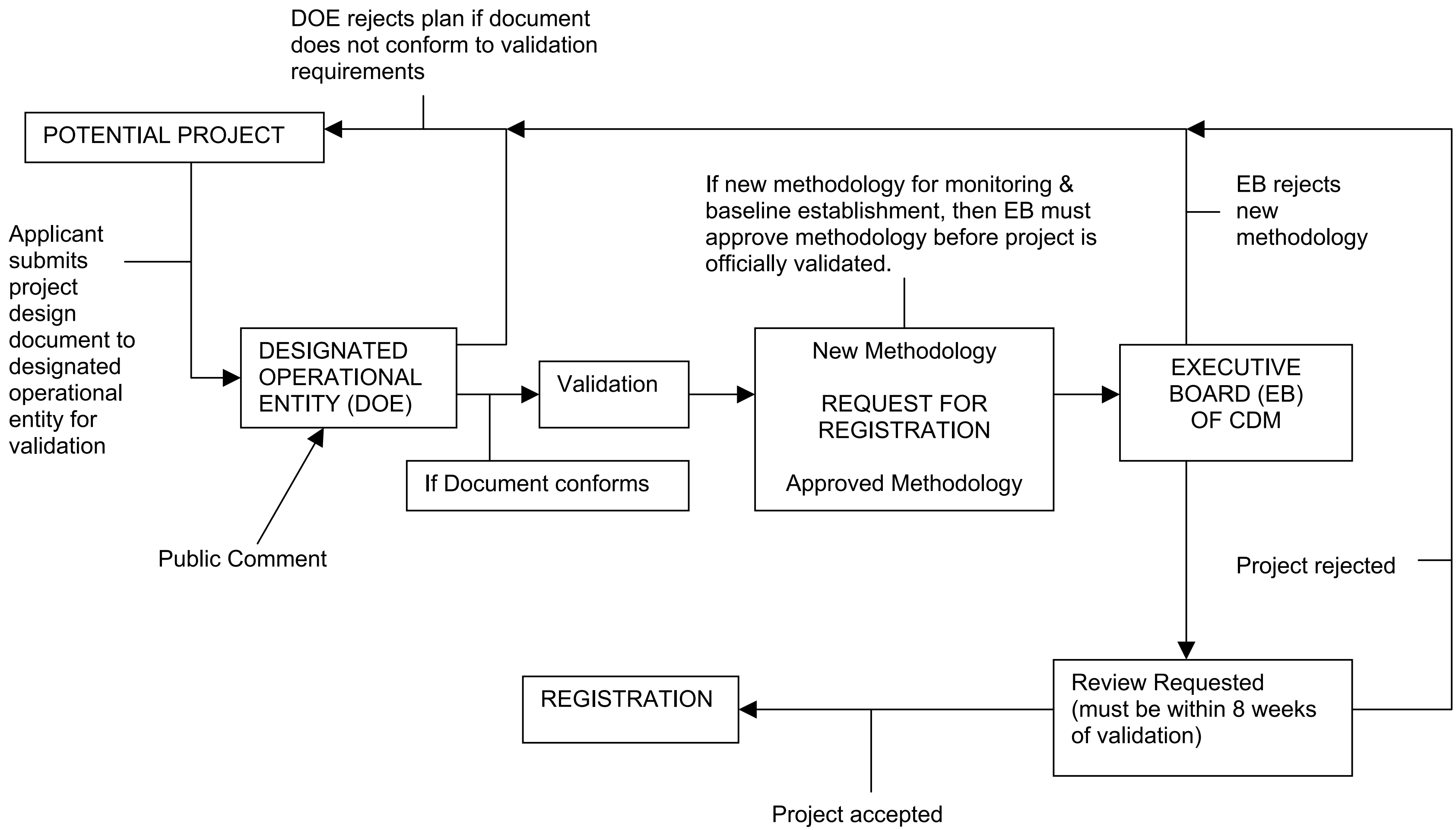
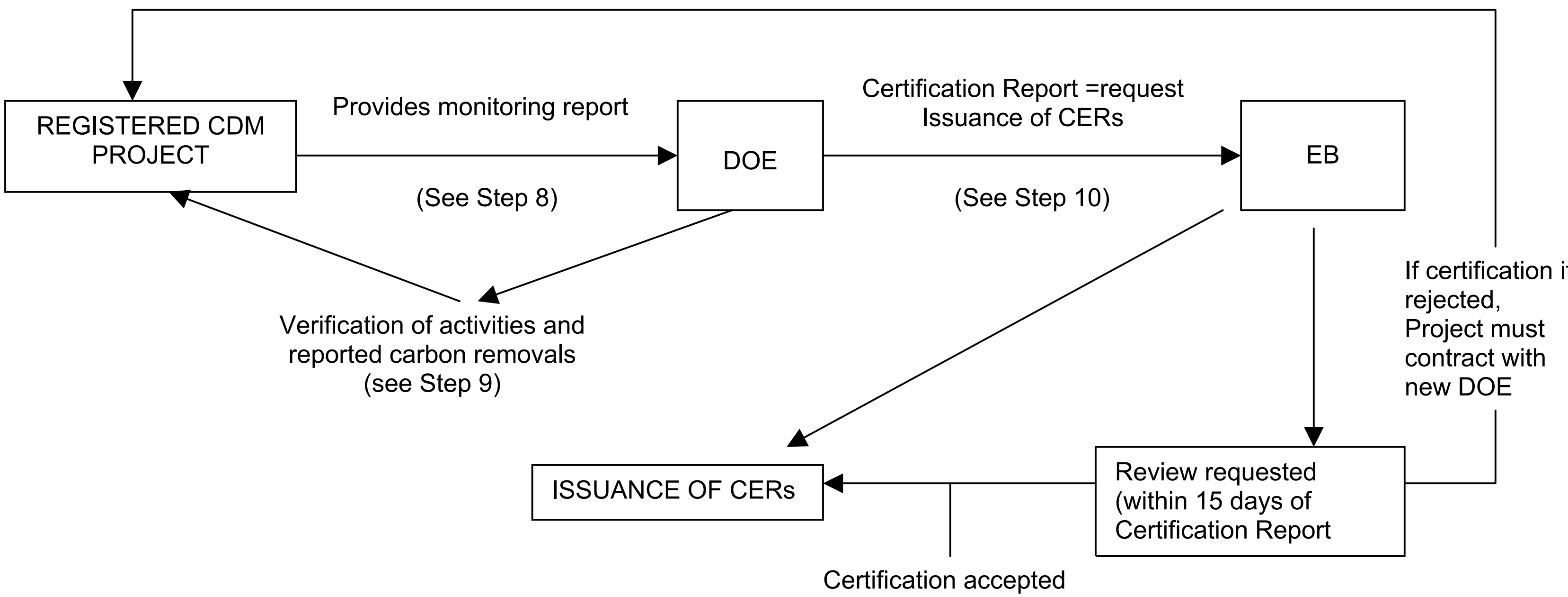


FIGURE 3: VERIFICATION, CERTIFICATION & ISSUANCE OF CERs



PART II: RURAL INDIAN CONTEXTS FOR FOREST CARBON PROJECTS

Andhra Pradesh (AP) is the fifth largest state in India with a population of 73.3 million in 1997. It is a major link between north and south India. The state has 23 districts, 26,586 villages, and 264 towns. Hyderabad is the state capital. Though rich in natural resources, AP is poor in human resource development. In 1991, the literacy rate was 35.7 percent, below the national average of 52.2 percent. [7] In recent years, however, the state government has focused its energies on improving human resources and building the capacity of local institutions thereby recognizing their linkages to poverty. The government's vision statement sets the year 2020 as a target for the "total elimination of poverty" from the state using twin strategies: 1) participation of local people in government programs and 2) empowerment of women. The government regularly mobilizes millions of rural poor to take part in public schemes such as planting of trees and cleaning of village commons. Reflecting the growing populist orientation, over the past decade, the AP government has begun to move away from more conventional, top-down, bureaucratic models for project implementation positioning itself as a *facilitator* of development rather than as *implementer* of development.

The District of Adilabad

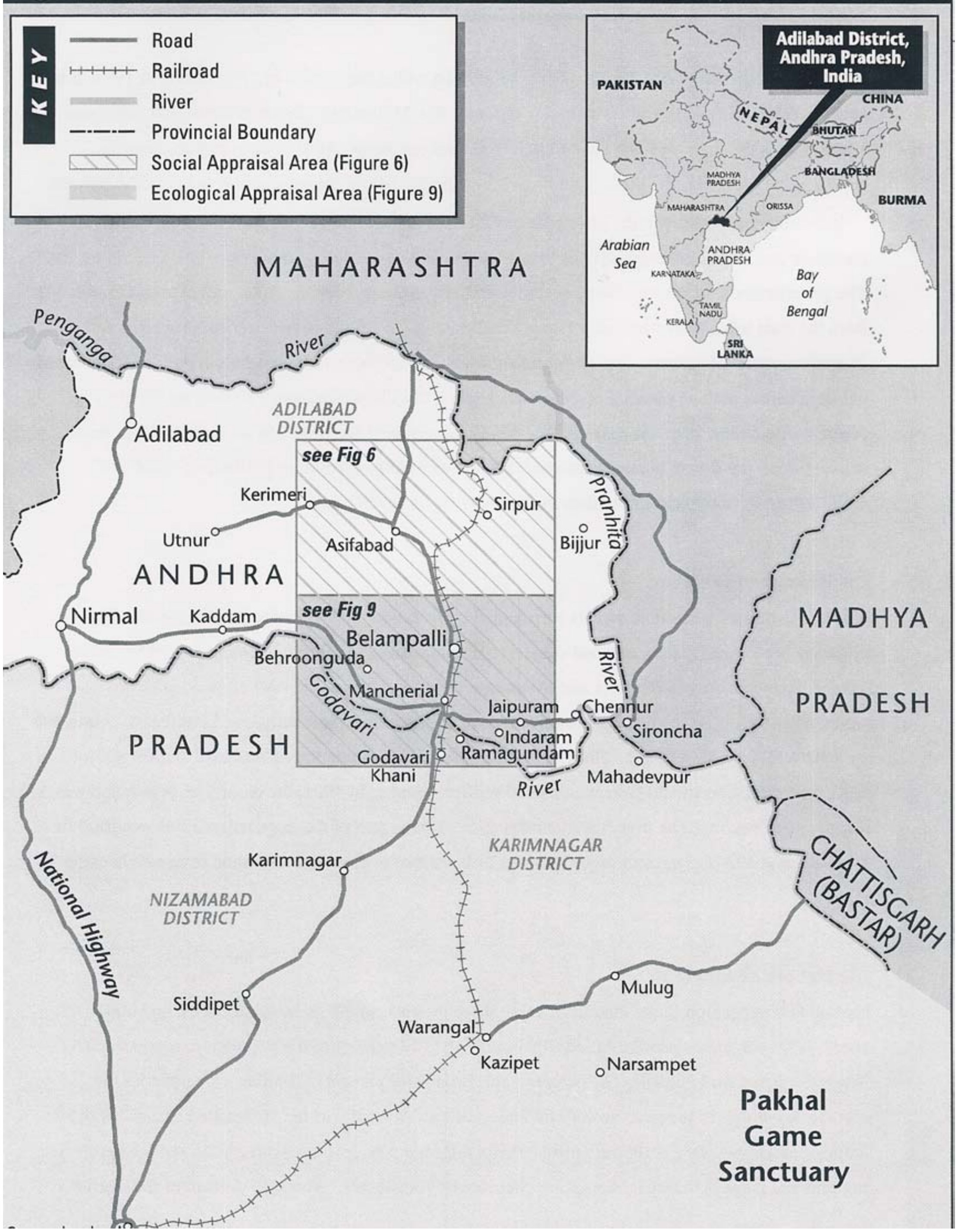
Adilabad is the northern-most district surrounded by rivers on its three sides (see Figure 4). The climate is hot and the area is arid and subject to frequent drought. Rainfall averages 1,100 mms. Despite having a network of rivers and tributaries, only 9 percent of the total cropped area was irrigated in 1991. The main crops grown are *jowar* millet, or *sorghum vulgare* (32 percent), cotton (27 percent), and rice (12 percent). The 1991 census placed the population of Adilabad at 2.08 million. In 2000, the population should have reached 2.5 million people. In 1901, the density of population was 28 per square km; in 2000, it was estimated at 155. A large part of the population influx occurred in the 1940s and 1970s as a result of government policies that encouraged migration from neighboring districts.

The People of Adilabad

The social composition of the district includes three groups: tribals, scheduled castes, and upper castes. The indigenous people, called tribals, comprise 17 percent of the population, represented by Gonds (52 percent), Lambadas (22 percent), and Kolams (8 percent). Another 18 percent of the population belongs to the poor, lower Hindu castes, known legally as the "scheduled castes." Tribals, landless, and low-caste families are most heavily dependent on forest resources, and tend to reside in more remote hamlets that neighbor or are enclosed by forestlands. About 65 percent of the district's

[7] UNDP, 1999

Figure 4 ADILABAD DISTRICT, ANDHRA PRADESH



population comprises higher-castes, such as Telugus and Marathas. Illegal timber extraction and smuggling of wood has been a serious problem in Adilabad District. Organized gangs are frequently involved in collusion with some forest officials, politicians, and local citizens. No official figures are available to indicate the extent of the problem, but one timber trader has estimated that 75 percent of the timber-sized teak trees have disappeared from the forest in recent decades. In 1990, the volume of teak was estimated at 9 million cubic meters.

- Lopping of trees for fuel or fodder and headloading of firewood constitute additional pressures on forests. A 1974 study by the Government of India estimated fuel wood consumption in the district at 1,594 kgs per household. Annual district-wide firewood consumption is estimated at 575,000 tons, a big burden on the fragile ecosystem.

- Compounding these resource-driven issues is the serious problem of corruption in the forest department. Embezzlement of public funds, fraud, and shortchanging local communities are not uncommon. The extent of corruption in the forest department has not been studied, but some development practitioners estimate that at least 30 percent of the funds allocated for poverty alleviation—including forestry—wind up in the pockets of officials, politicians, private contractors, and others.

- The problem of political extremism has also affected resource management. Groups of political radicals—known commonly as Naxalites or the People's War Group—have disrupted forest management activities in some areas. These groups owe their allegiance to the political philosophy of Marx, Lenin, and Che Guevara, and have tried to convince local communities not to participate in joint forest management.

These factors present serious challenges to the development of CDM project in rural Adilabad. Some of these factors are not uncommon in India and other developing countries. Such problems could be minimized, if not overcome, by involving local communities in the CDM process, giving them a say in the management of forests, as well as ownership of the carbon sequestered as a result of their efforts. Local institutions that could help in this process are described below.

The Forests of Adilabad

Adilabad's forests cover 42 percent of the district's land area including over 700,000 hectares of mixed teak forests, with timber valued at $2 billion. Adilabad has immense potential for rural afforestation and reforestation projects with more than 1,000 community-based forest protection committees who are protecting 300,000 hectares of degraded forests. The indigenous population is concerned about forest loss and, therefore, has been participating in joint forest management (JFM)—a partnership between the forest department and local communities. JFM has been fairly successful in rejuvenating the once degraded forests. Satellite imagery indicates an improvement in the forest cover at a rate of 1-2 percent per year in Adilabad brought about, in large part, because of community protection. There is concern in the country and in the district, however, that once external support for forest management ceases, the regeneration process might be seriously affected. For this reason, it is important to identify alternative sources of funding community efforts in forest protection, watershed protection, and other natural resource management. Carbon funds are seen as one of the alternative funding sources.

Pressure on Forests

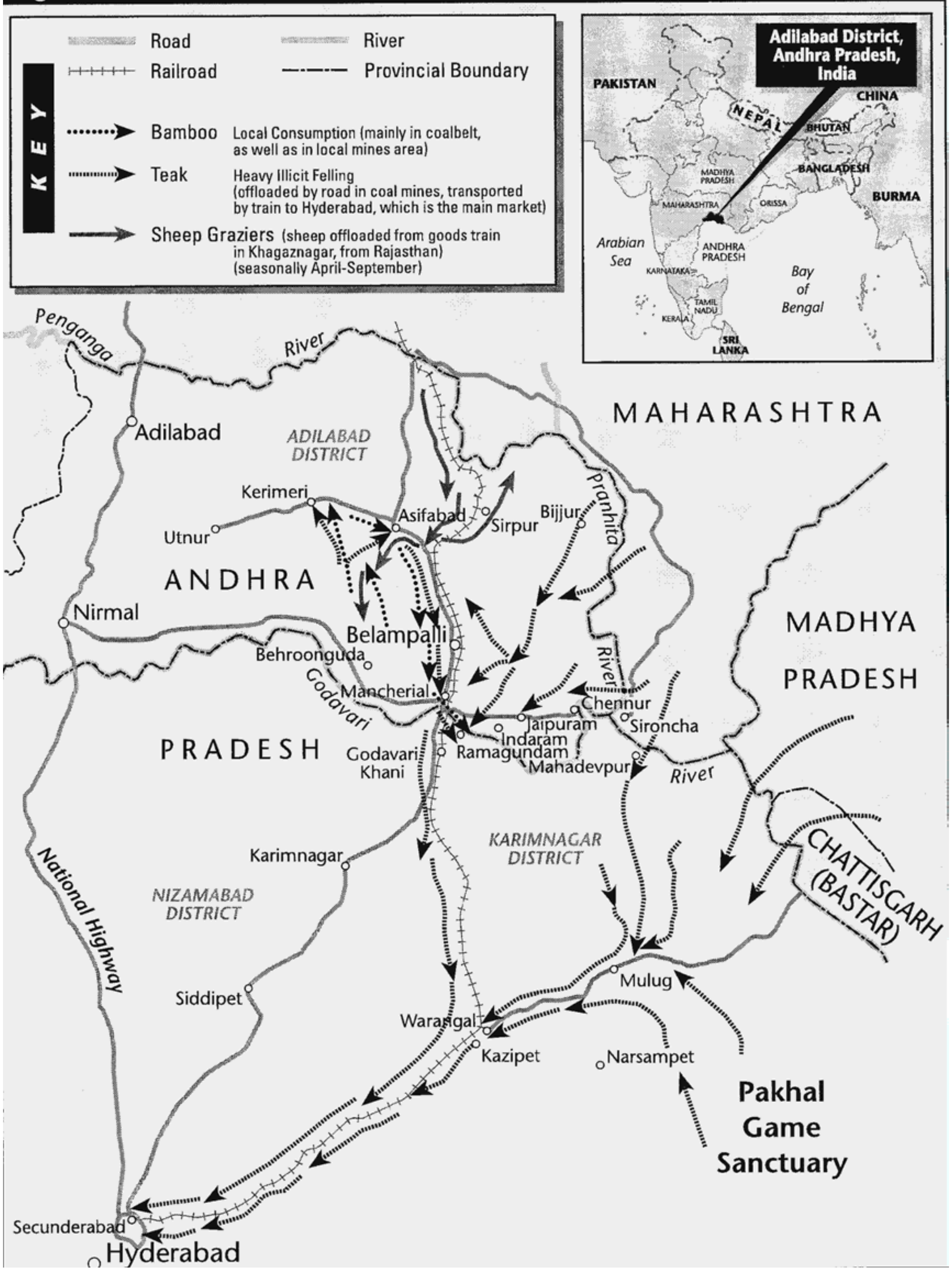
The potential for afforestation and carbon sequestration notwithstanding, the forests of Adilabad face enormous pressures:

- The greatest pressure comes from a large and growing human and cattle population. The human population of 2.5 million grew 550 percent in the last century. The livestock population comprised half of the human population. Together, man and beast have put tremendous pressure on the carrying capacity of the land and severely depleted the district's once extensive and dense forests.
- Uncontrolled grazing of cattle inside forests has also contributed to the ecological damage. Figure 5 illustrates the cattle-grazing route in the Kerimeri area and its impact on forest ecology. (Note the movement of cattle from more degraded to less degraded forest area in search of fodder.)
- Illegal occupation of forestlands (called "encroachment") and conversion of these lands for agriculture (known locally as *podu* culativation) have also been contributory factors. Government figures indicate that some 90,000 hectares of forestlands have been encroached in the past two decades; but these figures are likely to be on the low side. The forest department has made some effort to bring back the *podu* area back to forestry, but it has not met with much success.

The Institutions in Adilabad

In recent years, there has been a growth in the number of informal groups operating at the hamlet level—such as water users' association, watershed committees, education committees, forest protection committees, and credit-based self-help groups (thrift groups). Men control most of the resource-based groups, but women have more say in running the thrift groups. The state government of Andhra Pradesh refers to all user groups including waterusers, forest protection committees

Figure 5 TIMBER FLOWS FROM ADILABAD DISTRICT, ANDHRA PRADESH



(VSS),and VTDA's as "self-help groups," however, in this paper we will use the term "self-help groups" to refer specifically to women's thrift groups or micro-credit associations. The activities of these groups are often not well coordinated and their relationship with the local government (panchayat) is still not clear. The state government has been encouraging the growth of these groups as a means to disperse political power and authority. Some critics view the proliferation of the informal groups as undercutting the power and authority of local governments.

- **VSS** (Vana Samarakshana Samiti)

Of the nearly 1,700 villages in the district, 1,008 have formed forest protection committees (VSS) and participate in joint forest management. Nearly half of the forest area in Adilabad is covered by the VSS, but this coverage is uneven. While some VSS have done a fairly good job in forest protection, many others have not done so for a host of reasons ranging from a lack of local leadership to inadequate support from local forest officials. Men dominate the VSS. Women head barely 5 percent of the VSS, though by law at least a third of the executive of the VSS comprise women.

- **Self-help Groups**

Women's self-help groups are modeled along the lines of Grameen Bank's credit groups in Bangladesh.[8] In Adilabad, some 13,000 SHGs from 1,700 villages have been formed. Usually, 10 to 12 women constitute a self-help group. SHGs in the Adilabad District currently involve 150,000 women who have been able to save Rs 200 million ($ 4.16 million).[9] A large number of these groups were formed under the auspices of various government programs, including joint forest management. While most groups function to mobilize household savings, a few have attempted to deliver services previously rendered by government agencies (eg, forest nurseries, building check-dams, generating electricity, etc.). The SHGs are widely viewed as being better managers of money, more transparent, and accountable than most VSS and other community groups.

- **Panchayats**

The three-tier form of local government is called *Panchayat Raj*. Unlike the informal user groups, *panchayats* are democratically elected and have a legal basis under India's Constitution. Under the 73rd Constitutional amendment, most rural development activities have been brought under the purview of local government. But *panchayats* lack fiscal autonomy and a capacity to deliver public services. To overcome these limitations, the informal resource-based user groups were formed in villages, often with external funds. The relationship between these informal groups and *panchayats* is not clear and, at best, can be described as evolving.

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[8]The SHGs go by various names, including *awal* (or mothers') committees, DWACRA (development of women and children in rural areas) groups, and thrift groups.

For any community-oriented CDM project, a choice will need to be made from among these three institutions to deal with the sale of carbon credit and meet the requirements of the CDM regime. In view of the small size of the communities and their representative institutions, it is quite likely that a federation of village communities will need to be created to serve as an interface between the buyers of carbon emission reduction units (CERs) and local communities. The federations and the member communities would undertake contractual obligations to protect and manage the forest resource in accordance with CDM rules.

[9] All dollars are in US dollars. The exchange rate used is Rs 48 per US dollar.

PART III: SOCIAL APPRAISAL – PROCESSES AND METHODS FOR CDM

Part III provides a brief description the methodologies used in conducting social appraisals of potential community forest carbon project sites. This section proceeds to describe the socio-economic and forest management context of the sample communities in Kerimeri and Indaram forest beats. The section concludes by identifying a series of socio-economic and institutional factors that will need to be considered in the design of future community-based forest carbon projects.

Social and Financial Assessment Methods

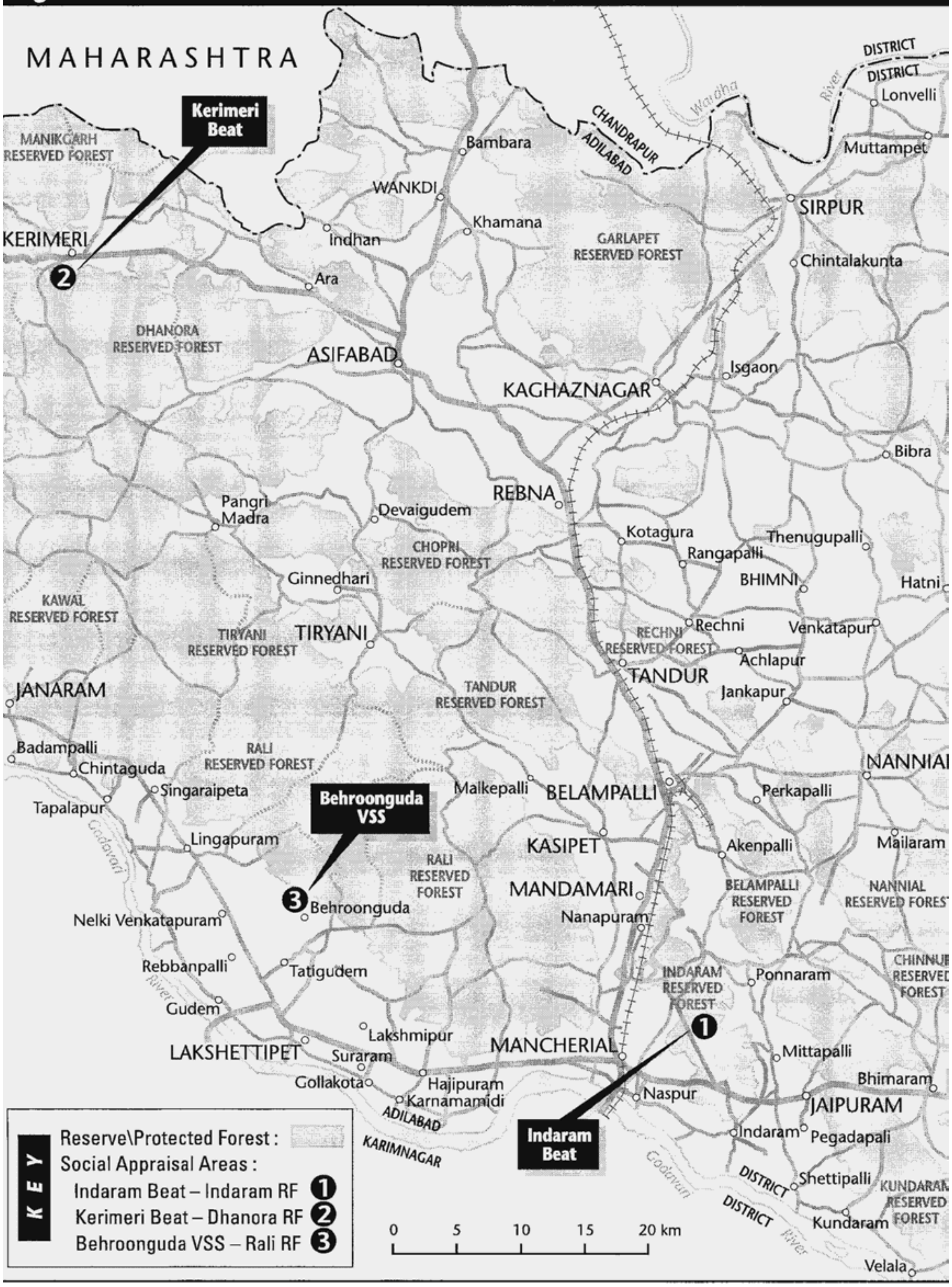
To establish social and financial baselines, representative surveys were conducted in a sample of four of the eight villages in Kerimeri forest beat and three of the six villages in Indaram forest beat (see Figure 6). A sample size of 5 to 20 percent of the households was taken in each village (see Table 1). The 5-percent sample was intended for detailed surveys, while the 20-percent sample was taken for gathering data on social indicators (eg, literacy and schooling). A similar sample size was designed for Indaram. After a pilot test, a survey questionnaire was used to interview both the male and female heads of households. The survey questionnaire attempted to gather socioeconomic data on such variables as household income, sources of income, employment of adults, literacy of adults, schooling of children, agricultural practices, and fuelwood collection and consumption (for details, see Appendix 1: Carbon Project Social Indicators, Adilabad District).

TABLE 1:
SAMPLE DESIGN OF STUDY VILLAGES, KERIMERI BEAT

Study Villages	Social group	Total No. of Households	Hamlets	Sample households for Social Indicators (>20%)	Sample households for Socio- Economic Survey (>5%)
Metapipri	Gonds	45	1	15	5
Koppuguda	Kolams	11	1	4	2
Hatti	Gonds	24	3	5	3
Chintakari	Gonds	17	2	6	4

In addition to the survey, open-ended group discussions on issues of concern to the community on natural resource management were conducted in the village. Participatory rural appraisal (PRA) techniques, involving an entire village, helped to understand the human, capital, and natural resource base of the community. Information from these PRA sessions generated a better understanding of resource flows,

Figure 6 SOCIAL APPRAISAL AREAS



both legal and illegal—such as for example, the smuggling of timber, grazing of cattle, and collection of firewood.

The Research Area

Adilabad district was chosen for the research project for at least two reasons. First, it is one of the most forested districts in Andhra Pradesh state, with some 42 percent of the land area under forest. Second, a large segment of the population comprises indigenous peoples, most of whom are poor and highly dependent on the forest for their subsistence needs. Two distinctly different forest areas—Kerimeri and Indaram forest beats—were selected for the study.[10] Kerimeri is a isolated and homogeneously tribal area, once rich in forest resources that are now steadily degraded by illegal logging and encroachment. Indaram is an industrializing area, close to a national highway, and comprised of mixed castes, many of them transplants from outside Adilabad district.

Kerimeri

The Kerimeri forest beat comprises twelve villages, four of which were selected for field studies comprising 97 households, and 594 residents living close to 906 hectares of forestland (see Figure 7).[11] The fairly homogenous indigenous communities comprise mainly Gond and some Kolam tribal families now settled agriculturists. Rice, *pulses* (legumes), and cotton are important crops that help to satisfy both their domestic needs as well as providing some cash income when the surplus is sold in the market. Household income averages Rs 22,972, above the poverty threshold of Rs 11,000, but some families still continue to live in poverty. Agricultural work is the main source of employment and sustenance, while forestry plays a complementary role (see Table 2).

The Kerimeri area is located away from the main roads, deep into the interior, and is generally regarded as economically backward. Villagers recall that prior to 1990, the Kerimeri forests were well-stocked with crown density exceeding 70 percent, but in the past decade illicit tree felling and timber smuggling reduced the density to below 40 percent, making it a degraded forest. The important species include *mahua (Madhuca indica)*, a source of food, oil, and liquor; tapsi, which provides resin gum for sale in the market; and local grasses, chudva and sukda, used traditionally to cover the roof of houses. Tirman (*Anogeissus latifolia*), Nalla kodesa, and Nallamaddi (*Terminalia tomentosa)* are important fuelwood trees. On average, a household collects about 100 kgs of firewood

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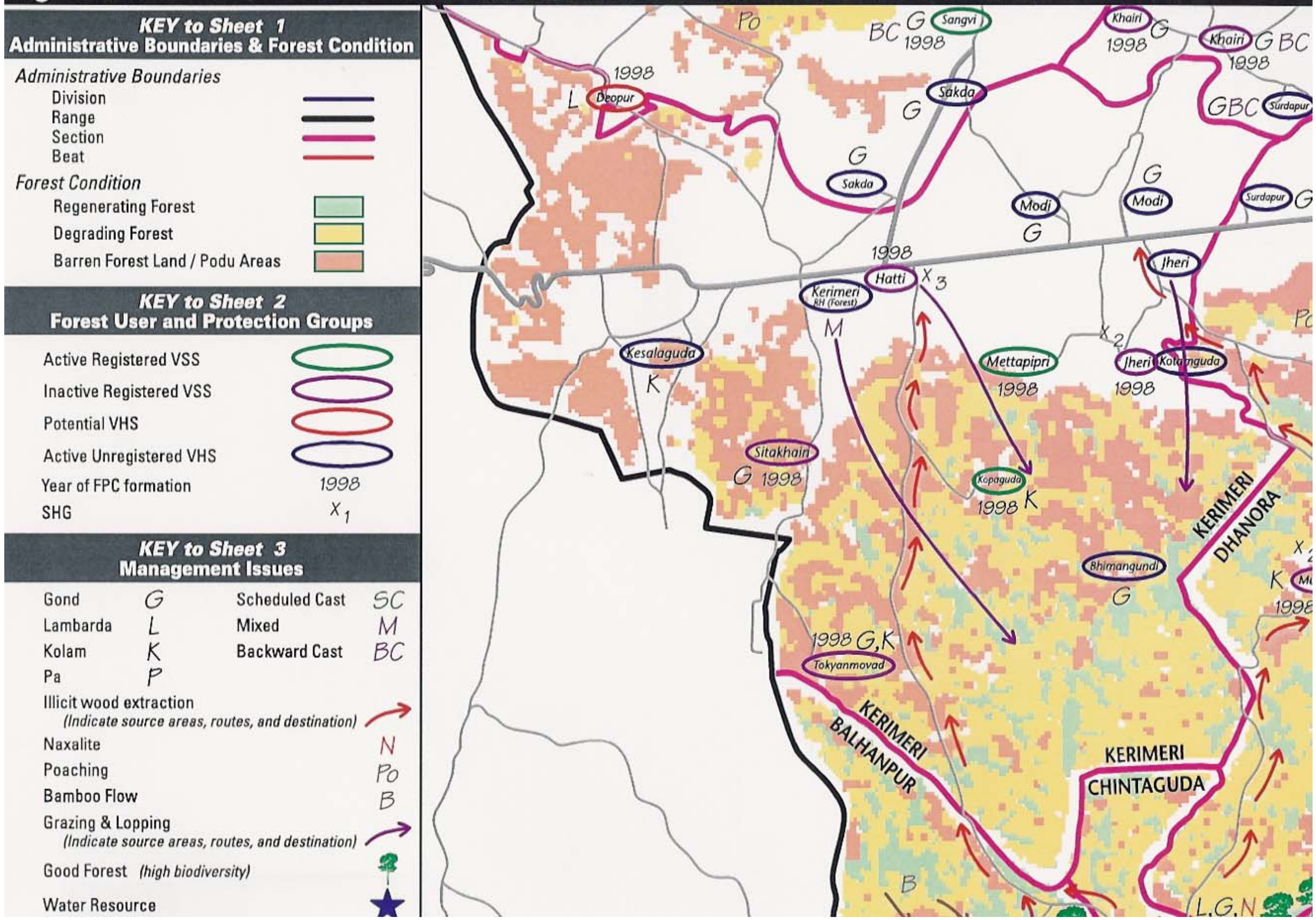
[10]A forest beat generally comprises four to six VSS, or between 1,200 to 2,000 hectares of forest area, and forms part of a forest range. Usually, 25 to 40 VSS constitute a forest range. Six to 12 ranges constitute a forest division. Adilabad district has five forest divisions and 1,008 VSS.

[11]. The four villages are Metapipri, Koppuguda, Hatti, and Chintakari.

Figure 7 MAP OF KERIMERI BEAT



per month for use at home. Collectively, this would constitute a leakage, in CDM terms, of 233 metric tons per year for the Kerimeri area. The local residents are able to meet their firewood needs from the local forest, but on occasions when they need timber to build or repair homes, they have to go south into better-stocked forest areas beyond Chintaguda, toward Jodeghat (see Figure 7).

TABLE 2:

SOURCES OF EMPLOYMENT PER YEAR, KERIMERI FOREST BEAT, 2002

Villages	Total days/ Family	Agriculture	Forest	Other	NTFPs	Outside Village
Metapipri	337	233 (69%)	31 (9%)	58 (17%)	15 (5%)	-
Koppuguda	182	180 (99%)	-	-	-	2 (1%)
Hatti	210	207 (98%)	-	-	3 (2%)	-
Chintakari	304	235 (77%)	7 (2.5%)	47 15.5%)	12 (4%)	3 (1%)

Note: Figures are in parentheses are percentage of total days of employment.

Forest protection committees (VSS) were formed in the four villages in 1998 under the auspices of JFM, but most villagers seemed unclear about the purpose of the VSS. The forest department had incurred some expenditure to treat the degraded areas silviculturally, but there appeared to be little transparency in the manner in which work was carried out and the money spent. The Village Tribal Development Agency (VTDA), created by the government's tribal welfare department, had a local head from the community. Through the VTDA, some agriculture and watershed works were undertaken, but the VTDA appeared to suffer from similar problems as the VSS. A third village institution now active in the Kerimeri area is a woman's self-help group (SHG). In the four villages, seven SHGs are in operation[12] often carrying out the work of the VTDA and the VSS under another government program funded by the International Fund for Agriculture Development (IFAD). The SHGs seem more dynamic, better able to maintain proper accounts, and more accountable for the work done and money spent.

Thus, Kerimeri's once rich forests have degraded by almost half over a decade on account of smuggling of timber and overextraction of firewood. While the villagers own up to their contribution toward the degradation, they express helplessness to control the large-scale smuggling of valuable teak. The VSS and VTDA institutions created by the government under various schemes appear ineffective in countering the process of degradation. There appears to be conflict between the leaders of these institutions and the general village population. However, the resurgence of SHGs in Kerimeri offers hope of improved social mobilization to counter the natural resource degradation.

Indaram

The Indaram forest beat comprises six villages, but for the survey only three villages were included comprising 4,019 people living in 658 households in three villages[13] (see Figure 8). The area is rapidly urbanizing and industrializing. Coalmining is an important source of employment, though not all adults work in the nearby Singareni Collieries. Unlike Kerimeri, the villages are close to the main road. Most local residents are transplants from other parts of the district and even other states. They belong to various castes and, therefore, are socially heterogeneous. Social conflicts among the villagers are widespread.

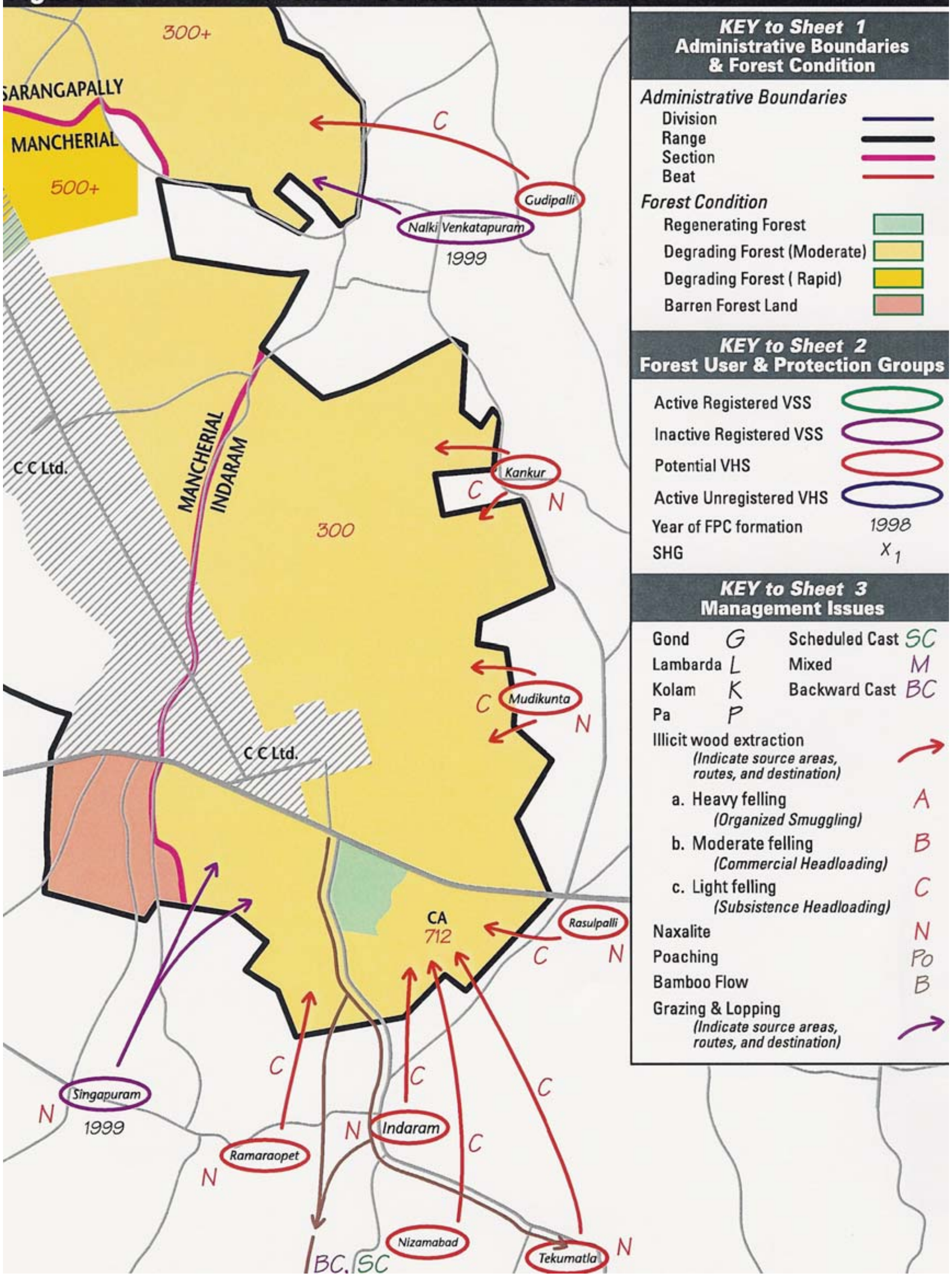
The average household income in Indaram is Rs 34,564, which is about 50 percent higher than in the Kerimeri area (see Table 3). While many households own some land (an average of 3.23 acres), agriculture is not the main source of employment or sustenance. Most residents find work outside their farm and village. Coalmines (15 percent) and agriculture (10 percent) provide complementary work.

TABLE 3:
ECONOMIC PROFILE OF HOUSEHOLDS, INDARAM FOREST BEAT, 2002

Villages	Sample Households	Land Holding (acres)	Income / year (Rs)	Expenditure / year (Rs)
Rasulpalli	4	1.5	18,800	23,075
Muddikunta	11	2.32	35,229	20,160
Singapuram	22	4.0	37,098	28,767
AVERAGE		3.23	34,564	25,593

[12]. Kopuguda village has not formed any SHG as yet.
[13] The villages are Rasulpalli, Muddikunta, and Singapuram.

Figure 8 MAP OF INDARAM BEAT



Income and employment from the forest is insignificant (1-2 percent of total). Prior to 1990, villagers recall that the crown density of these forests were about 50 percent, but has degraded to barely 10 percent since then. Where once stood tall timber-sized teak trees, none is to be found today. In some cases, even the rootstock has disappeared making natural regeneration impossible.

While providing employment opportunities, the opening of coalmines in what was once a dense forest has had severe negative environmental impacts on the area. With degradation of the forest, resources such as timber, firewood and non-timber products are scarce. Several residents have had to substitute liquefied petroleum gas for firewood; the others use the thorny branches of *babul* (*Prosophis juliflora*) that is difficult to cut and carry.

Only one of the three villages, Singapuram, has a forest protection committee (VSS); it was formed in 1998, the same year as the VSS in the Kerimeri study area. However, there appears to be conflict and lack of trust between the VSS president and women of the village. Some moisture conservation projects were conducted in the local forest, but villagers have little sense of ownership or involvement. Ten women's credit groups operate in the three villages collecting savings and circulating loans to the needy. Some of these groups have secured matching grants from the government and a few have leveraged their savings with local banks to secure larger loans for their members.

The active operation of the credit groups has helped to reduce dependence on local moneylenders and loan sharks. These self-help groups have not yet ventured into natural resource management, as SHGs have in the Kerimeri area, in large part because government agencies have not discussed these possibilities with the people of Indaram. Rasulpalli village has a *gram panchayat* that has taken up watershed management with funding from the District Rural Development Agency. Much of the work on building watershed structures, however, is being done through private contractors with little wage benefits accruing to local people.

Growing demographic and industrial pressures are driving the rapid deforestation of Indaram's forest cover. While providing a source of employment and income, the coalmines have attracted migrants from outside the state adding to the social tension in the area. Coalmining has contributed to the depletion of forests, timber, and non-timber products, as well as eroding important environmental services (eg, hydrology and biodiversity), however, the local VSS and *panchayat* shown little effectiveness in addressing these problems.

Socio- Economic Findings

- *A decline in the collection of nontimber forest products (NTFP)* has been caused by the severe degradation of forests (40 to 50% according to community estimates) for over a decade. In Indaram, the virtual disappearance of timber trees has made it difficult to find supplies for constructing or repairing homes and fashioning agricultural implements. In Kerimeri, the tribals have had to go deeper into the forest to find wood for use at home and in the field. Forest restoration and enrichment planting could substantially increase forest productivity, especially non-timber forest products (NTFP). As a consequence, carbon offset payments are only one of a number of economic incentives communities possess to protect and restore degraded forests.

- *Declines in household dependent on forest income and employment* are linked to forest degradation. Communities estimate that their income from non-timber forest products has dropped by at least a third. Income from NTFPs is now between 1 - 5 percent of total income for men. For women, NTFPs continue to be relatively more important an employment source than for men, but still below 5 percent of total employment (see Table 2).

- *The practice of shifting cultivation (podu) has steadily declined and virtually ceased* among the Kolam over the past fifty years. The Kolams are now largely settled agriculturists, growing mainly subsistence crops on hill slopes. The average land holding is 5.5 hectares. The returns on hill-slope agriculture are extremely low, a little more than Rs. 4240 per year (US$85). In Koppuguda, a Kolam village, the average household income is Rs 8,025 (US $160). This income is about one-third of the Kerimeri average and below the poverty threshold of Rs 11,000 (US $220). Another third of Kolam family income is derived from NTFPs. Agroforestry on *podu* land offers a viable alternative, if the forest department offers land security to the Kolams and agroforestry is accepted under the CDM as part of reforestation.

  Institutional weakness of VSS and the lack of transparency of the forest department are clearly evident in Adilabad study areas. There is little evidence of the benefits of Joint Forest Management (JFM) in the two forest beats. Even though the VSS have been engaged in watershed and silvicultural works, the expenditures have not translated into wage income for the local people, except in Metapipri (see "forest labor" column in Table 4). Forest restoration supported through carbon income could have greater potential to provide more meaningful local employment and income than has JFM.

TABLE 4:
FORESTS AS SOURCE OF EMPLOYMENT FOR MEN & WOMEN, KERIMERI & INDARAM

Village	MEN				WOMEN			
	Total Days of Employment	NTFPs	Forest Labor	Agriculture	Total Days of Employment	NTFPs	Forest Labor	Agriculture
KERIMERI								
Metapipri	337	15 (5%)	31 (9%)	233 (69%)	390	18 (5%)	2 (1%)	289 (74%)
Koppuguda	182	--	--	180 (99%)	145	2 (1%)	--	143 (99%)
Hatti	210	3 (2%)	--	207 (98%)	196	23 (12%)	--	123 (63%)
Chintakari	304	12 (4%)	7 (2.5%)	235 (77%)	222	12 (6%)	--	158 (71%)
WEIGHTED AVERAGE	278	9.4 (3.4%)		220 (97%)	265.4	15 (5.67%)		231.2 (87.1%)
INDARAM								
Rasulpalli	284	3 (1%)	--	11 (4%)	198	13 (7%)	--	28 (14%)
Muddikunta	214	6 (3%)	--	33 (16%)	102	8 (8%)	--	32 (31%)
Singapuram	262	1 (0.5%)	--	35 (13.5%)	84	5 (6%)	1 (1%)	37 (44%)
WEIGHTED AVERAGE	267.5	2.8 (1%)		31 (11.58%)	149.8	7 (4.67%)		20.5 (13.68%)

- *Regenerating degraded forests could reestablish as an important source of income and employment* for women in Adilabad, besides providing important inputs for agriculture, such as an increase in water supply from improved hydrology (as shown in Table 4). The study indicates that NTFPs provide twice the employment to women as men, but under 5 percent of the total income. With forest regeneration, it should be possible to double the employment potential from NTFPs.

Institutional Assessment

While meeting CDM's complex technical requirements is a challenge, a bigger challenge is to create an institutional framework that supports local communities and minimizes transaction costs. Adilabad has a variety of local institutions, both formal and informal. The formal institution is the democratically elected local government, known as *panchayat*. The informal institutions are mainly user groups, such as the forest protection committees (VSS), watershed committees, credit-based self-help groups, and so forth. Some of these informal groups have been created by government agencies with the support of external funds (eg, VSS and watershed committees); some have been established by communities themselves (eg, credit groups). Among the Gonds, there also exists a tribal council called *Rai Sabha*, which exercises considerable moral authority. Care must be taken in choosing from these institutions.

Methods

PRA exercises in the sample villages helped to bring out information regarding the existence of various institutions that operated at the community level. Open-ended group discussions held in the villages revealed the strengths and weaknesses of various institutions. Separate discussions were held with men and women, which often helped to expose areas of social conflict, leadership problems, and lack of transparency in decision-making among local leaders and government agencies. Scrutiny of documents available at the village level—eg, village register, bank account statements, microplans, and budgets—helped to understand the activities undertaken in the village relating to natural resource management. Discussions were also held with government agencies to verify some of the statements made by local communities.

Institutional Findings

- *Effective community institutions* are required to meet CDM requirements for forest carbon projects. The key local institutions that emerged from the fieldwork were the VSS, SHGs, and *panchayats.* The VSS have a more direct relationship with forests in that they were created to protect local forests. The SHGs have been involved in watershed management, including building soil and moisture conservation structures inside the forest. A few SHGs run tree nurseries, which provide seedlings to the forest department. The *panchayats* have been given the legal responsibility for social forestry, though not for protecting reserve forests.

- *Understanding the CDM requirements* is key to the success of any community-based institution because of complex technical requirements. At the moment, none of the three institutions have the capacity to propose and implement a CDM project. However, with proper training, leaders of these groups could be empowered to meet the requirements of a CDM regime.

- *Minimizing transaction costs* is critical for the success of a CDM project. To achieve cost minimization, it would be necessary for local institutions to federate into a larger body. Thus, SHGs or VSS could form a federation of 10 to 30 similar such groups so the buyer of carbon credits could negotiate with a few leaders of the federation instead of a large group of community representatives. A federation would also increase the bargaining power of local communities with the Indian and Andhra Pradesh governments as well as the carbon buyers. In some parts of Adilabad district, several SHGs have spontaneously formed federations, providing opportunities for a CDM project in the future.

- *Minimizing social conflicts* is also important for the success of any community-based forest carbon project. Where communities are homogenous (as in the Kerimeri area), social conflicts are often less than in more heterogeneous areas (as in Indaram). Facilitating cooperative activities by diverse cultural communities and caste groups can be problematic. The tribal community—in particular, the Gonds—have long-established traditions of working cooperatively, in contrast to the multi-caste and migrant communities that characterize Indaram.

- *Transparency in decision-making and public expenditures* were highlight by community members during field-level discussion. In Singapuram, women did not trust the VSS president. In Chintakari, villagers complained of lack of transparency in financial transactions by the forest department and the VSS president. In Hatti, people were not aware of the purpose of a VSS even after four years since its establishment. In any community-based CDM project it is important that local communities know the extent of funds flowing and the way these funds would be used locally.

- *Democratic leadership at the community level* is also important. A test of democratic leadership is its ability to rotate the head of the village institution. In many communities in Adilabad District, the VSS leadership has not been rotated unless serious conflicts have arisen. A proper gender balance is also necessary to achieve the larger goal of social equity. Barely 5 percent of VSS presidents are women, while women head most SHGs. In the study area, men headed all VSS while women presided over SHGs.

Summary

Unless eligibility parameters are changed, little forest land in the Kerimeri would qualify under CDM for at least two reasons. First, Kerrieri had dense forests after 31 December 1989, the cut-off date for CDM eligibility. Second, even though the forests are degrading, they are still above 10 percent, the CDM definition of “degraded.” By contrast, parts of Indaram beat might qualify for a potential CDM project because the crown cover is close to 10 percent. Yet, even in Indaram Beat, much of the land was being deforested and degraded after 31 December 1989, and as a consequence, it is not certain how much of degraded forests actually qualify. Moreover, because of continuing social conflicts among the transplanted heterogeneous population, it is unlikely that a potential CDM project will have community support, a requirement under CDM (see Step 5).

SHGs, rather than VSS, maybe the most appropriate local institutions to be associated with potential CDM projects in Adilabad. The SHGs—especially those headed by women—are generally viewed as more dynamic, accountable, and transparent than other local institutions. To minimize transaction costs, it would be useful if SHGs from 20 to 30 villages would federate. Such a federation could oversee between 5,000 and 7,500 hectares of forestland with potential for carbon sequestration. Considerable effort would be needed to build the institutional capacity of SHGs and their federation to meet the requirements of the CDM protocol. This is a challenge for the CDM and for the international community, which can be met in partnership with governments, local communities, NGOs, and others interested in reducing carbon emission.

PART IV: ECOLOGICAL APPRAISAL

A major goal of this research project was to field test cost effective methods for establishing carbon baselines and generating CDM scenarios. These methodologies were evaluated by measuring the species composition, biomass, basal area, and carbon stored in the forests and soils of sample sites in Adilabad District. The methodologies used are a further refinement of those field-tested in an early study in Harda Division in the state of Madhya Pradesh in central India.[14] Vegetation sample plots were drawn from Mancherial and Jannaram Forest Divisions of Adilabad District (see Figure 9).

Context for Ecological Appraisal

Mancherial and Janaram Divisions possess 111,000 and 61,000 hectares of forest respectively, representing 49 percent and 86 percent of the total land area. Population for the two divisions are 457,000 for Mancherial and 197,000 for Janaram. Approximately half of the Division's 225,000 hectares are under forest department control (see Table 5).

TABLE 5:
AREA AND POPULATION OF MANCHERIAL & JANNARAM FOREST DIVISIONS, ADILABAD DISTRICT

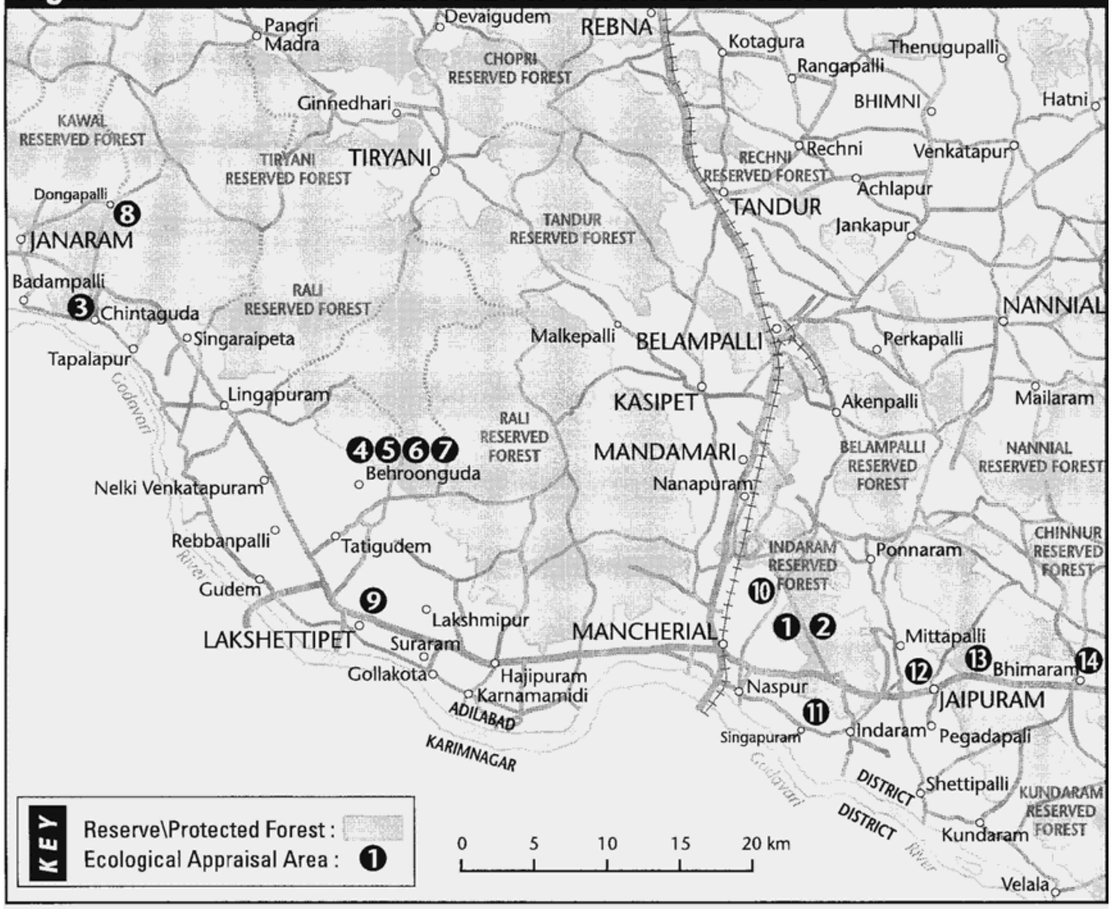
Forest division	Area (in ha)		Population	
	Geographic	Forest	Human	Livestock
Mancherial	225,299	110,669 (49%)+	457,181	242,186
Jannaram	70,550	60,860 (86%)	192,685	196,961

Values in parenthesis indicate % forest of the total geographic area

Both divisions, with their rich teak forests, were commercially logged according to working plan prescriptions up to the early 1980s, when a national logging ban was imposed. Despite the logging ban, illegal timber operations have continued up to the present. While it is impossible to generate precise estimates of teak and other logs taken from the divisions, reports by forest protection group members, APFD field staff, and other sources indicate that approximately one truck load per 100 hectare area were extracted each year. This would mean that Mancherial may be losing around 1,000 truck loads of mature trees annually, with perhaps, another 600 truck loads of timber leaving the forests of Janaram Division. Pressures on the forests of Mancherial Division have been especially intense due to its greater proximity to major transportation arteries, the growing urban center in Mancherial, and the activities of the Singareni Collieries, a major coalmining operation. By early 2002, only 26 percent of Mancherial's forests had 40 percent or greater canopy closure. Thirty percent of the forest area, approximately 33,000 hectares, is badly degraded with less than 10 percent forest over, making it eligible for CDM afforestation and reforestation projects (see Table 6).

[14] Mark Poffenberger (ed.) *Communities and Climate Change: The Clean Development Mechanism and Village-based Forest Restoration in Central India. (Santa Barbara:CFI) 2001.*

Figure 9 ECOLOGICAL APPRAISAL AREAS



Scenario	Site	Vegetation type	Village/ VSS	Forest division
Baseline	1	Degraded secondary forest – BSL	Doragarapalli	Mancherial
	2	Degraded teak forest – BSL	Doragarapalli	Mancherial
	3	Cropland – BSL	Chintaguda	Janaram
CDM Project	4	Regenerating teak forest 1996 – CDM	Behroonguda	Janaram
	5	Regenerating teak forest 1998 – CDM	Behroonguda	Janaram
	6	Regenerating mixed forest 1994 – CDM	Behroonguda	Janaram
	7	Regenerating mixed forest 2000 – CDM	Behroonguda	Janaram
	8	High forest (with bamboo and lower canopy) – CDM	Dongapalli	Janaram
	9	Clonal Eucalyptus plantation 1999 – CDM	Khazipalli	Janaram
	10	Mature Eucalyptus plantation 1990 – CDM	Singareni Collieries	Mancherial
	11	VSS Eucalyptus plantation 1999 I – CDM	Singapur	Mancherial
	12	VSS Eucalyptus plantation 1999 II – CDM	Kammaguda	Mancherial
	13	Mango orchard Young – CDM	Mamidagutta	Mancherial
	14	Mango orchard Old – CDM	Bhimaram	Mancherial

The forests of Janaram Division are in relatively better condition with just under 50 percent possessing 40 percent forest cover or more. This is due to the relative isolation of these forests, though they remain targets for illegal timber felling. In response to pressures on the forests and degradation trends,

TABLE 6: CONDITION OF FORESTS IN MANCHERIAL AND JANNARAM DIVISIONS

Forest Division	Area (in ha)				
	Dense forest (Crown Density above 40%)	**Open forest** (Crown Density 10 to 40%)	**Scrub forest** (Crown Density less than 10%)	**Blanks**	**Total**
Mancherial	29,100	48,614	24,395	8,560	110,669
Jannaram	29,011	7,806	12,922	1,121	60,860

the Andhra Pradesh Forest Department has implemented a number of afforestation and reforestation projects. The scale of these projects expanded dramatically in 1996, with assistance from the World Bank. Afforestation coverage increased from approximately 200 hectares in each Division in 1995-96 to over 2000 hectares in 1999-2000 (see Table 7).

TABLE 7:
CONDITION OF FORESTS IN MANCHERIAL AND JANNARAM DIVISIONS

Year	Area afforested (in ha)	
	Mancherial	**Jannaram**
1993-94	70.66	
1994-95	84.30	
1995-96	205.00	200.00
1996-97	1116.10	785.00
1997-98	2086.00	780.00
1998-99	2145.00	1662.25
1999-00	2290.16	2839.00
TOTAL	**7997**	**6266**

The World Bank financed A.P. Forestry Project mandated that community-based forest protection committees (VSS) be the primary vehicle for implementation, building on the pre-existing state and national Joint Forest Management program. Between 1996 and 2000, the number of VSS in each division increased from 8 to nearly 100 (see Table 8). Our social appraisal (see Part III) found that many VSS were ineffective and generally suffered from a lack of transparency in financial dealings. There was also a fundamental failure to build community capacity to manage forests. With the termination of the first phase of the project, many of the groups ceased to function when funds for forest-related employment came to an end.

TABLE 8: SPREAD OF JOINT FOREST MANAGEMENT IN MANCHERIAL AND JANNARAM DIVISIONS				
Year	**Mancherial**		**Jannaram**	
	Number of VSS	**Area (ha)**	**Number of VSS**	**Area (ha)**
1993-94	2	516		
1994-95	1	256	1	456
1995-96	8	2052	8	3474
1996-97	13	3334	37	15483
1997-98	22	5643	12	4193
1998-99	43	11029	31	10857
1999-00	-	-	3	896
2000-01	5	1289	5	1124
TOTAL	**94**	**24112**	**97**	**36483**

Source: Working plan – Mancherial and Jannaram forest divisions

Vegetation Types and Sampling Framework under Baseline and CDM Scenarios

The two scenarios considered in this study are the baseline and the CDM scenario. As defined at COP 7, the baseline for a CDM project is "*the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity.*" [15] The first step in determining a project's additional green house gas (GHG) benefits (known as additionality) is therefore development of a *'without- project'* baseline scenario against which changes in carbon stocks occurring in a project area over different time periods (eg. 2008, 2012) on can be compared. It is necessary to demonstrate that the estimated GHG emission avoided or carbon sink enhanced is real. Further, the proposed CDM project must demonstrate the rationale for funding through one or more additionality tests such as; technical, institutional and financial intervention. Non-occurrence of such interventions in the baseline or *'without-project'* scenario needs to be convincing and verifiable. The CDM scenario indicates the potential vegetation status and changes in carbon stock when the project is implemented.

- The baseline scenario includes degraded forest land as well as non-forest lands with potential for increasing carbon stocks through afforestation and reforestation activities

- The CDM scenario includes areas where there is reforestation and afforestation of degraded forest and non-forest lands aimed at increasing carbon stocks in vegetation and soil, over the baseline carbon stocks

A number of different approaches could be used to develop baseline. Reliable quantified measurements of actual emissions or removal of CO_2 are an important requisite for establishing a baseline. One way of developing a baseline for a forestry project is by establishing control plots within the project area that continue the current management regime or are not subject to active human

[15] UNFCCC, 2001

management. [16] This would satisfy the requirement of "direct human-induced conversion" set forth in the definitions of afforestation and reforestation. The methods for estimating carbon density will also vary for the different pools to be accounted for in the project area.

Vegetation Types

Under the baseline scenario, three categories of land systems were selected: degraded secondary mixed forest, degraded teak forest, and croplands (see Table 9). They are:

- Degraded secondary forest: Large open areas interspersed with few species that characterize the area. The area is fairly open with low tree canopy and growth of pioneers, and an abundance of weeds and thorny bushes.
- Degraded teak forest: A degraded area, predominantly teak with low tree crown. The area has several thorny bushes and shows signs of human interference as indicated by remains of tree stumps extracted.
- Cropland: The croplands had no trees, if present very few and isolated trees.

Under the CDM scenario, five potential afforestation and reforestation activities were included. They are:

- Regenerating teak
- Regenerating secondary forest
- High forest
- Eucalyptus Plantations
- Mango Orchards

To understand the potential that could be achieved in terms of number of species, basal area and above ground biomass, sites with regenerating forests under management for different time periods as well as eucalyptus plantations of three categories were considered. Plantation oriented management scenarios included those managed by a beneficiary groups and a VSS (mature and young eucalyptus plantation), an industrial plantation (clonal eucalyptus), and privately managed mango orchards. The baseline vegetation types, and the potential activities that may qualify as CDM reforestation and afforestation strategies, are listed in Table 9. The locations of the sample sites are indicated in Figure 9. The findings from the field tests concerning species diversity, basal area, and above ground biomass are presented in Appendix II, along with a discussion of their significance. The following section describes the preliminary findings regarding the mean annual growth rate and yearly carbon increment in regenerating forests and plantations in the study area. Under the CDM scenario, this data would provide the basis for calculating carbon-offset payments that might be available to communities for reforestation and afforestation activities.

[16] LULUCF, 2001

TABLE 9: SAMPLING FRAMEWORK FOR ESTABLISHING BASELINES AND CDM SCENARIOS				
Scenarios and Vegetation Types				
Scenario	**Vegetation type**	**Features**	**Village/VSS**	**Forest division**
Baseline	1. Degraded secondary forest – BSL	- highly degraded secondary forest representing secondary growth of multiple species	Doragarapalli Dandepalli	Mancherial Jannaram
	2. Degraded teak forest – BSL	- degraded forest patch with teak as the dominant species	Doragarapalli	Mancherial
	3. Cropland – BSL	- abandoned croplands and crop bunds with isolated or very few trees	Chintapalli	Jannaram
CDM	1. Regenerating mixed forest 1994 – CDM	- forest regenerating due to protection and management efforts of a community	Behrunguda	Jannaram
	2. Regenerating mixed forest 2000 – CDM	- forest regenerating due to protection and management efforts of a community	Behrunguda	Jannaram
	3. Regenerating teak forest 1996 – CDM	- forest regenerating due to protection and management efforts of a community, dominated by teak	Behrunguda	Jannaram
	4. Regenerating teak forest 1998 - CDM	- forest regenerating due to protection and management efforts of a community, dominated by teak	Behrunguda	Jannaram
	5. High forest (with bamboo and lower canopy) – CDM	- a relatively undisturbed forest patch with large trees and species representing the area, characterized by lower canopy and bamboo	Dongapalli	Jannaram
	6. Clonal Eucalyptus plantation 1999 – CDM	- plantation raised by Singareni collieries with clonal varieties of eucalyptus, representing the technical potential of a species	Khazipalli	Jannaram
	7. Mature Eucalyptus plantation 1990 - CDM	- plantation raised under family assistance scheme and currently enumerated and sanctioned for harvest	Singareni Collieries	Mancherial
	1. VSS Eucalyptus plantation 1999 I - CDM	- plantation of 3 years, raised as a part of JFM scheme for the Singapur VSS	Singapur	Mancherial
	9. VSS Eucalyptus plantation 1999 II – CDM	- plantation of 3 years, raised for Kommaguda VSS under the JFM program	Kommaguda	Mancherial
	10. Mango orchard – Young	- a private orchard raised in 1997 with grafted seedlings	Mamidagutta	Mancherial
	11. Mango orchard – Old	- a private orchard of 18 years, grafted seedlings planted	Bhimaram	Mancherial

Carbon Stock and CDM Scenario and Carbon Sequestration Potential

This section briefly reviews major findings from the vegetative assessment regarding mean annual growth rates for below and above ground biomass and carbon under different CDM project scenarios.

Mean Annual Growth Rate

The mean annual growth rate has been computed for the regenerating stands (secondary and teak forests) as well as the eucalyptus plantations and mango orchards, as the age of the plantations and orchards, and the year of initiation of protection and management is known for the regenerating stands of secondary and teak forests (Table 10). The growth rates for the different vegetation types under the CDM scenario are as follows:

- Regenerating teak: ~ 7 to 11 t/ha/year
- Regenerating secondary forest: ~ 11 t/ha/year
- Clonal eucalyptus: ~ 9 t/ha/year
- Mango: ~ 0.3 t/ha/year

TABLE 10:
ABOVE GROUND BIOMASS GROWTH RATE UNDER CDM SCENARIO

Vegetation type	Years under protection or age (years)	Standing above ground biomass (t/ha)	Mean annual growth rate (t/ha/year)
Regenerating teak 1996 – CDM	6	44	7.33
Regenerating teak 1998 – CDM	4	47	11.75
Regenerating secondary forest 1994 – CDM	8	86	10.75
Regenerating secondary forest 2000 – CDM	2	61 (22)*	30.50 (11)*
Clonal Eucalyptus plantation 1999 – CDM	3	27	9.00
Mature Eucalyptus plantation 1990 – CDM	12	42	3.50
VSS Eucalyptus plantation 1999 I – CDM	3	3	1.00
VSS Eucalyptus plantation 1999 II – CDM	3	7	2.33
Mango orchard Young – CDM	5	1.4	0.28
Mango orchard – Old – CDM	18	4.6	0.25

** Figures in parenthesis give standing biomass and mean annual growth rate of the forest, excluding medium and large trees, present at the initiation of protection*

Thus, under mean annual growth rate is moderate to high for regenerating teak and secondary forests (in the range of 7.3 to 11.7 t/ha/year). The regenerating protected forest 2000 shows very high growth rate of 30 t/ha. This is because of the presence of several large and medium sized trees at the onset of protection. Clonal eucalyptus also has high biomass growth rates, as the variety was bred specifically for rapid growth charactistics. Growth rates for other plantation eucalyptus sites were far lower than the clonal variety. Thus regenerating teak, regenerating secondary forests (under community protection and management) and clonal eucalyptus are estimated to yield moderate to high carbon sequestration rates. The observed moderate to high rates of carbon sequestration is partly contributed by the presence of few medium to large sized trees in the regenerating secondary as well as teak forests. Mango, though an economically valuable species, has very low biomass growth rate and thereby low carbon sequestration rates. The high growth rate in regenerating secondary forests protected since 1994 is not the actual rate of growth as there are several large trees on the site, which must have been present even before protection was initiated. In fact, 30% of the basal area of this site is contributed by trees with girth > 30 cm. If this 30% was deducted from the total biomass reported from the site, the above ground biomass would be only 25 t/ha and the mean annual growth rate is only 3 tons/ha/year.

Vegetation Carbon Density

Carbon storage in vegetation is estimated by taking 50% of the biomass as carbon. The carbon stocks in above ground biomass under the baseline scenario are quite low, compared to the AGB stocks in regenerating vegetation under the CDM scenario. It is less than one ton per ha in both degraded secondary as well as teak forests. The AGB carbon under the CDM scenario ranges between 73 tC/ha in high forests to 43 tC/ha in regenerating secondary forest, protected since 1994 and about 23 tC/ha in regenerating teak forests. The eucalyptus plantations of the VSS have very low carbon and it is 1.5 and 3.5 tC/ha. The mature plantation has AGB carbon of 21 tC/ha while the industrial clonal plantation has 13.5 tC/ha. The AGB carbon in mango orchards is very low at 0.7 in young orchards and 2.3 tC/ha

Soil Carbon Density

The soil organic carbon content in different vegetation types – both baseline and CDM are estimated using standard methods. The soil collected from two depths is used for estimating the carbon content.

Soil organic carbon content (%): Soil carbon is typically estimated to a particular depth, depending on the expected depth of carbon accumulation or depletion. There is considerable uncertainty in the literature on soil carbon content and the factors that affect it. As a percentage of total carbon benefit, soil carbon is more significant where the vegetation carbon is low. In this study, the total amount of soil carbon is calculated using the formula:

$$\text{Total soil carbon} = \text{Soil mass X Organic carbon X } 10^{-2}$$

Under the baseline scenario, the soil carbon content in degraded secondary forests is highest at 38.8 tC/ha while that of degraded teak forest is 30.31 (see Table 11). In croplands, the organic carbon content is comparatively low at 22.49. In the CDM scenario, the organic carbon content is high in the high forests (61.35 tC/ha). Among the regenerating forests, the soil carbon is highest in the 2000 protected secondary forests, followed by the 1994 protected forests (~ 47 tC/ha). The regenerating teak forests have about 36 tC/ha. Among the eucalyptus plantations, the carbon content is lowest in the mature plantation (19.21 tC/ha). In the VSS protected plantations, the soil carbon is about 30-35 tC/ha. The industrial plantation has the highest carbon content of 37 tC/ha, which is comparable to the carbon in soils of regenerating teak forests. The mango orchard also has soil carbon comparable to VSS plantations (33.56 tC/ha).

TABLE 11: ORGANIC CARBON IN SOILS OF DIFFERENT VEGETATION TYPES UNDER BASELINE AND CDM SCENARIOS			
Baseline scenario		***CDM scenario***	
Vegetation type	**Soil carbon (tC/ha)**	**Vegetation type**	**Soil carbon (tC/ha)**
Degraded teak – BSL	30.31	Regenerating teak 1996 – CDM	36.84
		Regenerating teak 1998 – CDM	35.81
Degraded secondary - BSL	38.81	Regenerating secondary forest 1994 – CDM	46.94
		Regenerating secondary forest 2000 – CDM	54.09
		High forest (with bamboo and lower canopy) - CDM	61.35
Cropland	22.49	Clonal Eucalyptus plantation 1999 – CDM	37.53
		Mature Eucalyptus plantation 1990 - CDM	19.21
		VSS Eucalyptus plantation 1999 I – CDM	30.24
		VSS Eucalyptus plantation 1999 II – CDM	35.32
		Mango orchard Young – CDM	-
		Mango orchard – Old – CDM	33.56

Total Carbon Density (tC/ha)

The total carbon stock in vegetation and soil combined is given in Table 12. The same methods and formulae used for estimating baseline carbon density are used to calculate the rate of change of carbon density under the CDM project, including accumulation of vegetation and soil carbon. The total carbon stock in degraded secondary and teak forests as well as croplands is much lower than the total carbon estimated for the different vegetation types under the CDM scenario.

Under the baseline scenario, the total carbon in degraded secondary forest is about 40 tC/ha and that of degraded teak forest is 31 tC/ha. In croplands, about 22 tC/ha has been estimated. In the CDM scenario, the high forests have maximum carbon stock of 134tC/ha. Among the regenerating forests, the 1994 protected secondary forest has the maximum carbon stock (~ 90 tC/ha) and the 1998 and 1996 protected forests both have about 59tC/ha. The VSS protected eucalyptus plantations have comparable carbon stocks, more than 30 tC/ha. The mature eucalyptus plantation and the mango orchard have about 40 tC/ha.

Carbon Stock Changes in Vegetation and Soil

The net change between baseline and project estimates is the difference in total carbon storage in the two scenarios. The carbon increment in CDM scenario over the baseline for teak is 28 tC/ha. For secondary forests, the increment is in the range of 95 tC/ha to 50 tC/ha as in the high forests and regenerating secondary forests protected since 1994. The option of raising eucalyptus or mango on croplands can result in carbon increment of 13 tC/ha as in the case of mango orchards and 9 tC/ha to 28 tC/ha, if eucalyptus plantations are raised (see Table 12).

TABLE 12: TOTAL CARBON STOCK IN BASELINE AND CDM SCENARIO					
Vegetation Type	**Carbon Stock (AGB + Soil) TC/ha**	**Vegetation Type**	**Carbon Stock (AGB + Soil) tC/ha**	**Incremental Carbon Stock (tC/ha)**	**Incremental Carbon Sequestration Rates (tC/ha/year)**
Degraded teak – BSL	30.65	Regenerating teak 1996 – CDM	58.84	28.19	4.69
		Regenerating teak 1998 – CDM	59.31	28.66	7.16
Degraded secondary - BSL	39.25	Regenerating secondary forest 1994 – CDM	***89.94***	***50.69***	***6.33***
		Regenerating secondary forest 2000 – CDM	***61.10***	***21.85***	***10.92***
		High forest (with bamboo and lower canopy) - CDM	134.35	95.10	-
Cropland	22.49	Clonal Eucalyptus plantation 1999 – CDM	51.03	28.54	9.50
		Mature Eucalyptus plantation 1990 – CDM	40.21	17.72	1.48
		VSS Eucalyptus plantation 1999 I – CDM	31.74	9.25	3.08
		VSS Eucalyptus plantation 1999 II – CDM	38.82	16.33	5.44
		Mango orchard Young – CDM	-	-	-
		Mango orchard – Old – CDM	35.86	13.37	0.74

Incremental Carbon Sequestration Rates in Vegetation and Soil (tC/ha/year)

The carbon sequestration rates under the CDM scenario was estimated for vegetation types for which the age was known. Among the regenerating forests, the carbon sequestration rate is highest in the regenerating teak forest 1998 at an increment of 7 tC/ha/year (Table 12). The regenerating secondary forest 1994 and regenerating teak forest 1996 have carbon sequestration rates of 6 tC/ha and about 5 tC/ha, respectively. The highest sequestration rate recorded is in the clonal eucalyptus plantation (9.5 tC/ha/year). The other eucalyptus plantations have sequestration rates ranging from 1.5 tC/ha/year in mature eucalyptus to 5 tC/ha/year in VSS eucalyptus plantation 1999-II. The mango orchards have very poor carbon stocks and, thus, the rate of sequestration is very low at 0.7 tC/ha/year (see Table 12).

Potential Area for Reforestation under CDM in Mancherial and Jannaram Forest Divisions

About 34,000 hectares of land is potentially available for reforestation in Mancherial and Janaram forest divisions of Adilabad district, based on a few assumptions. It is assumed that 50 percent of the areas under open and scrub forests will be available for reforestation, considering regeneration of mixed species or teak as an option (see Table 13). For croplands, the options considered are plantations of eucalyptus and mango orchards. The area under crops in Adilabad district according to the Directorate of Economics and Statistics is 340,000. Ten percent of this comprises the bund area and therefore the area available for reforestation on croplands is 34,000 ha. Provided the definitions for eligibility were favorably defined by the CDM, Table 13 indicates the potential area for CDM projects in Mancherial and Jannaram Division. Should the interpretation of current definitions be restrictive, this area would be considerably reduced. Project carbon sequestration studies showed that only clonal eucalyptus generated high levels of carbon capture. As a consequence, CER payments for afforestation of agricultural lands with plantation crops would not begin to cover the relatively high establishment costs.

TABLE 13:
POTENTIAL AREA FOR REFORESTATION

Vegetation type for reforestation under CDM scenario	Potential area (ha)		Assumption
	Mancherial	Jannaram	
1. Secondary forest regeneration 2. Teak regeneration	40784	21526	50% of area under open and scrub forests and blanks available for reforestation
3. Eucalyptus plantation 4. Mango orchard	34000		10% of area under crops as given by Directorate of Economics and Statistics is considered available for reforestation

PART V: CONCLUSION

In Part V, we will analyze the challenges of building local institutional capacity, minimizing transaction costs of community-based institutions, and financing investments to ensure the sustainability of any potential investment.

Building Local Capacity

Of the three local institutions analyzed in Adilabad, our study has indicated that SHGs would be the most appropriate one to be associated with a potential CDM project. As noted in Part III, relative to many panchayats and VSS, the women-run SHGs are dynamic, accountable, and transparent. A number of SHGs actively operate in the Kerimeri and Indaram area. To deal with the complex requirements of a CDM regime, and minimize transaction costs, a federation of SHG, perhaps including 20 to 30 or more villages, and covering between 5,000 and 7,500 hectares of forestland, would be required. At the present time, however, the SHGs and other local institutions lack awareness of CDM, and the capacity to propose and implement a carbon sequestration project. A major initiative would be needed to create awareness of CDM issues among communities and local governments and, through a process of consultation, to develop and implement a CDM project.

The local capacity building would require the help of several actors. The forest department could provide technical assistance on managing forests. Local NGOs could provide specific skills (eg, maintaining accounts). International NGOs could help to raise awareness regarding CDM requirements and develop carbon sequestration projects, securing buyers for community generated CERs. As third-party audits of carbon sequestered are mandated by the CDM protocol, registered auditors will have a role to play. Finally, there are important roles for the Union and State governments that are legally vested with the overall responsibility for state forest land.

Involving all of these actors and stakeholders, and getting them to agree on the methods and processes of CDM, will be an enormous challenge. But this challenge can be met through a process of regular, multiparty consultations and goodwill among the various actors. It is likely that the process of consultation, awareness raising on CDM issues, and designing and implementing a CDM project, will take two to three years. The process would need to be approached with flexibility on the part of all participants, especially in the developmental phases. It is difficult to estimate the cost of local capacity building, but they would be substantial.

Investment Costs for Community-based CDM Forestry Projects

External financial support has been important in mobilizing community-based forest restoration activities in Andhra Pradesh in recent decades. Financial assistance from the World Bank, as well as from government programs, has supported communities to form forest protection groups (VSS). In Behroonguda, the cost of regenerating one hectare of forest land is estimated to be approximately Rs. 497 per hectare ($10) as shown in Table 14.

TABLE 14:
FINANCIAL COSTS PER HECTARE FOR NATURAL FOREST REGENERATION, BEHROONGUDA, 1998

ITEM	COST
Village Patrolling [1]	67,525
Forest Department salaries and overheads [2]	38,352
Silvicultural treatment, soil conservation, etc. [3]	131,973
Miscellaneous [4]	10,440
TOTAL COSTS	248,290 (for 500 hectares)
COSTS PER HECTARE	**RS. 497**

Note: 1. The village patrolling party comprises, on average, four men and one woman. VSS wages are used in the calculation. 2. 30% of the establishment cost and allowances of forest staff was divided among 70 VSS in Janaram forest division. 3. Based on the expenditure incurred by the forest department in Behroonguda. 4. Covers the time spent on VSS activities by the president and 12 managing committee members.
Source: Emmanuel D'Silva and B. Nagnath, "Community Forest Management in Behroonguda, Andhra Pradesh, India: Economic Benefits," Asia Forest Network Working Paper Series, Volume 3, 2000, p.14.

By contrast, the cost of establishing a plantation of eucalyptus is far higher than for natural regeneration. In areas neighboring Behroonguda, forest department costs for the year a plantation was established were Rs. 10,272 per hectare ($214). In addition, costs for plantation site preparation and for yearly maintenance after plantation establishment were Rs. 11,566 ($240) and Rs. 2322 ($48) respectively (see Table 15). This indicates that the total costs for plantation establishment in the first three years may cost up to Rs. 24,000 or $500.

TABLE 15: FINANCIAL COSTS PER HECTARE FOR PLANTATION ESTABLISHMENT, MANCHERIAL DIVISION, 2000	
Operations	**Amount (Rs./ha)**
1. Alignment and staking including preparation of stakes (4X4)	121
2. Scooping of earth 45 cm pits; 3.20X625 pits/ha	2000
3. Transportation of plants from nursery to plantation site (20X30 cm bags for 35 kms)	845
4. Transportation within the plantation site 245.10X625 plants (20X30) per 1000	153
5. Planting of seedlings 91.10X625 in 45 cm pits per 100 pit	569
6. Cost of insecticides @ 10 gm/plant @ Rs. 25/kg	158
7. Cost of fertilizer i) Super phosphate 20gm for 625 plants 12.5 kg @ Rs. 3.50/kg ii) Ammonium nitrate 10 m for 625 plants 6.25 kg @ Rs. 8/kg	 44 50
8. Cost of application of insecticides and fertilizer	43
9. Ploughing with tractor	1355
10. First circular weeding	267
11. 2nd soil working	385
12. Replacement of casualties @ 203.3/100 for 125	254
13. Enumeration of planting points	16
14. Miscellaneous	17
15. Cost and application of FYM., ¼ Cu.ft for pit 3.12X625 per pit 3.12X625 per pit	1950
16. Pay for casual labour for watch and ward @ 20 ha for one @ Rs. 2000/month for 12 months for 20 ha	1200
Add 15% border of agency area allowed 5640	845
TOTAL FOR PLANTATION PLANTING – YEAR TWO	**10,272**
TOTAL FOR ADVANCE OPERATIONS – YEAR ONE	11,566
TOTAL FOR MAINTENANCE – YEAR THREE	**2,322**
TOTAL – PLANTATION ESTABLISHMENT – YEAR 1-3	**RS. 24,160**

If we examine the divergent costs of the two options against the potential income generated by CDM offset credits (see Table 16), it is apparent that plantation approaches for afforestation or reforestation projects are not financially feasible, while natural regeneration appears much more promising.

TABLE 16:
COSTS AND POTENTIAL CER INCOME FROM NATURAL REGENERATION AND PLANTATIONS AS CDM REFORESTATION STRATEGIES

Type of Reforestation Strategy	Establishment Cost (per hectare)	Projected Carbon Sequestered (Mt.C /ha./ annum)	Gross Annual Income from CERs* ($ / Ha. / annum)
Natural Regeneration	$8	5 to 7	$40 - 56
Eucalyptus Plantation	$493	1.4 to 9.5	$14 – 95

**CER units for forest carbon estimates are based on $10 per mtC/ annum. Current prices for forest carbon are lower, ranging from $5 to $8 per mtC/annum.*

The costs of plantation establishment are almost 50 times the cost of natural regeneration due to the higher costs for labor, heavy equipment, and other technical inputs. Natural regeneration costs are far lower as only minor silvicultural treatment is required to stimulate healthy growth of coppice shoots from tree stumps (stools) and thin weaker shoots to retain one to two emergent poles. As a consequence, if CERs for forest carbon are based on a rate of $8 per metric ton per annum, communities engaged in natural regeneration of teak and mixed deciduous forests could secure substantial returns on their investments. By contrast, high-cost eucalyptus accumulates carbon much more slowly and would not be able to generate CER revenues that match the level of investment. Thus, community forestry activities that seek financing through the CDM should emphasize natural regeneration, where possible.

Transaction Costs for Community-based CDM Forestry Projects

The CDM projects could be small or large. Developing, implementing, monitoring, reporting and verification of CDM projects would require number of activities involving costs termed as 'transaction costs.' The transaction costs involve:

- Development of the project proposal; studies on soil and vegetation, household surveys, developing technical and institutional packages, consultations, workshops, satellite images assessments, GIS application etc.
- Organizing capacity needed to physically implement the project
- Periodic measurement, monitoring and verification of baseline and CDM project scenario carbon stocks and flows, socio-economic parameters etc.
- Capacity building activities to enable local communities and NGOs to participate in the project activities.

Estimating Costs for Establishing Carbon Baselines and Project Scenarios

In this section, we discuss the human efforts and cost involved in developing the baseline and CDM scenario estimates for vegetation and soil carbon. Estimating baseline for potential CDM projects is a critical step in assessing environmental or carbon sequestration additionality. The procedure involves estimating carbon stocks in land categories and sites, under "without project scenario". It is generally assumed that estimating carbon stocks and changes in carbon stocks for a baseline scenario involves significant human effort (technical and non-technical) and cost. In the present study, the human effort needed for estimating carbon stock under potential CDM project scenario is also assessed. The human effort is converted to financial value to estimate the cost of developing baseline scenario. Human effort is estimated in terms of number of person days involved. Human effort is required at three levels in estimating baseline and CDM scenario AGB and soil carbon and the incremental carbon sequestration potential. They include field data collection, data compilation and entry, and analysis and report preparation.

In all, 34 person days were spent in doing the vegetation analysis. Four person days were spent in estimating baseline vegetation-related parameters in the field, while 7 person days were required for estimation under the CDM scenario. The time required for data entry and data compilation was 3.5 person days for baseline and 5.5 person days for CDM scenario. Analysis of data involved 2 person days for the baseline and 3.5 person days for the CDM scenario. In addition, 8.5 days of local community time was associated with the study. The total human cost for field data collection and analysis from 14 sites, was approximately $1,200 (see Table 17 for details).

TABLE 17:
COST ESTIMATE FOR VEGETATION AND SOIL CARBON ESTIMATION.

Scenario	Vegetation Type	Cost estimates for Vegetation C estimation *(Rs.)*			Cost estimate for soil C estimation *(Rs.)*		Total Cost Per Sample Site (Rs.)
		Field	Data Entry	Analysis	Field	Laboratory	
BSL	Degraded teak – BSL	1200	600	500			4200 (89)*
	Degraded secondary - BSL	850	500	500			3750 (80)
	Cropland	50	-	-	100	1800	1950 (41)
CDM	Regenerating teak – CDM	1700	600	-			4200 (89)
	Regenerating secondary forest – CDM	1450	700	500			4550 (97)
	Eucalyptus	550	100	250			2800 (60)
	Mango	300	100	250			2550 (54)

- *Value in parenthesis is total cost in US$. 1 US$ = Rs. 47.*

Estimating Other Transaction Costs in Developing CDM Forest Projects

In addition to the costs of the collecting and analyzing vegetative and soil data, costs are incurred in the process of designing the project and conducting social assessments. In this feasibility study, the social assessment team spent 30 days in the field conducting social and institutional appraisals. These appraisals allowed researchers to gather relevant data for establishing socio-economic carbon baselines that could be utilized for project design and monitoring. Field costs for the social appraisal were comparable to the vegetation assessment, around $1500.

Aside from the basic field costs, additional costs were incurred by the social and ecological assessment teams in designing the methods and documenting their experience. The total expenses incurred by the social appraisal were approximately Rs. 171,500 ($3,573) and the ecological appraisal around Rs. 367,500 ($7,656). Managing the project, organizing the field research team, hiring technical consultants, coordinating with state and national government of India agencies, reviewing CDM rules and protocols, and other supportive actions required the additional $49,000. Ongoing monitoring systems and third party audits might require an additional Rs. 150,000 per year ($3,125).

Transaction Cost vs Potential Income

In Indaram beat, approximately 500 hectares were identified to have characteristics consistent with CDM project requirements. With revenues of $40 per hectare, a gross income of $20,000 per year might be secured to cover project costs. This would represent the high end of potential income, however, since forests with poorer root stock would accumulate carbon at a slower rate. Further, current calculations of $8 per metric ton of carbon may be optimistic. Based on a $5 per metric ton payment and an annual carbon increment of 2 to 3 metric tons per hectare, a lower estimate for CER revenues in this area might be closer to $10 to $15 per hectare, or $5,000 to $7,500 for the entire 500 hectare Indaram tract. Given these lower estimates, local monitoring and third party audit costs could require 50 percent of revenues or more of the gross income.

The research team assumed that participating households would require at least 15 per cent of their total household income to be generated by the CDM project to create an adequate financial incentive to participate. In Adilabad district, this would mean Rs. 150 per month ($3) or $36 per year per household or approximately $3600 per year in net income to a village of 100 households. To meet this goal, a community of 100 households would require 250 eligible hectares of degraded forest for regeneration with an average productivity of 3 metric tons of carbon per hectare annually and a minimum price of $5 per ton. The community would then have 50 percent of the gross income available to cover transaction costs and overheads. If these minimum conditions cannot be met, it is unlikely a CDM project will be viable in Adilabad.

The difficulty with this scenario is that it only covers the field based informational costs of the program. It does not incorporate support needs related to building institutional capacity, nor does it reflect the real charges incurred in developing a CDM project for international markets. These involve dealing with the steps outlined in Part I of this paper (see Figures 1,2, and 3). These types of costs will also be present in developing and negotiating CDM projects. Nor will they abate once projects are approved, as ongoing international monitoring and validation requirements continue throughout the life of the project.

The Andhra Pradesh Forest Department (APFD) will need to be involved in any forest carbon project on state land. Under JFM agreements, communities are empowered with certain rights and responsibilities, but the APFD is the ultimate authority in management decision making. Involvement of the APFD will certainly carry additional transaction costs on any payments being made by CER buyers to the VSS or other community management groups.

Transaction costs in implementing a CDM project are likely to be high relative to the funding generated through the project. Project development costs alone are substantial, especially the institution and capacity building components. If communities are to retain some payment for forest restoration activities though the CDM, it will be necessary to control transaction costs, especially those imposed by intermediary organizations. Among others, these might include payments to: 1) CDM brokers, 2) project developers and negotiators, 3) forest departments and other technical assistance agencies, or 4) third party auditors. At the same time, the community will have to restrict capital investments and monitoring activities to remain within the revenue flow levels generated by the CER payments. In order to respond to funding limitations due to the low market price proposed for forest carbon, communities will need to view these revenues as supplemental to other sources of income generated by the forest including sustainable timber harvesting, non-timber forest products, and other environmental services.

Ensuring Sustainability

Ensuring sustainability after the life of a project has always been a big challenge for the donor community. Nearly $500 million has been invested in India's forestry projects—most of it going for JFM. The sustainability of JFM and of the prime JFM institution—the VSS—is at best questionable. In Andhra Pradesh, perhaps 5 percent of the 1,008 VSS created under the first phase of the World Bank-assisted project has been officially deemed as being sustainable at the end of six years, reflecting an ability to sustain forest management activities without external subsidies.

Most donor-driven forestry projects have a project life of five to six years, even though forestry is a long-term investment with an extended gestation period. The life cycle of teak, the predominant species in the forests of Adilabad, is at least 40-50 years. A CDM project could have the potential of providing an alternative source of external funding for local communities, one that can be sustained over the life cycle of forests. As the biomass increases with better protection and management, so does carbon sequestration and, thus, carbon income. There is potential for transferring such carbon income to local communities to cover two generations or more. Thus, a carbon sequestration project has the potential of ensuring the sustainability for a longer period of time than current externally-aided forestry projects and also dealing with issues of intergenerational equity that is the cornerstone of sustainable development.

The potential of CDM projects to sustain community-based reforestation is limited by existing CDM rules that tend to reward communities that have yet to take action, while penalizing those who are active in forest protection and management, making them ineligible for CDM project registration under "additionality" criteria. Thus, exemplary communities like Behroonguda, which began to protect its 500 hectares of degraded forests since 1990, do not qualify because under CDM terms the "intervention" has already taken place. In contrast, some of the heterogeneous, conflict-prone communities in Indaram, whose inaction has contributed to continuing forest degradation, qualify because no intervention has taken place. Unless there is a change in the rules and incentives to assist community-based natural regeneration, CDM projects in poor, degraded would not be sustainable.

Summary

It is apparent that areas in the Adilabad District suitable for CDM project eligibility are limited. CDM eligibility criteria require land that has been deforested to a state of less than 10 - percent crown cover prior to January 1, 1990. Much of the forest land in Adilabad District retains more than 10 percent cover, although in many places forest biomass is being rapidly depleted. As a consequence, 77 percent of Janarram's forest area and 70 percent of Mancherial Division's forest would fall outside of any CDM support due to its greater than 10 percent cover, despite much of this area being illegally logged and rapidly degrading. Perhaps another 5 to 10 percent of the degraded area might be disqualified because it had been deforested after 1990. In sum, it is likely than no more than 20 percent of the forest area in the two divisions would qualify in terms of forest cover and time of deforestation, excluding most of the interior forests of Kerimeri beat.

From a financial standpoint, lands that have lost their rootstock would not be good candidates for CDM projects as the costs of establishing plantations would far exceed potential revenues from CER payment. This would include the extensive *podu* lands scattered in forests throughout the district that have been used by tribal communities for long rotation agriculture (swidden). The exclusion of *podu,* and other lands barren of rootstock, would reduce the potential pool of forest land for CDM projects to perhaps 10 percent of the total forest area. In areas like Kerimeri, the presence of degrading forests with over 10 percent canopy closure, together with extensive *podu* lands, would present no opportunities for CDM projects. On the other hand, Indaram beat, with its extensive degraded forests with root stock, would be a suitable area for CDM projects if institutional constraints could be overcome.

The limited amount of area appropriate for CDM reforestation projects in Adilabad is compounded by its fragmented nature. Under current eligibility criteria and cost considerations, suitable areas will be scattered and often no more than a few hundred hectares in size. This presents problems for project design and greatly increases transaction costs. Under the present forest carbon project eligibility criteria and prevailing forest carbon market price structure, there are both promising and discouraging elements. These are explored from social, institutional, economic and ecological perspectives.

Supportive Conditions

- Social: Homogenous, tribal communities have a long history of forest protection and many are presently engaged or ready to initiative forest restoration activities in Adilabad district.

These communities represent a good social basis for carrying out field level reforestation work consistent with the intent of the CDM.

- Institutional: Among the many local institutions in Adilabad, women-administered self-help groups (SHGs) offer the best prospect for managing income from CERs. These SHGs are already exploring the formation of federations to allow them to negotiate with government, non-government, and private sector institutions. The formation of such federations could help to lower transaction costs.
- Economic: Long - term income from CER contracts would provide both an alternative source of funding and greater economic stability to communities implementing reforestation, especially if carbon income constitutes at least 15 percent of total family income. Natural regeneration costs in Adilabad are also modest allowing for higher net revenues in contrast to plantations.
- Ecological: Vegetation samples from the study indicate that naturally regenerating teak and mixed deciduous forests in Adilabad can sequester an increment of 5 to 7 metric tons of carbon annually, a relatively high level of productivity given the low costs for establishment.

By contrast, the study identified a number of serious constraints to CDM forest carbon project development.

Constraining Conditions

- Social: Heterogeneous communities—particularly, multi-caste and migrant groups—often have weak ties to natural forests and often cause social conflicts that constrain their ability to organize CDM projects. Political instability characterized by Naxalite insurgencies in Adilabad District could threaten the sustainability of potential CDM projects.
- Institutional: The presence of multiple village level organizations working without coordination handicaps efforts to identify CDM project management institutions. The failure of local communities to form a larger federation of resource management groups would limit their ability to formulate a multi-village CDM project lower transaction costs, and reduce their bargaining power with potential CER buyers.
- Economic: The narrow and rigid criteria for CDM projects—eg, the 30 December 1989 cut-off date, the 10-percent crown cover, etc.—limit the ability of communities to actively participate in CDM projects through natural regeneration. Given the lower levels of carbon sequestation and high establishment costs, eucalyptus plantations are unlikely to qualify for CDM funds under current forest carbon market prices of $ 3 to $5 per metric ton.

- Ecological: Under current eligibility guidelines, less than 10 percent of the forests of Adilabad may qualify for CDM projects, limiting the capacity of this mechanism to facilitate protection and restoration over the vast majority of the district's forests.

Recommendations

The research team presents the following recommendations to COP VIII delegates to consider during their deliberations in New Delhi:

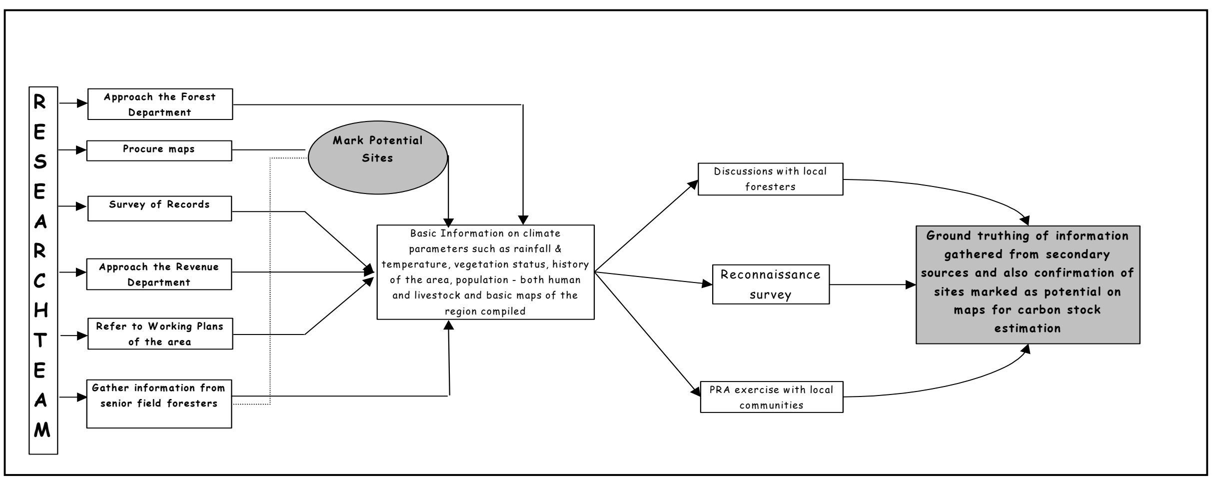
- The CDM criteria for community forest restoration need to be changed to include areas with more than 10 percent crown cover. In India, forests with less than 40 percent crown cover are designated "open" forests and considered to be degrading. These forests should be eligible for reforestation funding through CDM projects.
- CDM should allow agroforestry systems to be included under reforestation project guidelines. This would provide incentives to rural communities to shift away from swidden farming systems with low productivity and incomes, to restore forest cover and obtain additional income.
- CDM projects should be permitted in areas where communities are actively regenerating degraded forest lands. Current eligibility guidelines discriminate against communities that have begun to take action to reforest degraded lands; therefore, the guidelines should be modified. Carbon baselines could be established and payments made from the time contracts are formalized.
- CDM should encourage the development of specialized niche markets for community-based reforestation activities. Such projects make an important contribution to the development goals of the international community. Premium prices should be provided for forest carbon when community development, biodiveristy conservation, and other goals are integrated into project design.
- CDM should explore the development of new institutional mechanisms to assist community groups to design and develop forest carbon projects and to assist them to find buyers. Such an international or national agency could provide technical assistance in project formulation and brokering. This would help lower transaction costs and facilitate community involvement in the CDM. CDM should also develop special monitoring and auditing requirements for community reforestation projects that are less cumbersome, cost less, and are more accessible to the rural poor.

APPENDICES

APPENDIX 1: METHODOLOGY FOR VEGETATION SAMPLING

An important goal of the project was to develop cost-effective field methods to collect and analyze data that would establish carbon baselines and CDM scenarios. To understand how the carbon density will change with the implementation of the proposed project, we must first understand conditions such as general landscape, climate, weather (especially rainfall and temperature), vegetative history, soil type and nutrient status. These factors are all relevant to the baseline. The preliminary steps involved in sampling are given in the flow chart. As it can be seen from the chart, the steps are a combination of information compilation at two levels – the secondary and the primary level. The secondary level information is all gathered from records available in the different government departments regarding population, climate parameters, vegetation status etc. Also, discussions were held with the division level foresters as well range foresters to gather as much information as possible regarding the study area. The primary level information gathering is during the reconnaissance survey, when sites marked as potential were visited and discussions were held with local communities' help to understand the status of vegetation in the past as well as now, and also the pressure on the forests by way of dependence for subsistence or other purposes.

FIGURE 10: APPROACH TO SITE SELECTION



The reconnaissance visit aids in final decision making on sampling sites. The sites selected for baseline and CDM scenarios are given in Table 9. As can be seen, two sites for the baseline estimation are in the Mancherial forest division; the rationale being this division has large area under open forest and scrub forest categories as well as blanks. These categories are potential sites of reforestation, even under traditional management systems. However, cropland has also been sampled in Jannaram forest division or the baseline scenario.

Under the CDM scenario, for estimating the carbon sequestration potential, regenerating secondary and teak forests were selected from Behroonguda. This VSS was selected due to its long protection history and availability of regenerating teak and mixed forests, protected and managed for different time periods, in close proximity.

Eucalyptus plantation, considered as an option for reforestation in croplands, was sampled both in Mancherial and Jannaram forest divisions. In Mancherial, sites sampled included a plantation under management with a VSS (Singapur) since 1999, an industrial plantation being raised by Singareni Collieries with clonal seedlings, and a mature plantation raised under the Family Assistance Scheme during 1990 and ready for harvest during 2002. In Jannaram, another eucalyptus plantation raised during 1999 for the Kommaguda VSS was also sampled. This was to help understand the growth difference, if any because of soil quality and management system. A young and a mature mango orchard were sampled in Mancherial divisions in Mamidagutta and Bhimaram villages to get an estimate of the growth rate in carbon sequestration.

The selection of plots for sampling and measurement within a vegetation category was done using the random sampling procedure. This was to ensure that each and every section of the population has the same chance of being included in the process, avoiding bias. Once the sampling plots were located, the research team camped close to the study area to enable easier access to the sites. Materials required for the field sample taking included:

- Maps
- 4 sets of ropes for demarcating the quadrat
- Pegs for fixing the ropes at the corners
- Compass
- Vernier calipers
- 30 m metal tape
- Tailor tape
- Sickle
- Oil chalk for marking the trees measured
- Note books for recording observations

The nearby village community was contacted one day before work initiation and volunteers to guide the research team through the forest and also to work along with the team were identified. The team assembled at the edge of the forest and one of the technical persons briefed the group about the purpose of the study and the tasks that were to be undertaken. The group split into three groups – One technical group to actually guide and undertake vegetation inventory; a group of two or three persons to lay the quadrats along with the technical team and a third group to collect soil samples. The vegetation study team included one technical person to record + one field staff to measure trees + one local knowledgeable person to identify local tree species. The technical person should also be able to identify the tree species with the assistance of the local person.

Vegetation Sampling Methods

Sampling is a tool to understand the quality and quantity of an entire population or study area under investigation. A portion, or sub-set of the entire population is referred to as the sample. The vegetation sampling methods vary with several factors. Some of the factors determining the method and size of plots are:

- Area of the vegetation; large (>100 ha); medium (50-100 ha), small (<50 ha)
- Type of vegetation; primary forest, degraded forest, plantation (of one or a few species)
- Socio-economic pressure or proximity to village settlement; near or far

The size of the sample also depends upon;

- Degree of accuracy required
- Time availability
- Available human resources
- Available financial and other resources

The methods of sampling are:

- Census survey
- Quadrat Plot method
- Plotless method
  - Point centred quadrat
  - Transect – a belt transect or line intercept method

In this study, the quadrat, transect as well as census survey methods have been adopted. A quadrat is a square or a rectangular plot (Figure 11). A quadrat of a particular dimension is laid in replicates to account for variations in soil, topography and vegetation in the ecosystem. This method is preferred for standing biomass and productivity estimates and also biodiversity studies. It is generally preferable to have larger quadrats or more number of plots to enable revisits and periodic measurements. The sample plots should of course be randomly placed.

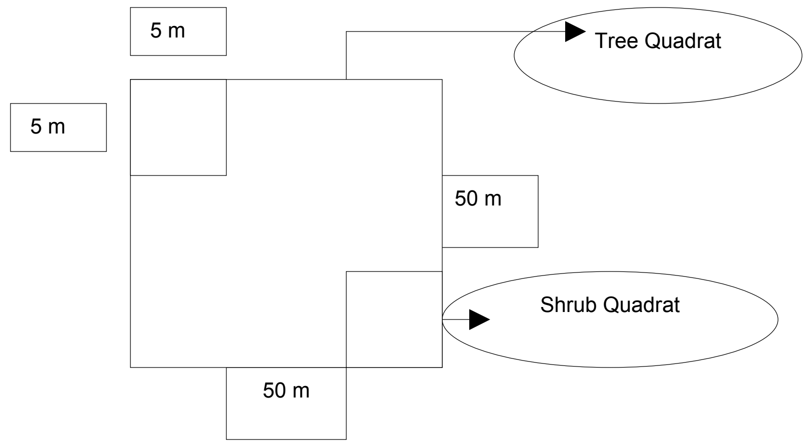
Steps in Laying a Quadrat

Tree quadrat:

- Mark the four corners of the site with pegs at the defined dimension
- The rope is tied to mark the perimeter of the plot
- Observations of all trees within the demarcated area are recorded

Shrub and herb quadrats: Once the tree quadrat is laid, a shrub quadrat of defined dimension is laid within the tree quadrat, at the four corners. Within this shrub quadrat are laid multiple herb quadrats.

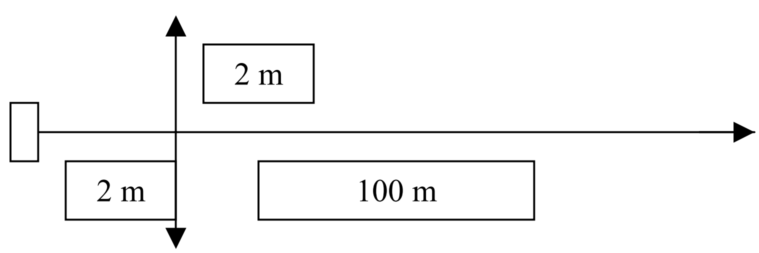
FIGURE 11: A QUADRAT



Transect Method

The transect method is adopted when there is a non-randomly distributed vegetation across a large area or in other words is widely spaced. In this method, a point is selected in the study area and fixing that point, a rope of 100 m or less is laid along a straight line (Figure 12). Another line parallel to the first line – 1.5 or 2 m on either side is marked and all trees intercepting this line are enumerated.

FIGURE 12: LAYING OF A TRANSECT.



The research team initiated work following the steps outlined above. To help reduce possible errors when a staff member measured the girth of trees at breast height, the individual was provided with a stick measuring 130 cm. One of the technical persons identified the species along with the local person and recorded the observations. The height of the trees was also estimated visually. Table 18 gives details of the quadrat size and also the number of replicates laid in each of the vegetation categories for detailed ecological studies.

Census method

For plots less than 1 ha and when tree density is low, the census method is adopted. In this method, all trees in the defined area are enumerated.

Details of Sampling under Baseline and CDM Scenarios

The quadrat size adopted is 50 X 20 m in the degraded secondary as well as regenerating secondary forests. Similar plot dimensions have been used for regenerating teak forests. However, in degraded teak forests, a larger plot size of 50 X 50 m has been laid to provide a better sample of the vast area under degraded teak forests. In the eucalyptus plantations, 50 X 50 m plots were laid in all but the 1999 plantation – II (Kommaguda), where census survey was undertaken as the total area was only 1 ha. Census survey was also conducted in the mature mango orchard of Bhimaram that spanned an area of only 0.8 ha. The transect method was followed only in the high forests with bamboo and lower canopy to account for the heterogeneity of the area.

Baseline and CDM scenarios varied.

- *Degraded secondary forest and regenerating forest*: Total area sampled with multiple replicates of 4 to 10 was 1 ha.
- *Eucalyptus plantation:* Total area sampled was 0.25 ha as vegetation is homogenous.
- *High forest:* Five transects (of 100 X 10 m) equal to an area of 0.5 ha was demarcated for measurements.
- *Eucalyptus and Mango:* For plots less than 1 ha, as for Eucalyptus plantation and mango, the census method was adopted.

Sampling for shrub and seedlings: Within the tree quadrats, 2 shrub quadrats were laid wherever there were shrubs or regenerating seedlings. The dimensions of the shrub quadrat was 5 X 5 m. Herb quadrats were not laid in any of the sample sites due to the absence of a ground layer of vegetation, the month of enumeration being peak summer.

Vegetation Parameters

Tree quadrats were laid and all trees > 1.5 m in height or > 130 cm in girth were enumerated in this study. The dimensions of the plot as mentioned earlier varied. Once the tree plots are laid, smaller plots were marked within the larger plot to study shrubs and regenerating seedlings. The parameters monitored on laying the quadrat/transect/census survey are given in Table 19. In the shrub quadrat, the parameters monitored were name of the species and girth of species. The rationale for monitoring the different vegetation parameters is given in Table 20.

TABLE 18:
SAMPLING DETAILS OF VEGETATION STUDY

Scenario	Vegetation type	Methodology	Size (m)	No. of replicates	Area sampled (ha)	Comments
Baseline	Degraded secondary forest – BSL	Quadrat	50 X 20	10	1	Large open areas with similar species composition and distribution
	Degraded teak forest – BSL	Quadrat	50 X 50	4	1	Highly degraded area with human interference and dense growth of thorny bushes along with teak
	Cropland – BSL					Degraded patch of forest with similar vegetation composition
CDM Project	Regenerating teak forest 1998 - CDM	Quadrat	50 X 20	10	1	Regenerating forest that is teak dominated and under protection by community
	Regenerating teak forest 1996 – CDM	Quadrat	50 X 20	10	1	Regenerating forest that is teak dominated and under protection by community
	Regenerating secondary forest 1994 - CDM	Quadrat	50 X 20	10	1	Regenerating mixed forest under protection by community
	Regenerating secondary forest 2000 – CDM	Quadrat	50 X 20	10	1	Regenerating mixed forest under protection by community
	High forest (with bamboo and lower canopy) - CDM	Transect	100 X 10	5	0.5	Large trees, representing species of the region and interspersed with bamboo. Transect method adopted due to large diversity of the area
	Clonal Eucalyptus plantation 1999 – CDM	Quadrat	50 X 50	2	0.25	Homogenous vegetation with fixed spacing
	Mature Eucalyptus plantation 1990 - CDM	Quadrat	50 X 50	2	0.25	Homogenous vegetation with fixed spacing
	VSS Eucalyptus plantation 1999 I – CDM	Quadrat	50 X 50	2	0.25	Homogenous vegetation with fixed spacing
	VSS Eucalyptus plantation 1999 II – CDM	Census	-	-	1	Homogenous vegetation with fixed spacing
	Mango orchard Young – CDM	Quadrat	50 X 50	-	0.5	Homogenous vegetation with well defined spacing between individual trees
	Mango orchard – Old – CDM	Census	-	-	0.8	Homogenous vegetation with well defined spacing between individual trees

TABLE 19: VEGETATION PARAMETERS MONITORED	
	Parameters monitored
Biodiversity of tree species	- Species name - Number of species in a quadrat or transect
Above ground biomass of trees	- Species name - Number of species in a quadrat or transect - Girth of individuals - Height of individuals
Shrub, Herb/Seedlings	- Species name - Number - Girth

TABLE 20: RATIONALE FOR MONITORING VEGETATION PARAMETERS		
	Parameters monitored	**Rationale**
BIODIVERSITY	-Species name -Number of species in a quadrat or transect	To obtain the density of individuals per ha as well as biodiversity by computing diversity indices
BASAL AREA & ABOVE GROUND BIOMASS	-Species name -Number of species in a quadrat or transect -Girth of individuals -Height of individuals	The girth and height parameters measured will help compute the basal area of individual trees, pool them species wise and obtain total basal area of the site. This value is used to obtain the above ground biomass of the site.

Estimation of Above Ground Biomass

The estimation of above ground biomass is critical for assessing growth rates under baseline and CDM project scenarios. In the present study, above ground biomass is estimated using the following method.

- Activity 1: Measuring DBH of tress in sample plots
- Activity 2: Estimating basal area for the sample plots and per unit area (/ha).
  Using DBH values, basal area was estimated for individual trees and aggregated across species within a plot. Cross-section area of different plots of a vegetation type was aggregated and further projected per ha. The basal area estimate is presented in terms of m^2/ha.
- Activity 3: Estimating above ground biomass in terms of volume of biomass
  Basal area is one of the best indicators of volume or biomass of trees. In this study, volume equations were used to convert basal area into volume and tree biomass was estimated in terms of volume (m^3/ha). The species-specific equations were used wherever available along with generic equations. The species-specific equations were obtained from Forest Survey of India (FSI) reports. The equations for the dominant species are as follows.

- *Tectona grandis* – V = 0.023613-0.531006D2 (Local equation); V = 0.001103 +0.31458D^2H (General)

- *Anogeissus latifolia* - $V = -0.0069 + 0.4108D^2H$ (Local equation); $V = 0.034725 - 0.78412D + 7.1873D^2 + 6.9495D^2$ (General)
- *Diospyros melanoxylon* - V = 0.024814-0.578532D6.11017D2; $V = 0.01456+0.32613D^2H$ (General)
- *Lagerstroemia parviflora* - $V = -0.066188-1.334512D+9.403257D^2$
- *Eucalyptus species* - $V = 0.02894 - 0.89284D + 8.72416D^2$

The volume estimates of biomass are converted to tons/ha using the density values. The above ground biomass is presented in terms of tons/ha.

Soil Sampling

Soil carbon is typically estimated to a particular depth, depending on the expected depth of carbon accumulation or depletion. There is considerable uncertainty in the literature on soil carbon content and the factors that affect it. In this study, soil samples were collected at two depths - 0-15 cm and 15-30 cm. The soil samples were later mixed to give a composite sample, one each at two depths. The number of soil samples collected varied from one vegetation type to another, the details of which are provided in Table 21. The soil samples collected at different places in a particular vegetation type was also collected from the crop field and similar procedure followed to obtain a composite sample.

Material required for soil carbon study

- Crowbar for digging the earth for soil samples
- Polythene covers for collecting samples
- A 30 cm stick marked mid-point at 15cm for measuring soil depth
- Small chits of paper to label the soil samples
- Pens and Pencils
- Calculator

Team for soil sampling: One technical person to select location for collecting soil samples within the demarcated plot and for recording details + 1 field staff to dig the earth and remove soil sample and mix the same.

TABLE 21: SOIL SAMPLING DETAILS			
Village	**Land Category**	**Sample depth**	**Composite samples**
Doragarapalli	Degraded teak – BSL Degraded secondary forest - BSL	0-15; 15-30 0-15; 15-30	5; 5 3; 3
Chintapalli	Cropland - BSL	0-15; 15-30	3; 3
Singapur	VSS eucalyptus plantation I - CDM	0-15; 15-30	3; 3
Singareni Collieries	Clonal eucalyptus plantation – CDM	0-15	3
Khazipalli	Mature eucalyptus plantation – CDM	0-15; 15-30	4; 4
Kommaguda	VSS eucalyptus plantation II - CDM	0-15; 15-30	4;4
Bhimaram	Mango orchard mature - CDM	0-15; 15-30	2; 2
Behrunguda	Regenerating teak 1996 – CDM Regenerating teak 1998 - CDM Regenerating secondary forest 1994 – CDM Regenerating secondary forest 2000 – CDM	0-15; 15-30 0-15; 15-30 0-15; 15-30 0-15; 15-30	5; 5 3; 3 5; 5 3; 3
Dongapalli	High forest (with bamboo and low canopy)	0-15; 15-30	3; 3

APPENDIX 2: VEGETATION STATUS UNDER BASELINE AND CDM SCENARIOS

The materials presented in Appendix 2 summarize findings from vegetation field samples not presented in the main body of this report. The data documents species richness and distribution, size class distribution, basal area, and biomass stocking levels in baseline and areas presenting different CDM scenarios. The vegetation data recorded in the field was entered into a database using Microsoft Excel software and analyzed using the tools in the spreadsheet. The vegetation analysis aimed at estimating; species diversity, Important Value Index (IVI), Size class or DBH (Diameter at Breast Height) distribution of trees, basal area, above ground biomass and mean annual biomass growth rate.

Species Richness and Number of Stems

Species richness is the total number of species present in a given area. Abundance refers to the number of individuals of each species present in the total population while density is the number of individuals of a species or number of stems in a unit area. This indicates species diversity and also helps identifying the dominant and rare species in an ecosystem. This is also an indicator of abundance as well as standing biomass of a region. Tree stems were counted in the field i.e. if a tree had multiple branches – coppiced branches, they were counted and measured individually. This was also used for estimating basal area and above ground biomass. The number of species as well as individuals per ha in the different vegetation types under the baseline and CDM scenarios is presented in Table 22. The table also presents the index of evenness, indicating the number of species present in the area sampled. This is also a measure of diversity and abundance of species. When all species are equally represented, the evenness index would be at the maximum level.

Under the baseline scenario, degraded teak forests have recorded the highest number of species as well as highest number of individuals per ha. However, the index of evenness is low (0.39) and indicates that the abundance of species is very different from each other. The degraded secondary forests have only 19 species as compared to 39 species in the degraded teak forests. The number of individuals in the degraded secondary forest is only one-quarter (332 as compared to 1384) of the recorded number of individuals in the degraded teak forests. But, the index of evenness is considerably higher at 0.72, indicating an even distribution of individuals across species.

Under the CDM scenario, the number of species in regenerating secondary forests, being protected since 2000 and 1994 is about 35. However, the number of individuals per ha in the secondary forests of 2000 is only 55 percent of that reported from the 1994 protected forests. Among the regenerating teak forests, the 1998 protected forest has more number of species (20), represented by 460 individuals while the 1996 protected forest has more number of individuals (536) belonging to 15 species. The index of evenness is about the same in both the regenerating teak forests.

The high forests have maximum number of species (50) represented by 228 individuals. The evenness index is highest (0.7) among all vegetation types – both BSL and CDM, indicating effective representation of all species. The industrial eucalyptus plantation as well as the mango orchards have been effectively managed to represent only a single species. All the eucalyptus plantations except VSS plantation-II of 1999, all have approximately 500 individuals per ha. The eucalyptus plantation-I of 1999 and the mature plantation support a few miscellaneous species and as expected the evenness index is very low, close to zero as these plantations have been principally managed only for timber.

TABLE 22:
NUMBER OF SPECIES, INDIVIDUALS AND EVENNESS INDEX UNDER BSL AND CDM SCENARIOS

Scenario	Vegetation Type	Number of Species/ha	Number of Individuals/ha	Index of Evenness
Baseline	Degraded secondary forest – BSL	19	332	0.72
	Degraded teak forest – BSL	39	1384	0.39
	Cropland – BSL	3	5	-
CDM Project	Regenerating teak forest 1998 – CDM	20	460	0.33
	Regenerating teak forest 1996 – CDM	15	536	0.39
	Regenerating secondary forest 1994 - CDM	33	713	0.44
	Regenerating secondary forest 2000 – CDM	36	389	0.69
	High forest (with bamboo and lower canopy) - CDM	50	228	0.70
	Clonal Eucalyptus plantation 1999 – CDM	1	505	-
	Mature Eucalyptus plantation 1990 - CDM	10	502	0.06
	VSS Eucalyptus plantation 1999 I – CDM	10	540	0.11
	VSS Eucalyptus plantation 1999 II – CDM	2	866	0.06
	Mango orchard Young – CDM	1	102	-
	Mango orchard Old – CDM	1	44	-

The number of species per hectare is thus highest in the degraded teak forests (1384) and in the degraded secondary forests it is 332 and 475/ha (Table 22). In the sites sampled for potential CDM scenario, the number of species was highest (713) in regenerating secondary forest 1994. This is followed by the regenerating teak forest 1996 (536), regenerating teak 1998 (460) and regenerating secondary forest 2000 (389). This clearly indicates that the longer an area is protected, the better the regeneration. The higher number of stems is largely due to regeneration of side shoots or coppices.

Biodiversity

Species diversity refers to variation that exists in an ecosystem. It is an indicator of the extent of biodiversity. Diversity is often represented in the form of indices. These indices incorporate both species richness and abundance into a single numerical value. These are also referred to as the heterogeneity indices. The two widely used indices are Shannon Wiener diversity index and Simpson's index. Shannon Wiener index gives the probability of occurrence of two individuals belonging to two different species in a habitat, when selected at random. The diversity indices consider the number of species, the number of individuals of a species as well as the total number of individuals of all species.

TABLE 23:
BIODIVERSITY INDEX OF BASELINE AND CDM SCENARIO VEGETATION PLOTS

Baseline Scenario	Shannon Wiener Index (H')	CDM Scenario	Shannon Wiener Index (H')
Degraded teak – BSL	1.31	Regenerating teak 1996 – CDM	0.94
		Regenerating teak 1998 – CDM	0.89
Degraded secondary - BSL	1.90	Regenerating secondary forest 1994 – CDM	1.44
		Regenerating secondary forest 2000 – CDM	2.30
Cropland	-	High forest (with bamboo and lower canopy) - CDM	2.27
	-	Clonal Eucalyptus plantation 1999 – CDM	-
	-	Mature Eucalyptus plantation 1990 - CDM	0.10
	-	VSS Eucalyptus plantation 1999 I – CDM	0.18
	-	VSS Eucalyptus plantation 1999 II – CDM	0.04
	-	Mango orchard Young – CDM	-
	-	Mango orchard – Old – CDM	-

The biodiversity of the baseline vegetation types is low as indicated by the Shannon Wiener Diversity Index (H'). It ranges between 0.78 in degraded teak forests to 1.9 in degraded secondary forests. Under the CDM scenario, H' is high for the high forests (2.27) and community managed regenerating secondary forests (2.3) of 2000 (Table 23). In the regenerating teak forests of 1996 and 1994, the diversity is 0.9. In the eucalyptus plantations, the diversity is low as expected and ranges between 0.04 and 0.1. The mango orchards that are privately managed as well as the clonal eucalyptus plantation that is managed by an industry both support no other species other than mango and eucalyptus, respectively.

Importance Value Index of Species

IVI is calculated following standard practices as prescribed by Mori *et al.,* (1983). The calculation of relative density and relative dominance is straight forward in that relative density is the ratio of individuals of a species to the total number of species recorded and relative dominance is the ratio of basal area of a particular species to total basal area of all the individuals in the area sampled. However in order to calculate relative frequency, the various plots were pooled together and the occurrence of species was recorded every time it appeared in a sampling unit. Pooling was done to record significant variations in frequency and density. The ratio of the number of occurrences of a particular species to the total number of occurrences of all the species yields relative frequency. Summing the relative density, the relative dominance, and the relative frequency, and multiplying by hundred generates the data for the Important Value Index. Tables 24 and 25 list the top ten species in the different vegetation types in the baseline and CDM scenarios and gives Important Value Index (IVI) as well as basal area (m^2/ha).

TABLE 24: IVI AND BASAL AREA OF TOP TEN SPECIES UNDER BASELINE SCENARIO

Degraded secondary forest – BSL			Degraded teak forest - BSL		
Species	**Basal area (m2/ha)**	**IVI**	**Species**	**Basal area (m2/ha)**	**IVI**
Diospyros melanoxylon	0.2047	***87.24***	***Tectona grandis***	0.0556	**102.33**
Morinda tinctoria	0.1056	49.91	*Diospyros melanoxylon*	0.1066	69.50
Lagerstroemia parviflora	0.0534	33.12	*Xantolis tomentosa*	0.0100	12.54
Anogeissus latifolia	0.0431	29.07	*Morinda tinctoria*	0.0035	10.07
Azadirachta indica	0.0358	23.61	*Holarrhena antidysenterica*	0.0063	9.98
Albizia procera	0.0160	17.27	*Calycopteris floribunda*	0.0060	8.98
Holarrhaena antidysenterica	0.0130	13.86	*Anogeissus latifolia*	0.0015	7.92
Cassia fistula	0.0114	11.12	*Zizyphus xylopyrus*	0.0023	7.08
Ixora brachiata	0.0042	8.08	*Cassia fistula*	0.0009	6.46
Aglaia roxburghii	0.0039	8.02	*Zizyphus oenoplea*	0.0006	6.04
Others	0.0130	18.69	Others	0.0116	59.10
TOTAL	**0.50**		**TOTAL**	**0.21**	

In the baseline scenario, *Tectona grandis* is the dominant species in degraded teak as well as one of the degraded secondary forest sites. In the degraded teak site, teak accounts for 70 percent of the total number of individuals present. In the second degraded secondary forest site, the dominant species is *Diospyros melanoxylon* (Table 24). Under the CDM scenario, in all the sites – regenerating secondary as well as regenerating teak forests and high forests, teak is the most dominant species with an Important Value Index ranging from 76 in regenerating secondary forest 2000 to 175 in regenerating teak forest 1998. The other dominant species in regenerating teak and secondary forests include, *Acacia catechu*, *Lagerstroemia parviflora*, *Diospyros melanoxylon* (see Table 25).

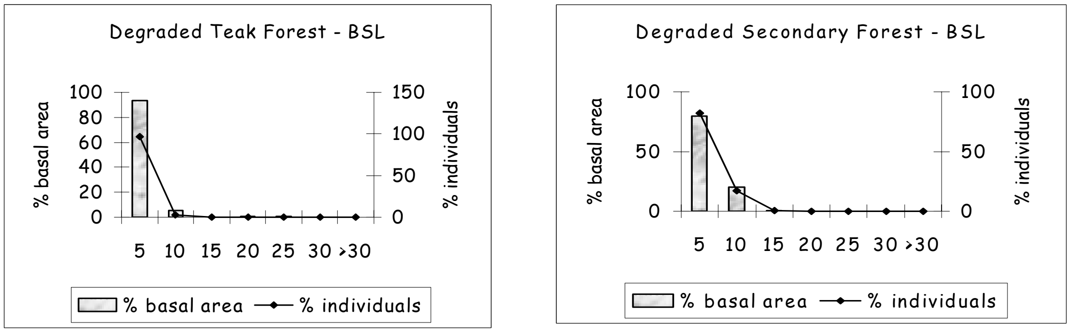
TABLE 25:
IVI AND BASAL AREA OF TOP TEN SPECIES UNDER CDM SCENARIO

Regenerating secondary forest 2000 – CDM			**Regenerating teak forest 1998 – CDM**		
Species	**Basal area (m2/ha)**	**IVI**	**Species**	**Basal area (m2/ha)**	**IVI**
Tectona grandis	***1.6552***	***76.11***	***Tectona grandis***	***5.4338***	175.37
Terminalia tomentosa	1.2283	38.19	*Lagerstroemia parviflora*	0.3039	25.26
Acacia catechu	0.7551	20.79	*Acacia catechu*	0.4883	18.02
Lagerstroemia parviflora	0.4711	20.06	*Pterocarpus marsupium*	0.2192	14.94
Madhuca latifolia	0.7451	13.83	*Diospyros melanoxylon*	0.0213	14.69
Clesistanthus collinus	0.1840	13.82	*Pterocarpus santalilnus*	0.0956	12.26
Wrightia tinctoria	0.1836	12.46	*Bombax malabaricum*	0.0577	7.31
Diospyros melanoxylon	0.0580	11.14	*Azadirachta indica*	0.0340	6.96
Strychnos nux vomica	0.1591	11.03	*Terminalia tomentosa*	0.0393	4.10
Lannea coramandelica	0.0737	8.99	*Zizyphus xylopyra*	0.0461	3.91
Others	0.8040	73.58	Others	0.0704	17.00
TOTAL	**6.32**		**TOTAL**	**6.81**	
Regenerating secondary forest 1994 – CDM			***Regenerating teak forest 1996 - CDM***		
Tectona grandis	5.7644	127.39	*Tectona grandis*	*4.3405*	*162.50*
Acacia catechu	2.7380	40.41	*Acacia catechu*	1.0705	38.03
Wrightia tinctoria	0.3445	20.02	*Diospyros melanoxylon*	0.1831	30.54
Diospyros melanoxylon	0.0934	14.16	*Azadirachta Indica*	0.2007	21.87
Strychnos nux-vomica	0.3764	13.73	*Lagerstroemia parviflora*	0.1314	15.09
Lagerstroemia parviflora	0.1928	12.83	*Aegle marmelos*	0.0134	7.63
Azadirachta indica	0.2037	11.95	*Butea Monosperma*	0.0955	5.11
Zizyphus xylopyra	0.3406	11.72	*Albizia procera*	0.0618	4.82
Bauhinia racemosa	0.2790	6.39	*Pterocarpus marsupium*	0.0438	4.78
Morinda tinctoria	0.0433	6.13	*Anogeissus latifolia*	0.0358	4.40
Others	0.4674	35.26	*Others*	0.0720	5.23
TOTAL	**10.84**		**TOTAL**	**6.25**	
High forest (with bamboo and lower canopy) - CDM					
Tectona grandis	*5.7964*	*60.82*			
Dalbergia paniculata	0.4342	18.69			
Ficus bengalensis	3.0394	17.58			
Ficus religiosa	2.2180	16.83			
Terminalia arjuna	2.5605	16.19			
Butea monosperma	0.3797	13.01			
Bombax malabaricum	1.7861	11.63			
Holeptelia sp	0.3102	10.40			
Terminalia belerica	0.5806	9.06			
Others	3.9516	125.78			
TOTAL	**21.06**				

Size Class or Frequency Distribution of Species

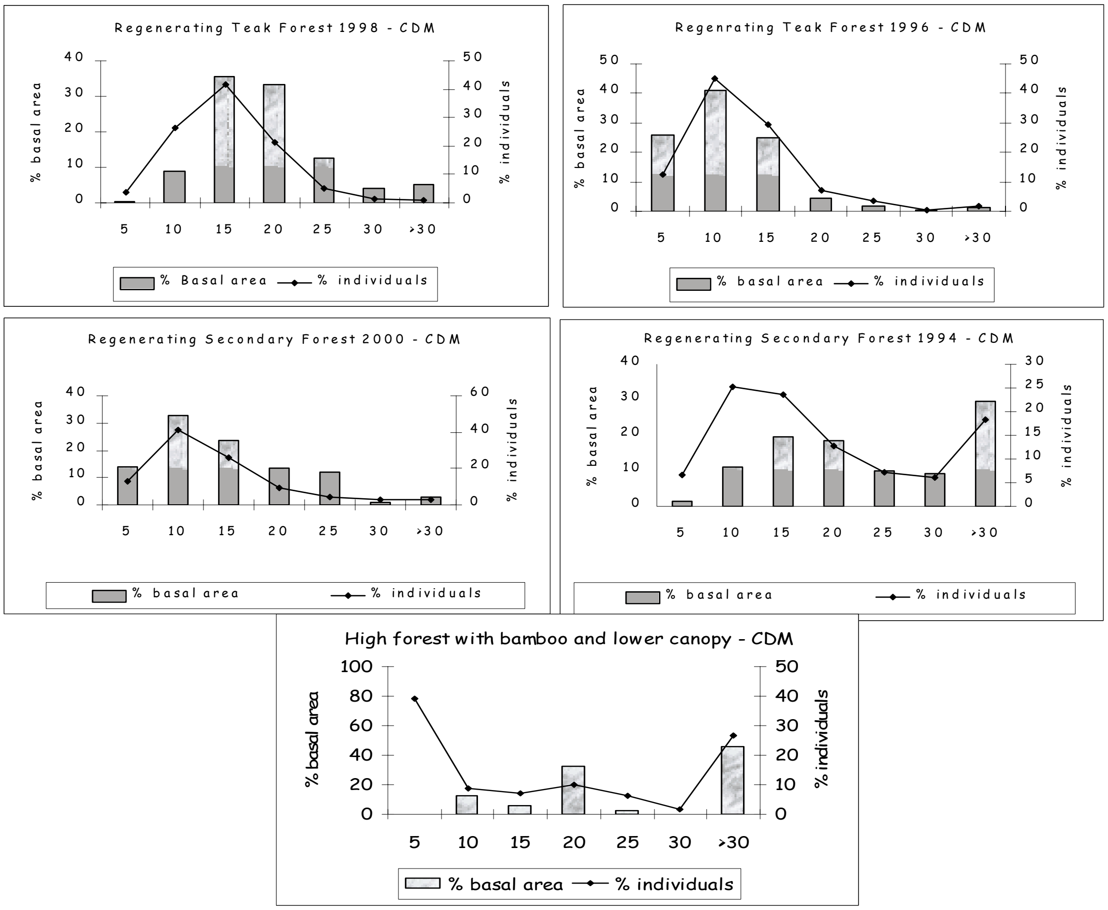
Under the baseline situation, the degraded secondary forests have individuals in the size class ranging from 0-15 cm only. There are no individuals in the higher size class of 15 cm to beyond 30 cm. Eighty percent of the individuals are in the 0-5 cm size class and only 0.3 percent is in the 10-15 cm size class indicating that the area was totally degraded and is now regenerating. It also indicates that if properly protected and managed, the forest would recover back to normal. In the degraded teak forests, almost 94 percent of the individuals are in the 0-5 cm size class and about 5 percent is in the subsequent size class of 5-10 cm. The rest of the individuals (1 percent) are in the 10-25 cm size class (Figure 13).

FIGURE 13: SIZE CLASS DISTRIBUTION OF INDIVIDUALS IN BASELINE SCENARIO.



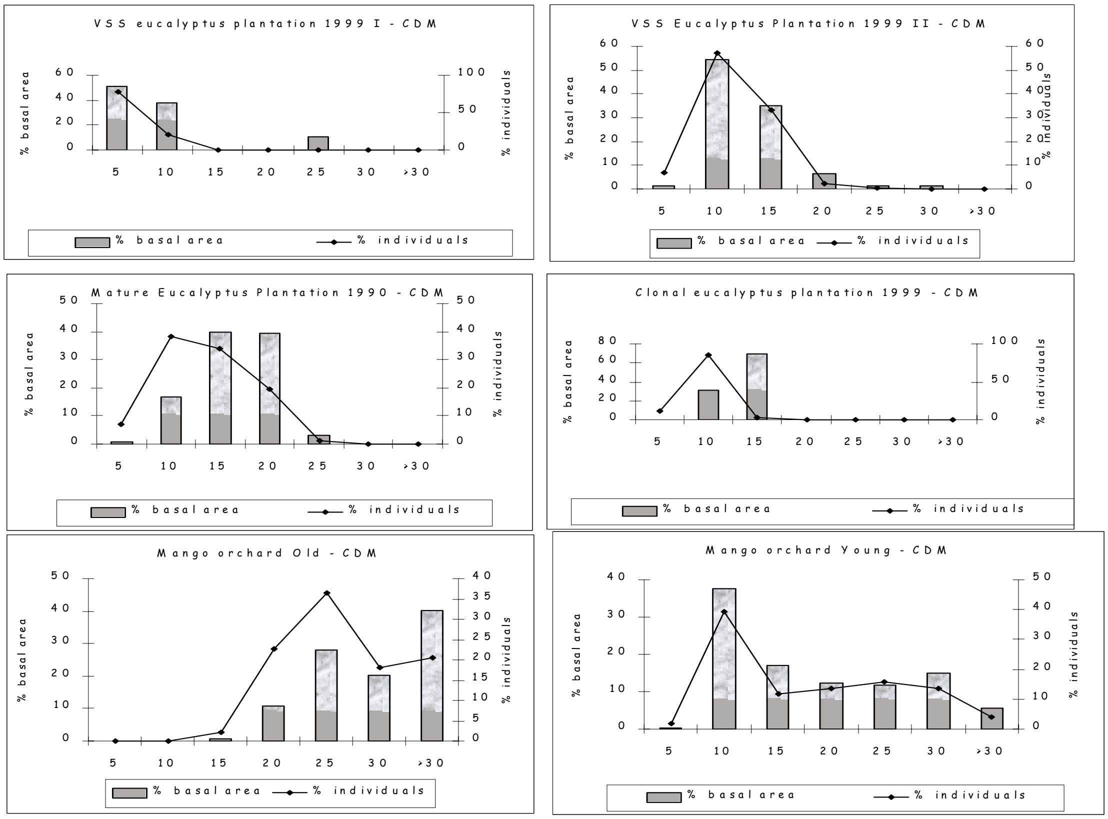
In the CDM Scenario, among the regenerating secondary forest protected since 1994 had 18 percent the total number of individual trees in the > 30 cm size class. This indicates that there were some large and mature trees in the area, even when protection was initiated in 1994. The 5-10 cm and 10-15 cm regenerating class each has nearly 25 percent of the individuals, an indicator of effective protection (Figure 6). The regenerating protected forest of 2000 has maximum percentage of individuals in the regenerating size class of 5-10 cm size class and has representative individuals spread across all size classes, indicating health of the forest. The regenerating teak forests also have significant representation in the regenerating size classes. However, the 0-5 cm class in regenerating teak 1998 has less than 0.3 percent individuals, indicating some disturbance to the area (Figure 14).

FIGURE 14: SIZE CLASS DISTRIBUTION OF INDIVIDUALS IN REGENERATING AND HIGH FORESTS UNDER CDM SCENARIO.



The high forest with bamboo and lower canopy species has good representation in the regenerating size class (39 percent) as well as the higher size class of > 30 cm (27 percent). All the eucalyptus plantations have individuals distributed across similar age class as they were all planted at one point of time and given the same silvicultural treatment (Figure 15). The mature mango orchard has more number of individuals in the higher size class as compared to the young orchard with more representation in the lower size class (Figure 15). The orchards also have individuals distributed across the various size classes. These are individuals planted on mortality of some individuals (Gap-filling).

FIGURE 15: SIZE CLASS DISTRIBUTION OF INDIVIDUALS IN EUCALYPTUS PLANTATIONS AND MANGO ORCHARDS UNDER CDM SCENARIO



Basal Area

Basal area is the area occupied above ground when cross-section area of trees is taken at a height of 130 cm. It is the single most important indicator of size, volume or weight of trees. This is an important parameter for estimating standing biomass in a given area, which in turn can be used as a measure of productivity. Using equations developed by Forest Survey of India, volume of individual trees was computed using species-specific equations, wherever available and for others volume was computed as a product of basal area and height. Table 26 is a summary table giving the number of stems and basal area in the different plots under baseline and CDM scenarios.

Basal area under baseline scenario: The basal area of degraded teak forest is 0.21 m^2/ha and that of the degraded secondary forest site is 0.5 m^2/ha (Table 27). This indicates that the area is not fully degraded but if left unmanaged, will continue to degrade and may lose the existing biomass. In the degraded secondary forests and teak forests, the basal area reported is very low as 82 percent and 97 percent of the individuals are in the 0-5 cm size class, respectively.

TABLE 26: NUMBER OF STEMS/HA AND BASAL AREA OF VEGETATION TYPES UNDER BASELINE AND CDM SCENARIOS			
Scenario	**Vegetation type**	**Number of species/ha**	**Basal area (m^2//ha)**
Baseline	Degraded secondary forest – BSL	19	0.50
	Degraded teak forest – BSL	39	0.21
	Cropland – BSL	3	
CDM Project	Regenerating teak forest 1998 – CDM	20	6.81
	Regenerating teak forest 1996 – CDM	15	6.25
	Regenerating secondary forest 1994 - CDM	33	10.84
	Regenerating secondary forest 2000 – CDM	36	6.32
	High forest (with bamboo and lower canopy) - CDM	50	21.06
	Clonal Eucalyptus plantation 1999 – CDM	1	4.26
	Mature Eucalyptus plantation 1990 - CDM	10	5.36
	VSS Eucalyptus plantation 1999 I – CDM	10	0.77
	VSS Eucalyptus plantation 1999 II – CDM	2	0.63
	Mango orchard Young – CDM	1	0.57
	Mango orchard – Old – CDM	1	0.94

Basal area under CDM scenario: Under the CDM scenario, the basal area of regenerating secondary forest 1994 is the highest at 10.84 m^2/ha. This is because nearly 30% of the basal area is contributed by large trees in the size class > 30 cm. In the other regenerating forests – both secondary mixed as well as teak forests, the basal area is about 6 m^2/ha. The high forests, supporting several large and mature trees has a basal area of about 21 m^2/ha. The eucalyptus plantations belonging to the VSS, although of same age (3 years old) show different growth rates, may be because of the variation in site quality and therefore the basal area is slightly higher (0.77 m^2/ha) in one than the other (0.63 m^2/ha). The industrial eucalyptus plantation of the same age as VSS plantations has nearly six times more basal area (4.26 m^2/ha), as the seedlings used for planting were high quality clones. The mature eucalyptus plantation has the highest basal area among plantations (5.36 m^2/ha). The mango orchards – both young and mature have biomass less than 1 m^2/ha. This could be because of the large spacing between individual trees, resulting in low density of trees/ha (see Table 26).

Above Ground Biomass (AGB)

The above ground biomass is estimated using biomass (or volume) equations. 0.67 percent of the total volume, based on average density volume is considered as above ground biomass. If the basal area is less than 1 m^2/ha, the above ground biomass is likely to be less than 10 t/ha. Thus, the basal area is insignificant for degraded teak and secondary forests under the baseline scenario. In the CDM scenario, the above ground biomass for regenerating teak is 44 and 47 t/ha for protection since 1998 and 1996, respectively (see Table 27). The regenerating secondary forests protected since 1994 has above ground biomass of 86 t/ha while the forest protected since 2000 supports a biomass of 61 t/ha. In the 1994 regenerating forest, 30 percent of the total basal area is contributed by 18 percent of the trees with > 30 cm girth. In the 2000 protected regenerating forest, there are several individuals in the medium as well as higher size classes. This indicates that at the onset of protection, there were some mature trees in the area.

TABLE 27: BASAL AREA AND ABOVE GROUND BIOMASS (T/HA) OF VEGETATION PLOTS UNDER BASELINE AND CDM SCENARIOS					
Baseline scenario	**Basal area (m^2/ha)**	**Above ground biomass (t/ha)**	**CDM scenario**	**Basal area (m^2/ha)**	**Above ground biomass (t/ha)**
Degraded teak – BSL	0.21	0.67	Regenerating teak 1996 – CDM	6.25	44
			Regenerating teak 1998 – CDM	6.81	47
Degraded secondary - BSL	0.50	0.87	Regenerating secondary forest 1994 – CDM	10.84	86
			Regenerating secondary forest 2000 – CDM	6.32	61
			High forest (with bamboo and lower canopy) – CDM	21.06	146
Cropland			Clonal Eucalyptus plantation 1999 – CDM	4.26	27
			Mature Eucalyptus plantation 1990 – CDM	5.36	42
			VSS Eucalyptus plantation 1999 I – CDM	0.77	7
			VSS Eucalyptus plantation 1999 II – CDM	0.63	5
			Mango orchard Young – CDM	0.57	2
			Mango orchard – Old – CDM	0.94	5

Eucalyptus plantations planted under VSS during 1999 (3 years old) have very low above ground biomass. However, industrial eucalyptus plantation of high quality clones has a biomass of 27 t/ha and the mature plantation has about 42 t/ha. The mango orchards have recorded very low AGB as the tree density per unit area is less, resulting in low basal area and correspondingly lower biomass.

APPENDIX 3: COMMUNITY REFORESTATION: A CDM PROJECT SCENARIO[17]

How can poor farmers and foresters benefit from the Clean Development Mechanism? This question is currently being investigated by a number of international forestry research organizations. In an effort to assess the potential economic benefits for rural people in central India, a scenario was constructed to estimates the expenses and income from a possible community forest carbon project. The CDM scenario makes a number of assumptions, reflecting the social, economic, and ecological conditions documented in a recent CFI study in Adilabad District. The scenario is based on a reforestation strategy utilizing assisted natural regeneration (ANR) of degraded mixed secondary forest with less than 30 percent crown cover deforested prior to January 1, 1990. The assumed parameters are given below:

- Size of eligible project land: 2,000 hectares (100 ha. per village)
- Number of villages: 20
- Number of households: 1000
- Average annual incremental carbon sequestration rate: 5 tC/ha.
- Total annual carbon increment within Project Accounting Boundary: 10,000 tC
- Cost of treatment: US $20/ha. (Rs.1,000/ha,)
- Total annual gross revenue from CERs: $80,000 (Rs. 40,00,000)
- Net annual household income from CERs: $46 (Rs.2300) –
  approximately 20% of annual household income

Discussion

After one time costs for project establishment are covered, the community participants could anticipate revenues of approximately $80,000 annually from CERS. Divided among the 1000 participating households, this would result in an average annual income of $46 (Rs.2,300) each year, representing just under 20 percent additional income for the average household in the area. At this level, participating households would have reasonable financial incentives to support the project. This CDM project scenario, however, is based on a number of optimistic assumptions including the following**:**

- Twenty villages can develop the institutional capacity through federated structures to collaborate in implementing a forest carbon project.

[17] This scenario was presented at a COP VIII organized by CIFOR on October 28th, 2002 in New Delhi India.

Considerable institution building by local NGOs and community leaders will be needed to create capacity for internal administration, financial management, and interactions with government and outside institutions.

- Each village would have 100 hectares of eligible degraded forest land available with good potential for Assisted Natural Regeneration (ANR).
  Many communities have this much forest area or more, but given emerging CDM eligibility criteria, the majority of their degraded forest lands could be excluded.

- Average rates of carbon sequestration above and below ground would be 5 tC/ha./year.

These rates of sequestration are premised on the presence of vigorous root stock, without which more costly technical interventions are required.

- CERs payments of $8 per ton of carbon are available on international markets.
  Some market activity for forest carbon is operating at $3 to $ 5 per ton.

- One time costs for CDM Project Processing could be held to 5 percent of total CER revenues. If international private sector firms perform these roles, costs could exceed these projections considerably. Local firms need to emerge to develop and process CDM proposals.

Projected Transaction and Implementation Costs for CDM Project Scenario: 2004-2012

ACTIVITY	ONE TIME	ANNUAL RECURRING COSTS (8 YEARS)	TOTAL COSTS
Project Identification and Baseline Cost	$20,000		$20,000
Project I.D	$5,000		
Social Baseline	$2,500		
Ecological Baseline	$2,500		
Project Proposal Development	$10,000		
CDM Processing	$35,000		$35,000
Project Support Services with Private Sector	$25,000		

COP Registration and Approval with CDM	$10,000		
Government Processing	$15,000		$15,000
3rd Party Audit	$10,000 (2 x $5,000)		$10,000
Community Support Costs	$30,000	$20,000 (160,000)	$190,000
Treatment Costs*	$15,000	$5,000 ($40,000)	$55,000
Institutional Support (NGO)		$5,000 ($40,000)	$40,000
Technical Support (Forest Department)		$5,000 ($40,000)	$40,000
Community Federation Project Administration and Monitoring+	$15,000	$5,000 ($40,000)	$55,000
Total Project Costs	$110,000	$20,000 ($160,000)	$270,000
Total Gross CER Project Revenue		$80,000 Annual	$640,000 8 year commitment period
Total Project Net Income	($40,000) (Year 0)	$220,000 (Year 1-8)	$370,000
Total Household Net Income			$370 (Rs.18,500) ($46 per year or Rs. 2300/year)

*Most of these funds would be used to employ community members to perform silvicultural treatments, soil conservation, and patrolling.
+These funds would be managed by community representatives through their project federation and include capacity building in fiscal management and accounting.

Summary

This scenario suggests that community-based forest carbon projects maybe financially feasible if eligibility criteria are flexible enough to include areas with up to 30% crown cover, forest carbon market prices are around $ 8 per ton, and international contracting costs can be controlled. Since many of the transaction costs are fixed, if the project scenario area was reduced, the carbon yield lower, or the market price less, this scenario would loose its financial viability. Financial feasibility is also dependent on controlling transaction costs from government agencies including national and state authorities, and forest departments. Finally, CDM procedures for project contracting, registration, and validation need to be streamlined to facilitate the processing of community-based forest carbon projects. Experimentation should be encouraged to explore the development of different types of facilities and mechanisms to process project proposals.