# USDA Forest Service Mission, Fianarantsoa, Madagascar In Support of the Landscape Development Interventions Project


## FINAL REPORT

**Mission Dates: July 2 – 21, 2001**

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## LIST OF ACRONYMS AND TERMS

| | |
|---|---|
| **CAF** | o Cadre d'Appui Forestier |
| **COBA** | o Communal associations brought together around forest and watershed issues |
| **DIREF** | o Direction des Eaux et Forêts (Department of Water and Forests) |
| **EASTA Iboaka** | o Ecole d'Application des Sciences Techniques et Agricoles (The local forestry school in Fianarantsoa) |
| **FCE** | o Fianarantsoa Côte Est Railroad |
| **fmg** | o Francs Malgache |
| **GCF** | o Gestion Contractualisée des Forêts (Transfer of Forest Management) |
| **GELOSE** | o Gestion Locale Securisée (A law that provides the mechanism for management transfer of lands to village communes) |
| **ha** | o Hectare |
| **IRR** | o Internal Rate of Return |
| **km** | o Kilometer |
| **LDI** | o Landscape Development Interventions |
| **lm** | o Linear meter |
| **m3** | o Cubic meters |
| **MECIE** | o A local law that requires private operators on communal lands to do environmental impact assessments. |
| **MEF** | o Ministre des Eaux et Forêts Ministry of Water and Forests |
| **MFmg** | o 1000 francs malgache |
| **Miray** | o Consortium PACT – Conservation International – WWF |
| **mo** | o Month |
| **NPV** | o Net present value |
| **ONE** | o Office National de l'Environnement (National Office of the Environment) |
| **PACT** | o Private Agencies Collaborating Together |
| **PCT** | o Pre-commercial Thinning |
| **TIC** | o Total investment costs |
| **TPH** | o Trees per Hectare |
| **yr** | o Year |

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# FORWARD

A USDA Forest Service funded mission of three USDA Forest Service professionals was undertaken during July 2 – 21, 2001. The mission team consisted of:

Denise Ingram – Forestry Economist, USDA Forest Service, Office of International Programs, Washington, DC

John Townsley – Forest Sivilculturist, USDA Forest Service, Okanogan and Wenatchee National Forests, Pacific Northwest Region

Peter Gaulke – Land and Resource Management Planner, USDA Forest Service, Cibola National Forest, Southwestern Region

Aims of the mission where presented in detail to the team upon arrival in Fianarantsoa. Three primary and over-ridding objectives of the mission where undertaken. Within these three objectives resource specific objectives were articulated.

## Reforestation of the Haute Matsiatra

1. An Outline and Process for Management of the Pine Plantations of the Haute Matsiatra.

   Develop a silvicultural management plan (prescription) for one or two stands (parcelles) to be used as models for preparation of other silvicultural plans. This model will serve as an example for the preparation of other plans in much larger stands. The model should be simple and clear for the private operators and the Department of Water and Forests so that other plans from could be developed. Calculate the value of the wood in these plantations at different densities and calculate the cost of stand treatments based on different values. Undertake a small training with EASTA Iboaka and other partners on how to simply measure the standing volumes of the trees within these stands. The program should be simple and follow a process which can be used on 15-20 year pine plantation concessions to justify the investments by the private sector in forest management.

2. Economic Analysis of Single Units Within the Pine Plantations of Haute Matsiatra.

   Do a detailed analysis of one or two reforestation stands on the profitability, cost of maintenance, etc. Do an analysis on the same stands or one of the plans under management. The model should present and teach a practical analysis and punctuate the profitability of a forest stand. The model should calculate the financial value of stands of different densities and the approximate costs of rehabilitations of these stands. This model should be simple, easy to manipulate by the users and the forest operators, and should be narrowly focused on the management plans.

## Management of the Watershed Surrounding Lac Antarambiby

1. Evaluation of the Environmental Impacts of Management of the Pine Plantation Within the Watershed of Lac Antarambiby.

   This objective centered on providing direction and potentially a framework for modeling the impacts of the current state of the pine plantations on water yield within the Fianarantsoa watershed. As an extension of this, review and propose analysis needed to develop sustainable water yields for the watershed through silvicultural and other management practices within the

pine plantations. Identify analysis needs to assist in the modeling of impact of the existing and proposed management of the pine plantations on water yield. Provide direction on the dialogue and future conversations between local Malagasy parties on the management of the Fianarantsoa watershed.

The "Forest Corridor"

1. Analysis of The Processes Used and Potentials for Natural Forest Management Plans Within the Forest Corridor.

   Study the procedures and techniques in use currently for development of natural forest management plans in the Forest Corridor by GCF and GELOSE through a zoning process for the Corridor. Propose a method to develop natural forest management plans simply and less costly. Visit and focus on the examples of GCF in Miarinarivo and Alaitsinany-lalamarina, but consider these examples in context of the work of GCF and GELOSE with the village commune of Tolongoina. Tie these discussions with observations on how to prioritize and develop a process for zoning the forest within the "Corridor".

This report is organized into three distinct yet related sections. Each section is written by individual team members. Sections were review by the team for consistency. The first section, written by Mr. Gaulke, addresses a "simple, rule of thumb" process for the development of forest management plans. The second section, written by Mr. Townsley, outlines a silvicultural management plan and harvest schedule for the pine plantations within La Haute Matsiatra. Finally, the last section, written by Ms. Ingram, provides an economic analysis of implementing the stand management scenarios discussion in Section Two.

# MISSION ITINERARY

**Lundi, 2 juillet**

19: 10 Arrivée à Ivato de M John Townsley par Inter-Air D6 0203 via Johannesburg (Equipe A). Loger à l'Hotel IBIS. Véhicule USAID rencontre John à l'aéroport

22: 25 Arrivée à Ivato de Mme Denise Ingram par AIR FRANCE # 3876 via Paris (Equipe A). Loger à l'Hôtel IBIS. Véhicule USAID rencontre Denise à l'aéroport.

**Mardi, 3 juillet**

9:15 Réunion à LDI Antananarivo. Rencontre avec M. Jean-Robert Estimé (Directeur) et Mme. Aliette (Responsable volet forestier). Véhicule USAID conduit l'équipe.

14:30 Réunion de courtoisie avec Mme. Fleurette, Directeur Général de Ministère des Eaux et Forêts

16:00 Introduction avec staff USAID et d'autres partenaires (ILO, PAGE, Pact) au bureau USAID.

**Mercredi, 4 juillet**

6:00 Départ de l'Hôtel IBIS de M. John et Mme. Denise. Voyage par la route à Fianarantsoa.

15:00 Arrivée à Fianarantsoa. Loger à Zomahotel.

19:00 Dîner avec Mark Freudenberger

20:25 Arrivée de Peter Gaulke. Air France no. 3876

**Jeudi, 5 juillet** Introductions sur le Contexte Forestier et les Reboisements de la Haute Matsiatra
***Coordinateur de la Journée: Mark et Haja avec DIREF***

6:00 Départ de Peter Gaulke de l'Hôtel Ibis pour Fianarantsoa

Equipe A

8:30 Visite Protocolaire au DIREF (Mark Freudenberger)

9:00 Présentation: "Coverted Corridor" (Mark Freudenberger) à LDI Fianarantsoa

10:30 Présentation: "La Politique Forestière Régionale" (DIREF) à LDI Fianarantsoa

11:00 Présentation: L'Historique, la Problématique, et les Activités au Tour des Plantations de Pins de la Haute Matsiatra" (DIREF) à LDI Fianarantsoa

12:30 Déjeuner

14:30 Présentation et Discussion : Les Connaissances Techniques et Economiques des Plantations de la Haute Matsiatra (DIREF, LDI, Miray, EASTA Iboaka) à LDI Fianarantsoa

16:00 Revue de la Littérature

**Vendredi, 6 juillet** Visite no. 1 sur le Terrain
***Coordinateur de la Journée: Haja et Robine***

8:00 Visite du Terrain d'Equipe A et Equipe B

1) Vue Générale des Reboisements de la Haute Matsiatra (DIREF/CIREF)
2) Visite à la Concession de la Scierie de Betsileo (François Bueche)

12:30 Pic Nic

3) Visite au site d'EASTA Iboaka

16:00 Visite à la Scierie de Betsileo à Fianarantsoa et autres opérateurs dans la ville (menuisers, scieries, etc.)

17:00 Restitution de la Journée: Rafiner les apprôches pour les prochaines semaines

**Samedi, 7 juillet** Visites Informelles sur le Terrain

7:30 Départ pour Sendrisoa pour voir cas de *lavaka* réhabilité par fonds cycloniques et puis visiter la forêt naturelle. Visite organisé par Mark Freudenberger avec équipe LDI.

8:45 Rencontrer Mme. Lydia à l'Hotel Bouganvilliers

9:45 Rencontrer M. Jean-Chry à Sendrisoa et puis départ pour le terrain

16:00 Retour à Fianarantsoa

**Dimanche, 8 juillet**

Repos pour l'Equipe A et B

**Lundi, 9 juillet**

***Coordinateur de la Journée : Haja, Ramy, et Amélie avec DIREF***

8:00 Equipe A et Equipe B : Visite au Lac Antarambiby avec les Parties Prenantes

Départ pour le Lac Antarambiby avec les parties prenantes. Visite aux alentours du lac, visite aux systèmes d'irrigation de Mahasoabe, discussions avec les associations et autres acteurs. (Pact Miray/ILO, LDI, ONG Miray….)

16:00 Retour à Fianarantsoa

17:00 Restitution : Raffiner les apprôches pour la reste de la mission

**Mardi, 10 juillet**

Equipe A: (Denise et John) ***Coordinateur : DIREF (Robine), François Beuche***

Denise: Visites sur terrain

John: Visites sur terrain

Equipe B: (Peter) ***Coordinateur: Ramy, Jean-Solo, Haja, DIREF (Mme. Philippine)***

8:30 Présentation : "Coveted Corridor" (LDI et Miray)

10:00 Présentation : "La Politique Régionale Forestière"

10:30 Présentation: "Le Transfert de Gestion Forestière": Perspectives et Expériences » (DIREF, LDI, Miray)

12:30 Déjeuner

14:30 Rencontres Individuelles

-DIREF/CIREF
-Haja (LDI): Le Cas de Miarinarivo et le Cas d'Alatsinany-Ialamarina

**Mercredi, 11 juillet**

Equipe A: (Denise et John) ***Coordinateur: DIREF (Mme. Robine), François Bueche***

Denise: Visites ou travaux sur le terrain.

John: Visites sur terrain

Equipe B : (Peter) ***Coordinateur: Haja et DIREF ( Mme. Philippine)***

7:30 Départ pour Miarinarivo avec LDI

10:30 Arrivée à Miarinarivo

Présentation: Présentation et Discussion

Nuit Passer la nuit au Gîte WWF

**Jeudi, 12 juillet**

Equipe A: (Denise et John) ***Coordinateur: DIREF, François Bueche***

Denise et John: Visites sur terrain

Equipe B: (Peter) ***Coordinateur: Haja et Mme. Philippine***

Matin Visite sur terrain de GCF

Soir Visite sur terrain de GCF

Retour à Fianarantsoa

**Vendredi, 13 juillet**

Equipe B: (Peter) ***Coordinateurs : Haja et Mme. Philippine***

Peter: Visite de terrain à Alaitsinany-Ialamarina

**Samedi, 14 juillet**

Equipe A & B:

Ecrit du rapport, discussions, revue de la littérature

**Dimanche, 15 juillet**

Repos

**Lundi, 16 juillet**

Equipe A et Equipe B ***Coordinateurs: Haja, Ramy, Dette Nature***

7:00 Voyage par Draisine sur le Corridor. Visite des stations forestières à Ampitambe et Ampamaherina (écrevisses) et descente sur Tolongoina.

Nuit Passer la nuit à Tolongoina

**Mardi, 17 juillet**

Equipe A et Equipe B

Matin Visite de la forêt communautaire GCF de Projet CAF/Dette Nature

Soir Retour par Draisine à Fianarantsoa

**Mercredi, 18 juillet**

Equipe A & B

Départ pour Antananarivo par avion

**Jeudi, 19 juillet**

Equipe A

8:30 John : Départ d'Ivato de M. John Townsley par AIR MADAGASCAR 722

6:00 Denise and Peter: Visite à LDI Moramanga. LDI Moramanga prépare tous les arrangements logistiques. Visite aux plantations de pin.

Soir Retour à Antananarivo

**Vendredi, 20 juillet**

11:00 Denise & Peter: Debriefing avec l'USAID et autres acteurs à Tana.

**Samedi, 21 juillet**

6:15 Départ d'Ivato de Mme Denise Ingram et Peter par AIR MADAGASCAR 720

# OBSERVATIONS AND SUGGESTED FOLLOW-UP

### Natural Forest Management Plans

- Presented within this report is a simple forest management plan process that follows six steps. The steps are displayed below and designed interdisciplinary to integrate social, economic, as well as natural resource issues.

  **Step #1** – Identify the Desired Condition for the Landscape/Watershed

  **Step #2** – Identify the Existing Condition for the Landscape/Watershed

  **Step #3** – Develop the Need for Change (Objectives) on the Landscape/Watershed

  **Step #4** – List and Detail the Actions Designed to Satisfy the Needs

  **Step #5** – Coordinate the Actions Across the Landscape/Watershed

  **Step #6** – Monitor the Effectiveness of the Actions to Meet The Stated Needs

- An Additional Considerations Forest Management Plan process builds upon the Simple Forest Management Plan process. It is increased in complexity and provides a more appropriate process for the resource diversity and issues associated with the natural forests of the corridor. It includes the addition of the following step:

  **Step #1** – Develop Zoned Areas within the Landscape or Watershed

- A matrix is used as a format to guide users in logically displaying the answers to the questions posed within the Simple Forest Management Plan outline.

- In order to achieve realized long-term results forest management plans need to be developed from the villager level up. Management of forested lands, both plantations and natural forests, is most effective when people who live in and near the managed areas reach consensus on its management and share the benefits the forest management plan produces.

- Adaptive management is particularly useful with natural forest management plans as the existing conditions continue to shift. It enhances the ability to flex or modify an on-the-ground action in response to natural or human caused events, new information, or unforeseen outcomes.

- Agroforestry is a viable option for management of conservation zones, particularly around encroached upon springs and streams. It is also a viable practice that, in part, may be a solution to reducing the encroachment of tavy into the forest corridor.

- Implementation of a monitoring plan for actions implemented under forest management plans answers the question of "Are the expected results being achieved?" Monitoring not only improves the quality of outcomes, it also improves the quality of the projects being implemented.

### Forest Management Plans Suggested Follow-Up

- The development of forest management plans, and the ability to integrate accurate resource data, could be greatly facilitated by the development of several key GIS layers.

- The existence of hydrologic data is lacking to non-existent. Efforts to address the issues of watershed management on all scales require baseline hydrologic data. Baseline data would facilitate the identification of actions designed to attain the identified desired conditions.

- A suggested follow-up on the process for the development of forest management plans is choosing a landscape and facilitate LDI Staff, DIREF, and COBA members through the process over a 7 to 10-day period. This could then be used as a model "train-the-trainer" exercise.

- The need is high for a natural forest management plan coordinator who can develop templates, facilitate the process, and review products. A likely location for this position would be Fianarantsoa.

### Silviculture and Management of Pine Plantations

- Observation: Stakeholders in the Haute Matsiatra Pine Plantations and in efforts to preserve the Corridor exhibited a high degree of interest in creating constructive solutions to difficult resource issues. Several individuals and organizations contributed substantially to educating the USDA Forest Service Team regarding the key issues.
    - The high level of commitment is evidence of a strong desire on the part of all stakeholders to invent acceptable management strategies.
- Observation: Current data available to resource managers may not be at the appropriate scale to address site-specific management problems.
    - Suggested Follow-up: Survey all stakeholders and develop an inventory of available data.
    - Suggested Follow-up: Prioritize data that is in hard copy media for digitizing if map data or input into a database or spreadsheet if numeric data.
    - Suggested Follow-up: A fundamental data need is accurate characterization of vegetation resources and land use patterns at the stand level (1:12000 to 1:16000 scale).
- Observation: Arterial road systems may be challenged by increased road traffic associated with intensified exploitation of the Pine resource.
    - Suggested Follow-up: Evaluate options to improve main arterial roads to expand capacity to handle traffic.
    - Suggested Follow-up: Initiate dialogue with the State entity responsible for transportation system design, maintenance, and upgrades to alert them to possible increases in use and to anticipate bottlenecks.

- Observation: Internal road systems on the Mandaratsy Pine Plantation may require investment in order to efficiently handle increased heavy truck traffic associated with intensive mechanical/industrial exploitation. This may also be true with other pine plantations within the Haute Matsiatra.
    - Suggested Follow-up: Eaux et Forêts, with permittees and other stakeholders, may consider initiating an evaluation of internal pine plantation transportation system capacity.
- Observation: Inventory information sufficient to project volume growth is not available.
    - Suggested Follow-up: Eaux et Forêts, with permittees and other stakeholders may consider implementing a systematic inventory of forest resources on all plantations.
- Observation: Hydrologic data may not be available to adequately respond to water quantity issues in the Lac Antarambiby watershed.
    - Suggested Follow-up: Stakeholders might consider locating hydrology expertise to provide technical expertise in evaluating possible changes in water yield from the Lac Antarambiby watershed.
- The location of existing hydrology data is not well known by stakeholders.
    - Suggested Follow-up: Stakeholders might consider conducting an inventory of hydrology data.
- Hydrology expertise may not be adequately engaged in efforts to resolve key water resource issues.
    - Suggested Follow-up: Consider seeking a Masters student from a reputable university who might address one or more of the data needs discussed above.
    - Suggested Follow-up: Future USDA Forest Service teams may include hydrology expertise as well as expertise in conducting vegetation inventories and assessing vegetation conditions.
- Observation: Skilled labor necessary to successfully intensify exploitation of the pine resources of the Haute Matsiatra may not be available.
    - Suggested Follow-up: Stakeholders may consider options for establishing a technical school in Fianarantsoa that would provide technician training in forestry.
    - Suggested Follow-up: Consideration might be given to providing training in basic forestry skills in rural communes located near the pine forests.

### Economics Analysis of Single Units Within the Pine Plantations of the Haute Matsiatra

- The analysis of the economics of pine plantations in Madagascar could be a continuous process that is implemented throughout the Eaux et Forêts and on a regular basis. An increase in the capacity of the Eaux et Forêts to conduct this analysis will contribute to the development of strategies to optimize valuation of the resource and receipt of appropriate rents by the public sector.

- Suggested Follow-up: Conduct a workshop with Eaux et Forêts and non-governmental representatives on the application of the spreadsheet model (or similar tool) and analytical processes that can be incorporated into routine administrative and management responsibilities.

- The potential revenues generated by the pine plantations in Haute Matsiatra are currently left on the forest floor from logging and in-forest processing. Standard applications of royalty fees and the distribution of those fees to the respective administrative levels could provide much needed funds for the development and management goals of the Communes and the Eaux et Forêts. This requires increased control of areas under exploitation through standard levels of fees for all operators that reflect the costs of administration, protection and management of the plantations by the Eaux et Forêts.
    - Suggested Follow-up: Investigate and determine appropriate levels of fees to charge concessions and enforce collection consistently with incentive adjustment factors for more efficient operations.
- The forestry and forest products sector of the Fianarantsoa region could benefit greatly from a full utilization study of potential investments for small businesses, to process the un-recovered wood for value-added products.
    - Suggested follow-up: Conduct a utilization study of Fianaranatsoa wood products market with estimates of investment levels required for sustainable industries.
- The potential socio-economic and environmental gains from pine plantation management regimes require specific analysis of the input-output affects of increased forest sector employment for the communities in the watershed.
    - Suggested follow-up: Conduct input-output analysis of plantation management investments on rural economies to determine likely benefits to pursue and possible contradictions to be avoided.
- The environmental costs of inefficient harvesting and processing operations in the pine plantation forests to the watershed were not calculated in this analysis. These costs could be considered in terms of increased risk to fire, impacts on water supply and water quality.
    - Suggested follow-up: Estimate the impacts of inefficient resource exploitation on watershed values and reflect some proportion of these costs in royalties paid by the operators.

# Section 1: Process and Development of Forest Management Plans

# NATURAL FOREST MANAGEMENT PLANS

**Abstract**
Presented in this report is an iterative process that can be utilized to systematically develop management plans for natural forests, plantation forests, and broader scale watershed management activities. It is designed to allow for the initiation of immediate actions to meet short-term objectives while providing a framework for the development of a vision (i.e. long-term objectives) for the landscapes[1] in question. This iterative process utilizes the concepts of an interdisciplinary approach (sometimes referred to as systems thinking), adaptive management, and monitoring.

The process contained herein is designed to be a process and that can be used today. Immediate implementation is a basic premise in its design. Very little "train the trainer" time and energy is required to get the process working with villages within the communes. The questions provided with each step of the process are designed to allow the participants to arrive at their own conclusions. As stated below, the best management plans are those that are derived from the villagers within the communes themselves.

Although at this time it may sound unattainable, the process contained here is ultimately designed, as its USDA Forest Service Counterpart, to encourage a productive harmony between communal villagers and the environment is which they live, while limiting or substantially reducing damaging or unproductive forest management practices over the long-term. It is also designed to attain the widest range of beneficial uses of the landscape without degradation, risk to health, economic well-being and safety, or other undesirable and unintended consequences. It implies a degree of management consistency over time, which is variable across the Fianarantsoa region.

The process outline detailed below is a basic, bare-bones process that can be used relatively quickly to develop simple forest management plans. It provides the essential process steps for making conscious, well-reasoned decisions on which actions to implement within a landscape at a given time. At the same time, it is designed to present a systematic interdisciplinary approach integrated with physical, biological, economic, and social considerations. It is an interdisciplinary approach that provides for multiple use objectives. The integration of social (population density, natural family planning, village and communal infrastructures, etc.) and economic (transportation and access needs, increased family incomes, etc.) cannot and should not be under emphasized.

[1] In the context of this forest management plan outline, landscape is used loosely to refer to any scale at which the analysis is being conducted. Be it at the watershed or sub-watershed scale, landscape scale, plantation or individual stand scale, or a zoned area within any of these scales.


***Management of natural forests provides social and economic benefits: Sustainable water supplies offer opportunities for fish culture***

Presented within this report is a simple forest management plan process that follows six steps. The steps are displayed below and discussed in detail within this report.

**Step #1** – Identify the Desired Condition for the Landscape/Watershed

**Step #2** – Identify the Existing Condition for the Landscape/Watershed

**Step #3** – Develop the Need for Change (Objectives) on the Landscape/Watershed

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**Step #5** – Coordinate the Actions Across the Landscape/Watershed

**Step #6** – Monitor the Effectiveness of the Actions to Meet the Stated Needs

Beyond the initial management plan process are two options that develop a more detailed landscape analysis process that provides a framework more conducive to the spatial and structural diversity found within Madagascar's natural forests ("Forest Corridor"). These versions continue and build upon the logic presented in the basic outline. These detailed frameworks can also be utilized by the Direction des Eaux et Forêts (DIREF), non-governmental organizations (NGOs), and the international community who have staff that possess skills required to delve more conceptually into forest management planning issues.

Within an appendix is a short example of a natural forest management plan for one zone within the COBA of Miarinarivo. It is based on a two-day visit and should be used only as a starting point and demonstration of what the results of this forest management planning process can become.

Finally, contained within this report is a presentation of additional analysis needs. These are centered on the needs for better spatial data, the importance of sound hydrologic input, and additional work on implementation of this planning process.

# INTRODUCTION

Early in-country discussions with the Director of Landscape Development Interventions (LDI), coordination among the mission team, discussion with cooperating mission partners, and site visits provided a refinement of mission goals and objectives related to the development of a process leading to natural forest management plans.

As stated early on, the ultimate goal of the management plan component of the mission was to provide *"a simple, rule of thumb, approach to the development of natural forest management plans"* that could be used by village communes.

Through site visits and a review of literature presented to the team, the goal of the management plan emphasis can be stated as:

> *"How can the evolution of forest occupation best be managed to meet the economic needs of populations of the area and conservationists' concerns about the preservation of biodiversity, water, and the rural lifestyles and traditions?*

The answer to this question is complex. Yet iterative steps to this answer can begin by utilizing the interdisciplinary landscape management planning process contained within this report. It is important to note, particularly in the management of landscapes surrounding the forest corridor that the interdisciplinary process goes beyond a mere discussion of natural resources. Field visits and discussions with communal member highlighted the importance of integrating economic, social, and behavioral considerations into the forest management planning process. In this context management actions should be broadly defined to include social, and economic interventions as well as traditional resource management activities.

An over-riding premise in the development of the process utilized in this report is that management of forested lands, both plantations and natural forests, is most effective when people who live in and near the managed areas reach consensus on its management and share the benefits the forest management plan produces. Forest management planning properly administered results in local involvement, local solutions, local management and local optimism. Local involvement can provide incentives for sound and realistic forest management practices. Local involvement also ensures that the management plan is understood at the villager level. Having said this, it is imperative that there is a partnership between state ministries, the private sector, and village communes.


***Development of existing conditions and desired conditions requires a collaborative effort between villagers, COBA members, Eaux et Forêts, local NGO extension agents, and other international cooperators.***

This process is iterative in the sense that it follows a logical, step-by-step process for development of management plans. It borrows heavily from the USDA Forest Service Forest Plan Implementation process.

# PROCESS AND DEVELOPMENT OF FOREST MANAGEMENT PLANS

The process steps outlined below are presented in two parts. First, a discussion of the rationale and an understanding of the process step are provided. Secondly, a series of questions are provided to provoke a result, or answer for each stage of the process.

## Simple Forest Management Plan Process Outline

The process outline detailed below is a basic process that can be used relatively quickly to develop forest management plans. It provides the process points for making conscious, well-reasoned decisions on which actions to implement within a landscape. It divides the process for development of forest management plans into manageable pieces that can be built upon over a period of time. The process was field tested to a minor degree during site visits and received "nods" of understanding from villagers and COBA members.

At the same time, it is designed to present a systematic interdisciplinary approach with integrated consideration of physical, biological, economic, and social considerations. This process will result in both short-term goals and long-term objectives for a landscape, but decisions on site-specific actions as well. Said in simpler terms, it provides both visions and actions for the landscape in question.

**SFMP[2] Step #1** – Identify the Desired Condition for the Landscape or Watershed

*Discussion:* This first step describes the desired condition for an area, by site-specific resource(s) if possible, to determine the desired look for the area in the future. In the absence of quantifiable data the conditions are typically qualitative in nature and describe the area in broad generalities.

A continued narrowing of the focus on desired conditions can be accomplished by choosing indicators, or criteria. An indicator is defined as a condition that describes physical, biological, social, or economic characteristics for a given location. These are units of measure that can be used to articulate when the desired condition(s) are reached.

Examples of these indicators may be water quality, or water quantity; pine plantation density or pine plantation growth rates; soil erosion rates or soil fertility; poverty or productivity of rice fields. There can be many indicators associated with a particular area.

By identifying a discrete area, and particular indicators within that area, one can continue to focus attention on what they want to address in manageable pieces. One can do this for many discrete areas within in a particular area; however, it is simply unrealistic for a site-specific analysis to consider every situation and all their possible indicators. Therefore, it is important to focus on the most important desired conditions at the very beginning.

*Questions:*

- What do you want the area to look like in the future?
- How do you want individual resources to look on the ground?

[2] SFMP = Simple Forest Management Plan

- In terms of management (agriculturally, pastorally, or silviculturally), what would you being doing different in this area in the future?
- What aspect of the resource (indicator) in question am I particularly interested in?
- What are the desired conditions for the area from outside entities or organizations such as the DIREF, NGO's, etc.?
- What national laws, directions or initiatives are in place that effect the desired conditions?

**SFMP Step #2** – Identify the Existing Condition for the Landscape or Watershed

*Discussion:* The existing condition is a real time snapshot of the condition of the landscape. It is an honest and frank description of the conditions on the ground of all the resources within the landscape. It is not necessary that this step be a data rich driven description of conditions. Qualitative descriptions are acceptable, but where data is available, it is wise to use it. The existing condition provides a baseline for future data and resource information.

Existing conditions should parallel and be displayed in the same context as those conditions described in Step #1. As such, the indicators should remain the same and be measurable if at all possible. These indicators will ultimately show how the landscape responded to changes in the existing condition as a result of implemented actions.

In this step it is important to eliminate value statements associated with the resources. The resources are not in a good or bad condition. Conditions should be objective statements and are value neutral. This is easier said than done.

As in Step #1, attempt to describe the existing conditions for a discrete area and as site-specific as possible. The sources of existing condition information can come from:

- Direct discussions with villagers, COBA members, DIREF Technicians, NGO staff, and other project staff.
- Field trips.
- Information from previous site visits and reports.
- Raw inventory data (databases, GIS, etc.)

*Questions:*

- What is going on with the resource(s) today?
- What is today's condition you want to improve?
- What is the condition of the resource(s) as they exist today?
- What are, if any, are the resource problems that exist today?
- What are the natural resource and management driven situations that contributed to today's situation?

**SFMP Step #3** – Develop the Need for Change (Objectives) on the Landscape or Watershed

*Discussion:* Before determining what specific management actions to take within a given area first one must have an understanding of why you want to do it. Step #3 develops the reasons to change conditions and the associated objectives for the landscape. This step provides the reason (rationale) for changing the landscape from its existing condition into a preferred (desired)

condition. The need for change is a simple process of comparing the desired conditions and the existing conditions. As an equation this step in the process can be displayed as follows:

***Desired Condition – Existing Condition = Need for Change (Objectives for Action)***

Or said in other terms, it is subtracting the existing condition from the desired condition. The difference is the need for change. What are optimally compared are the indicators of the resource(s).

The need for change is usually thought of as more or less of something - more or less of the indicator being evaluated. For example, needs may be expressed as more water from a specific spring, increased soil fertility, decreased soil loss from pastoral lands, an increase in readily accessible sources of fire wood, more readily accessible sources of construction wood, sustained products from the Mandaratsy pine plantations, less density within pine stands, etc.

State the need for change as succinctly and objectively as possible. A final prioritization of needs in Step #4 will assist in Step # 5 of the process when an evaluation of the actions is undertaken.

*Questions:*

- Is there a disparity between the desired condition and the existing condition for the area under consideration?
- Is there a need for change in the area under consideration?
- What is the gap between desired and existing resource site-specific indicators?
- Is there gap between (or a difference) which will show us how close the existing condition is to our desired condition?

**SFMP Step #4** – List and Detail the Actions Designed to Satisfy the Needs

*Discussion:* Actions in this context are concise, time-specific, measurable and planned activities that respond to pre-established needs (objectives) and move the landscape toward the desired condition. Actions are designed to move the landscape, watershed or resource(s) toward its desired condition with acceptable and favorable results. As an equation this step in the process can be displayed as follows:

***Existing Condition + Action = Move Toward Desired Condition***

Step #4 can be viewed as a brainstorming exercise. Actions should not be preliminarily eliminated. List any and all possible actions that satisfy the stated objective (need). As in Step #2, these actions should be developed and listed objectively. An action that may not seem plausible today may become realistic in the future.

When creating this list within communes or at the village level, it may be necessary to solicit actions individually or in small groups so as not to develop a list of actions based on hierarchal input. It is important that the process be developed from the ground up (rural farmer). In this sense, who is proposing the action is less important than what the action being proposed is.

Actions should be as site-specific and detailed as possible. If at all possible, use measurable descriptions such as 15 hectares of reforestation with Grevillia and 25 hectares reforested with Eucalyptus, six gabions placed 25 meters apart within the stream course, four nurseries in these four villages, a thinning regime at years 2, 7 and 15, etc. Actions should include descriptors such as timing and location.

As previously stated, actions can be designed to have an effect on natural resources, yet they can also be designed to effect social or economic conditions within the area under consideration.

Ultimately the choice of what action(s) are undertaken at any given time at any given location is based on numerous factors. Factors such as funding, workforce issues, availability of materials, priority of stated needs by the local villagers and commune, transportation, and season of implementation all are important considerations. Many more social and economic considerations will ultimately be integrated and developed based on extension work.

*Questions:*

- What action(s) (activities) can be done to address the stated need for change?
- Does the action address the stated need for change in the area under consideration?
- Where is the action being proposed?
- When is the action being proposed?

**SFMP Step #5** – Coordinate the Actions Across the Landscape or Watershed


***Management of remaining tracts of natural forest must be developed in context with village agricultural needs.***

*Discussion:* At this stage of the management plan development process a list of possible actions has been identified. These actions now require a review to determine their appropriateness and ability to meet the stated needs for the area under consideration. This is a time to step back and review the list of actions globally.

Begin to review each action in context with other actions and establish a logical sequence for implementation both spatially and temporally. There may be trade-offs between the sequencing of actions. Also, a review of appropriate technologies for implementation and management of the actions is of value.

A brief review of the preliminary effects of implementation is advised. Conduct an initial review to determine if implementing the action, or sequence of actions, results in undesirable effects on individuals, villages, or the commune as a whole. A review of the actions as a whole may determine that the environmental consequences of implementing one action may have undesirable effects on the implementation of a subsequent action. This may result in the need to adjust the sequence of implementing actions.

This step should illustrate if some actions, or sequence of actions, are not always as they first appear. This step allows a look at actions for a longer time or from a different perspective and results in a confirmation of the course of action prior to financial and labor expenses. What initially appears to be the correct course of action to meet the desired objectives for a landscape may not necessarily be the right trajectory. The concept of a threshold of acceptable consequences is used in these cases.

This step also allows for a consideration of the immediacy of needs. Some stated needs may require prioritization over others. For example, the protection of the canal above the village of Amboarafibe from the encroachment of the lavaka provides an immediate need for action as the erosion threatens to substantially reduce the water flow to hundreds of hectares of agricultural production, including fish ponds. This is a reason for establishing a priority of needs in Step #3 of this process.

At this point it is important to note that costs of implementing actions will play an important role in determining their sequencing. Implementation of actions at times is often more opportunistic than strategic. When funding is available, then implementation is undertaken. This is a simple fact of the planning process. Yet being opportunistic does not over-ride the need for appropriate planning. Only those most intimately familiar with the resources and issues in question can develop implementation priorities and plans on how to distribute funding among actions.

*Questions:*

- Will implementing the action, or sequence of actions, result in undesirable effects on individuals, villages, or the commune as a whole?
- Are the actions proposed for implementation being proposed in a logical sequence?
- Are their immediate needs identified earlier that should be implemented without delay?

**SFMP Step #6** – Monitor the Effectiveness of the Actions to Meet The Stated Needs

*Discussion:* Monitoring is an essential, yet often overlooked step in the forest management planning process. A review of the criteria or indicators established in Step #1 of defining the desired conditions allows the determination of whether or not results are as expected. Indicators, or units of measures, should be quantifiable, predictable and understandable where practical.

Monitoring will help to close the identified data gaps in original actions and assumptions.

*Questions:*

- Did implementation of the action(s) move the existing condition toward the desired condition on the landscape under consideration?
- Have the existing conditions changed?
- Should actions be adjusted or cancelled based on changes to the existing conditions?
- What changes have occurred to the criteria or indicators that were established in Step #1, defining the desired conditions?
- How do you know if you have reached your desired conditions?

### Additional Considerations Forest Management Plan Process Outline

The Additional Considerations Forest Management Plan Process builds upon the Simple Forest Management Plan process detailed above. It is increased in complexity compared to the Simple Forest Management Plan process. It provides a more appropriate process for the resource diversity and issues associated with the natural forests of the corridor.

**ACMP[3] Step #1** – Develop Zoned Areas within the Landscape or Watershed

*Discussion:* This initial step identifies the areas of interest by dividing the landscape into zones. This will be particularly useful under natural forest conditions. A zone is this context is a generic term. Zones may be given more individual or defining terms, but regardless of the term, the concept is the same. Zones are areas of specific management emphasis. Zones can be segregated (named) by:

- Like resource objectives or goals
- Similar resources, topography or vegetation
- Uses of the resource(s), landscape or watershed (i.e. Agricultural, Forest Biomass Production, Pastoral, Forest Rehabilitation, exploitation)
- Similar Ecosystems
- Similar management objectives (extensive, intensive, protected, conservation)
- Areas where an opportunity or problem to address exists

The delineation of zones is typically associated with some form of natural boundary, such as a watershed boundary, ridgeline, stream or ancestral boundary. However, the size of a zone depends on the existing conditions to be addressed and the scale at which

[3] ACMP = Additional Considerations Management Plan

management activities can reasonably be addressed. Watershed conditions may require a look at an entire city watershed (i.e. Lac Antarambiby), a small sub-watershed adjacent to an individual farmer's rice fields, or an entire forested landscape where select tree exploitation is occurring.

Associated with this step is the establishment of standards (conventions) for development within each individual zone. Management actions may be permitted if it meets zone standards. A zone standard does not require projects to occur. As before, actions must conform to meeting the stated needs for change and move the landscape to its desired condition.

There is no correct or incorrect delineation of zones, yet a common process should be applied across the landscape. There are trade-offs between choosing how zones are segregated. Choose a process for delineation and continue with it over the entire area of consideration.

The primary advantages of zoning the landscape are several. First, it allows actions on the land to be site-specifically focused on the problems or opportunities of that individual zone. Focusing actions on specific locations translate into pinpointed results in the shortest timeframes. This equates to cost effective implementation of activities. Zoning also enables time efficient planning efforts. Utilizing a focus planning effort on specific locations results in efficiency of staff and funding.

In short the use of zoning helps make the most effective use of time, land and resources and saves money and labor by preventing costly mistakes and inappropriate actions.

*Questions:*

- What rationale or system for zone delineation will be used?
- Are the zones of an appropriate size to address problems, concerns or issues related to the existing and desired conditions?

**ACMP Step #2** – Identify the Desired Condition for each specific zone within the Landscape or Watershed

*Discussion:* Refer to SFMP Step #1.

**ACMP Step #3** – Identify the Existing Condition for each specific zone within the Landscape or Watershed

*Discussion:* Refer to SFMP Step #2.

**ACMP Step #4** – Develop the Need for Change (Objectives) for each particular zone within the Landscape or Watershed

*Discussion:* Refer to SFMP Step #3.

**ACMP Step #5** – List and Detail the Actions Designed to Satisfy the Needs of that particular zone within the Landscape or watershed.

*Discussion:* Refer to SFMP Step #4

**ACMP Step #6** – Coordinate the Actions for All Zones Across the Landscape or Watershed

Discussion: Refer to SFMP Step #5. Review spatial and temporal scales and consider the immediacy of stated needs.

**ACMP Step #7** – Monitor the Effectiveness of the Actions to Meet The Stated Needs

*Discussion:* Refer to SFMP Step #6

### Added Analysis Considerations for the Forest Management Plan Process Outline

Additional steps to consider:

1. Add Environmental Impacts Assessments on the Various Potential Actions (as needed by MECIE)

   As private concessions are allotted for management activities within plantations and natural forests the implementation of environmental impact assessments (EIA) will provide data on predicted outcomes or effects that can be used to compare actions being proposed across a landscape. The spatial and temporal analysis provided in an EIA would assist in choosing appropriate actions and their sequencing across the landscape. It may also provide a range of alternative actions from which a forest management plan could be developed.

2. Add analysis of competing needs from village communes, DIREF, Private Sector, Non-Governmental Organizations, and International Donor Community.

   On-site discussions with villagers, communal officials, DIREF, and NGO project staff identified contradictions between desired conditions, objectives, actions, and the immediacy of actions. As the forest management planning process develops there are opportunities to build consensus checkpoints on the disparity of these parties and partners.

### Sample Forest Management Plan Matrix

The following matrix will be used within this report as a format to guide users in logically displaying the answers to the questions posed within the Simple Forest Management Plan outline. Case examples are provided using three scales – (1) a single stand from a pine plantation in La Haute Matsiatra; (2) the entire watershed of Lac Antarambiby; and (3) Zone A in the Natural Forest of Fokontany D'Angalampona (Miarinarivo). These case examples are provided merely to illustrate the forest management plan development process and are based

initial site visits. They are not intended to be complete analyses of the landscapes under consideration.

Sample Forest Management Plan Matrix

| | Landscape, Watershed, Zone, or Stand to be Considered |
|---|---|
| **SFMP Step #1** Desired Condition | |
| **SFMP Step #2** Existing Condition | |
| **SFMP Step #3** Need For Action | |
| **SFMP Step #4** Actions To Satisfy Need | |
| **SFMP Step #5** Coordinate the Actions | |
| **SFMP Step #6** Monitoring | |

This process outlined above can also be used as a framework for the development of social and economic action plans. The questions identified in each step would change, but the process of comparing desired and existing conditions to define a need would remain identical. Social and economic issues can also be easily displayed with indicators of their conditions.

# INDIVIDUAL SITE VISITS

A complete itinerary and listing of sites visited is located at the front of this report.

### La Haute Matsiatra

*Discussion:* Two separate site visits occurred within the watershed that supplies the drinking water to the city of Fianarantsoa. Visits were to the Mandaratsy pine plantations of the La Haute Matsiatra and a site visit to Lac Antarambiby, the lake that supplies two-thirds of the domestic water for the city of Fianarantsoa. Both sites are within the same watershed and create of nesting of watershed and sub-watershed scale objectives.

The site visit to a private timber exploitation concession within the 3,500 hectares of Mandaratsy pine plantations within La Haute Matsiatra provided a review of issues related to individual stand and plantation scales. Yet the issues and objectives at this scale are and need to be directly related to issues at the watershed scale discussed in the next section.

*Observations:* Below is an example of the results (answers) generated by using the Simple Forest Management Plan process for one pine stand within the La Haute Matsiatra. A silvicultural discussion of this stand can be found in Section 2 of this report.

Sample Forest Management Plan Matrix for Pine Stand in the La Haute Matsiatra

| | **Pine Plantation Stand Scenario B: La Haute Matsiatra** |
|---|---|
| **SFMP Step #1** Desired Condition | • Pine trees fully occupy the site - Approximately 300 TPH<br>• Average diameter of 36 cm.<br>• Average height of 11 meters<br>• Maximum saw volume the site is capable of supporting is present (standing volume of 110 $m^3$/ha)<br>• Tree crowns are touching<br>• Very little understory vegetation exists on the ground<br>• Trees are in an undamaged condition with straight boles |
| **SFMP Step #2** Existing Condition | • Approximately 18,000 TPH<br>• Average diameter of 3 cm.<br>• Average height of 4 meters<br>• Standing volume of 0 $m^3$/ha |
| **SFMP Step #3** Need for Action | • Reduced stand density<br>• Allocate growing space appropriately to allow individual crop trees to fully exploit the site<br>• Generate commercial thinning volume and thereby revenue<br>• Develop saw log volume and thereby revenue |
| **SFMP Step #4** Actions to Satisfy Need | • Non-commercial thinning at age 3-4<br>• Commercial thinning at age 12 and 17<br>• Regeneration harvest at age 22 |

| | |
|---|---|
| **SFMP Step #5** Coordinate the Actions | • Individual stand prescriptions are coordinated within the Mandaratsy pine plantations and with individual private permittees to provide steady volume and revenue flows |
| **SFMP Step #6** Monitoring | • Stand density over time<br>• Damage from human and natural disturbances (fire, cyclone, etc.)<br>• Illegal harvest<br>• Growth response to thinning treatments |

**Lac Antarambiby – Domestic Water Source for Fianarantsoa**

*Discussion:* In contrast to the individual stand and plantation scales of the Mandaratsy pine plantations of the La Haute Matsiatra, Lac Antarambiby, a man-made reservoir, provides a planning scale at an overall watershed scale. Issues at this scale are more complex and interdisciplinary. There is an identified decrease in the water supply from the reservoir, but questions to clarify the problems are only just now beginning to be asked.

*Observations:* The sample Forest Management Plan Matrix provided for Lac Antarambiby is an over simplification of the issues and problems that face the domestic watershed for Fianarantsoa. This matrix is provided solely for the intent of demonstrating the use of the forest management plan process provided in this report. At this time, very little data on the existing condition(s) within the watershed is known. As discussed below, additional analysis needs are necessary prior to initiating a long-term management strategy for the watershed as a whole.

Sample Forest Management Plan Matrix for Lac Antarambiby

| | **Lac Antarambiby Watershed** |
|---|---|
| **SFMP Step #1** Desired Condition | • Supply 2/3rds of the potable water supply to Fianarantsoa<br>• All "sources" remain active in their supply to the lake<br>• Lake capacity is maintained, if not increased<br>• Forests within the watershed are hydrologically healthy<br>• Sustainable forest and agricultural management systems in the watershed are in place<br>• Size and number of tavy and rice fields remains constant<br>• Government ministries, non-governmental organizations and local communities work collaboratively for sustainable water supply |

| | |
|---|---|
| **SFMP Step #2** Existing Condition | • Water for agricultural and domestic use is exceeding water supply<br>• "Sources" have begun to dry up (13 out of 34 remain) within the past 7-8 years<br>• Silting up of lake and canals<br>• Reservoir capacity of lake is reduced<br>• No alternative source for potable water<br>• Periodic burning of pine plantations and other desirable vegetation<br>• Irrational use and harvest to forest plantations<br>• Forest is being cleared for agricultural uses<br>• Rice fields continue to grow and affect wet areas<br>• No maintenance of existing canals<br>• Erosion on tanety hillsides<br>• Administrative boundaries around the lake are not clearly defined |
| **SFMP Step #3** Need For Action | • Insure adequate water supply for domestic and agricultural uses now and in the future<br>• Increase the water holding capacity of the watershed<br>• Increase the "health" of the forested watershed<br>• Alternatives to agricultural land growth are explored<br>• Clarify the responsibilities of the Ministry of Waters and Forest and JIRAMA in watershed management |
| **SFMP Step #4** Actions To Satisfy Need | • Implement forest management plans in the Mandaratsy Pine Plantations<br>• Begin a systematic cleaning schedule for all canals & sources<br>• Initiate studies on the hydrologic balance of watershed<br>• Continue and increase extension activities with villagers<br>• Develop a working agreements between all partners (government ministries, non-governmental organizations and local communities)<br>• Development of new water codes<br>• Clarify jurisdictional boundaries and responsibilities around the lake<br>• Provide legal frameworks for lake protection |
| **SFMP Step #5** Coordinate the Actions | • Establish a priority list of immediate actions<br>• Prioritize implementation of actions within sub-watersheds that are at risk or have already gone dry<br>• Provide synergistic coordination between state ministries, NGOs, other partners, and with the legal and institutional framework |
| **SFMP Step #6** Monitoring | • Monitor the water flows (yields) below dam and at select "sources"<br>• Gather meteorically data to correspond with the flow data |

### Forest of Fokontany D'Angalampona - Commune of Miarinarivo

*Discussion:* The commune of Miarinarivo has recently signed a GCF transfer plan and a natural forest management plan. Included in the natural forest management plan is a six-month action plan (July to December 2001). Considerable work and community extension has taken place to reach this point. Villagers and COBA members, much to their credit, understand that they are just beginning the process of developing and implementing their management plan.

*Observations:* A sample Forest Management Plan Matrix is provided for Zone A of the Natural Forest of Fokontany D'Angalampona. Zone A is an area bordered by agricultural lands that has an overall management objective of reforestation. The forest management plan is displayed in narrative form in greater detail in Appendix C. It is based on an initial site visit to this zone and is presented as an example of the process, i.e. a starting point. It lacks measurable indicators and criteria in its objectives and site-specificity of its actions. It also lacks a detailed monitoring plan.

Sample Forest Management Plan Matrix for
Zone A of the Natural Forest of Fokontany D'Angalampona

| | **Natural Forest of Fokontany D'Angalampona (Miarinarivo)** |
|---|---|
| **SFMP Step #1**<br>Desired Condition | • Range of natural forest expands<br>• Zone A villagers no longer exploit fire wood from natural forest<br>• No new tavy on natural forest lands – tavy hectares remain stable<br>• Soil erosion is reduced or eliminated<br>• Soil fertility is maintain and increased<br>• Natural forest expansion is facilitated by development of "cover" crop tree plantations<br>• Plantations of desirable fire wood are established<br>• Springs are maintained and improved to provide adequate irrigation to rice fields<br>• All villagers abide by conventions |
| **SFMP Step #2**<br>Existing Condition | • Range of natural forest is being reduced<br>• Villagers living in Zone A continue to exploit natural forest for fire wood<br>• Soil fertility is declining resulting in new tavy fields<br>• No fire wood plantations within Zone A<br>• Brush fires and tavy cause soil loss and erosion<br>• Many villagers do not abide by conventions<br>• Lands within Zone A are privately owned<br>• Brush fires continue in grasslands and forests<br>• Natural forest succession is proceeding slowly |
| **SFMP Step #3**<br>Need for Action | • Exploitation of natural forests is decreased<br>• Increased and readily available supply of fire wood for villagers outside of natural forest in Zone A<br>• Fast growing fire wood species are introduced<br>• Increase in soil fertility<br>• Decrease in soil loss<br>• Increased protection of watersheds that provide water for agricultural uses<br>• Disregard of conventions is reduced |
| **SFMP Step #4**<br>Actions to Satisfy Need | • Fire wood plantations are established<br>• Data on species trials is reviewed and integrated into plantations<br>• Establish nurseries providing a ready supply of seedlings for fire wood plantations<br>• Agroforestry systems are used to increase soil fertility and reduce soil loss, particularly adjacent to streams<br>• At risk streams are identified<br>• Increased extension work to reduce encroachment into forest and increase use of composting systems<br>• Stricter enforcement of conventions and dinas |

| | |
|---|---|
| **SFMP Step #5** Coordinate the Actions | • Agricultural issues are more immediate than forest management issues<br>• Establish nurseries of fire wood and Agroforestry species first<br>• Agroforestry work is coordinated with plantation development<br>• Plantations are established<br>• Fire wood species are diversified |
| **SFMP Step #6** Monitoring | • New tavy within natural forest<br>• Amount of brush fires adjacent and within natural forest<br>• Rate of enforcement of conventions and Dinas |

### Commune of Alaitsinany-lalamarina

*Discussion:* In contrast to Miarinarivo, the commune of Alaitsinany-lalamarina is in the early stages of discussion on a natural forest GCF transfer and development of a natural forest management plan. Additionally, the social, economic and resource issues associated with Alaitsinany-lalamarina differ.

The commune of Alaitsinany-lalamarina has 123 members, which in itself makes the process of consensus all the more challenging. It appears that conventions and dina's within the natural forest lack enforcement. In discussions with the villagers, issues on management of the natural forest were closely intertwined with poverty issues. As an illustration, the first objective of the COBA president for the natural forest management plan was to cut the large trees in the natural forest to generate revenue and thereby reduce poverty within the commune. Yet other members of the COBA discussed economic diversification through the implementation of fish ponds and eco-tourism. Discussions quickly turned to fertility issues within rice fields and tavy.

Unlike Miarinarivo, the commune of Alaitsinany-lalamarina has 10 families living within the existing perimeter of the natural forest. These 10 families do not have permits from the DIREF to cut, manage or do tavy in the natural forest. Yet members of the COBA head all 10 of these families. A major issue towards signature of a GCF is the question how to address the activities of these 10 families within the natural forest corridor.

*Observations:* The commune of Alaitsinany-lalamarina illustrates the complexity of social and economic issues as they relate to forest management plans. Social, economic, and natural resource conditions need integration to successfully implement actions within the COBA. The forest management plan process outlined in this section provides a framework to achieve this integration.

### Tolongoina

*Discussion:* Tolongoina is in the middle of the forest corridor between two national parks. Starting in 1997 CAF, in cooperation with LDI and DIREF, began working on GCF transfers and natural forest management plans in Tolongoina. The area of Tolongoina, covering 5382 hectares, is divided up into 13 territories that equates to 13 COBA's. To date, two COBA's have signed CGF and natural forest management plans.

The forest management plans for Tolongoina choose from a menu of 4 zones; (1) Conservation Zone, (2) Exploitation Zone (Products), (3) Zone of Daily Needs, and (4) Reforestation/Rehabilitation Zone. Not all territories will utilize all four zones within their natural forest management plans. Several COBA's do not have natural forest within their boundaries. The villagers themselves delineate territory and management zone boundaries of each COBA.

*Observations:* A success of Tolongoina is the use of inventory data prior to the development of natural forest management plans and GCF transfers. This was the only site visited that started the management plan process by collecting this baseline data. Inventories of forest resources are used as a basis for exploitation and reforestation needs. The inventories consist of a combination of what species are present (natural resource inventory) and the usage of the species (socio-economic inventory). The technical presence of CAF has greatly assisted in these inventories. The use of inventories as baseline data for the development of forest management plans has been used successfully in Latin America.

Conservations with villagers highlighted a disparity in the connotation of long-term objectives. When asked, through several means of questioning, about long-term objectives, answers consistently had a product focus. A need to shift the concept of "product objectives" to "condition objectives" is important for long-term sustainability. DIREF, CAF, LDI and others need to bring the question into focus for villagers so that they are developing natural forest management plan objectives that develop objectives for conditions that produce a sustainable supply of products.

Workload is another important observation resulting from the visit in Tolongoina. Within Tolongoina there are 13 GFC plans needed, of which two are signed. To the south the workload for DIREF and CAF increases by another 41 GCF plans. The need for a natural forest management plan coordinator who can develop templates, facilitate the process, and review products is high. A likely location for this position would be Fianarantsoa.

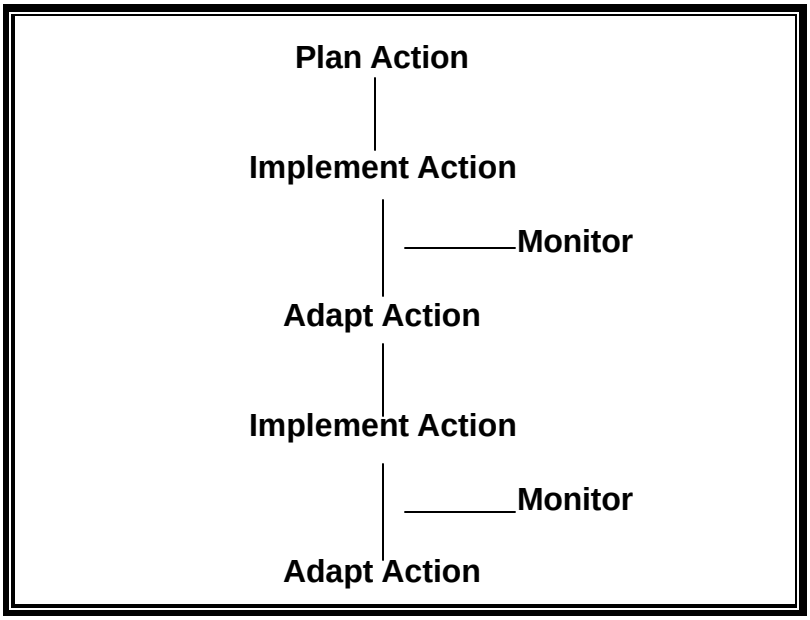
# OBSERVATIONS AND SUGGESTED FOLLOW-UP

### Concept of Adaptive Management

Adaptive management is a concept that addresses uncertainty in natural resource management and allows for adjustment, or adaptation, as implementation occurs. This concept is particularly useful with natural forest management plans as the existing conditions continue to shift. It enhances the ability to flex or modify an on-the-ground action in response to natural or human caused events, new information, or unforeseen outcomes.

In its simplest form it follows this model: An action is proposed. The action has predicted outcomes or effects. However, if these outcomes or effects do not occur then an alternative, or modified course of action is then implemented. This modified, or adapted course of action then has its own predicted outcomes or effects and the adaptive management cycle begins again. (See diagram below.)

The list of actions created in SFMP Step #4 provide a readily available list of projects from which adapted courses of actions can be derived. Adaptive management also emphasizes the need for quality and continuous monitoring. It is through monitoring that an action's predicted outcome or effects are verified. The following schematic graphically depicts the adaptive management process:




Some notes of discretion are important when implementing adaptive management concepts.

- Do not abuse its use. Use only where there is uncertainty of any outcome but reasonable certainty of the direction if a change in the course of action were necessary.
- Do not use it to cover data gaps. If data is truly needed information for a better understanding of anticipated effects, then acquire it before implementation. In other

words, do not take chances where the potential outcomes or environmental effects are unacceptable.

### Agroforestry

In discussions with villagers and LDI staff during field visits it became clear that Agroforestry is a viable option for management of conservation zones, particularly around encroached upon springs and streams. It is also a viable practice that, in part, may be a solution to reducing the encroachment of tavy into the forest corridor.

As private lands adjacent to springs and streams become increasingly used for tavy options other than reforestation become workable. These areas will continue to be managed for agricultural purposes, thus reforestation is less and less likely a solution to maintaining the quality and quantity of water desired.

What was almost universal among all parties in all sites visited was the narrow view of Agroforestry systems. Almost without exception when Agroforestry was mention is was assumed to mean the planting and cultivation of fruit trees. The potential of Agroforestry systems adjacent to watercourses, but within all tavy areas is enormous and vastly under appreciated.

The advent of new Agroforestry systems provides increased advantages beyond the traditional windbreak, fertility enhancement, soil improvement, timber integration, and animal fodder systems. Agroforestry systems managed using natural succession were tested as a strategy for improving degraded soils and as a sustainable production system in the Brazil. This agroforestry system improved soil fertility by tapping nutrients deep within the soil profile and by increasing the activity of soil biota. The use of natural succession-based management practices makes agroforestry systems dynamic and promotes nutrient cycling, contributing to maintenance of ecosystem health.

The use of new agroforestry systems, and a review of existing systems and species currently under use will require an in-depth cost benefit analysis.

### The Need for Monitoring

A brief discussion on the value of monitoring can never be overlooked. Implementation of a monitoring plan for actions implemented under forest management plans is an essential step that answers the question of "Are the expected results being achieved?" Monitoring is another term for "quality control." Monitoring plans need not be elaborate or expensive. Basic monitoring plans include several simple elements. They include:

1. Choose the indicator or criteria to be monitored. (Refer to SFMP Step #6.)
2. Describe in detail each monitoring indictor and its priority for accomplishment.
3. A monitoring frequency must be specified.
4. Describe a method of accomplishing the monitoring, including its frequency or duration.
5. Assign responsibility for conducting the monitoring.
6. Identify acceptable deviations of the indicators.
7. Reporting period must be identified.

As stated in the discussion on Adaptive Management, implementing a monitoring plan provides the necessary feedback loop to determine if adjustments are necessary to the action(s) or sequence of actions being proposed and implementing within a given landscape. Monitoring not only improves the quality of outcomes, it also improves the quality of the projects being implemented. Monitoring is not a static process. It also evolves over the life of a forest management plan, or an individual action.

### Suggested Follow-Up

Site visits, discussions with cooperating mission partners, in-country discussions with the LDI Director and his staff, and coordination among the mission team, highlighted data gaps, potential analysis needs, and opportunities for additional follow-up activities. Those related to the development of forest management plans are detailed below.

Geographic Information Systems (GIS)

Several non-governmental organizations have initiated the use of GIS. Training and support is being integrated. The use of GIS data and products for forest management planning and source data at appropriate scales is lacking. The development of forest management plans, and the ability to integrate accurate resource data could be greatly facilitated by the following GIS layers:

- Delineation of watershed and sub-watershed boundaries
- Delineation of management zones (ACMP Step #1) on which forest management plans are developed
- Transportation system by road conditions or surfacing
- Streams, lakes & wetlands
- Existing vegetation
- Existing land use polygons
- The evolution of land use indicating areas of expansion (priority conservation areas). This baseline of change would be helpful in terming the changes in existing and desired conditions over time.

Hydrologic Analysis

Without exception, every site visit generated issues surrounding water quality and quantity. The existence of hydrologic data is lacking to non-existent in nearly every location visited. Efforts to address the issues of watershed management not only in the scale associated with Lac Antarambiby, but in small sub-watersheds such those in the Forest of Fokontany D'Angalampona require baseline hydrologic data. Baseline data briefly discussed below would facilitate the identification of actions designed to attain the desired conditions identified during site visits (see sample SFMP Matrices below).

- Water yield studies from replicated sites using sound research methodologies
- On-the-ground delineation of watershed and sub-watershed boundaries
- Flow measurements, particularly within the Lac Antarambiby watershed

- Rainfall analysis over time
- Impacts of various agricultural practices on the water regime
- Impacts of various plantation and natural forest management practices on the water regime

Hydrologic input could also assist in the development of cost conscious watershed rehabilitation activities and soil conservation practices.

Communal Framework

The site visits to Miarinarivo and Tolongoina illustrated examples where consensus was reached within the COBA following strong extension efforts by the DIREF and LDI staff. The COBA at Alaitsinany-lalamarina illustrated a scenario where the issues are more divergent and complex. Consensus in this commune will be considerably more difficult and conflict resolutions strategies may be of benefit. Efforts on facilitating methods for communes to reach consensus and for communes to work effectively with state Ministries may hasten the time required in developing transfer and natural forest management plans.

Consensus building within the planning framework outlined in Section 1 of this report requires efforts by state, regional and local participants to dismiss positional interests and focus on agreed upon desired conditions. This means that issues and position must be negotiable within the confines of the law. There is inherent conflict between rural and urban interests yet these differences do not have to result in irresolvable differences. Parties must be willing to seek consensus.

The use of Interest Based Problem Solving Techniques provides a consensus building process where competing and often conflicting interests can seek common ground in a respectful and mutually advantageous manner. Should a core team of partners (DIREF and NGO staff) be developed for a given region, team-building exercises are advisable. Team building can develop unified approaches and resolve differences prior to engaging local populations.

In addition to intra-communal frameworks, there is an opportunity to begin inter-communal frameworks. In certain instances, there is more than one commune within a watershed. Efforts to affect change within a given watershed in this case would require coordinated efforts not only within a given commune, but between communes as well.

Forest Management Planning

Presented in this report is a process for the development of forest management plans. Discussions and attempts at transferring the implementation this process to NGO staffs and communal members were initiated. Upon further review by in-country staff, should this process be viewed as viable for implementation region-wide, then a follow-up on its implementation is advisable.

A suggested follow-up is choosing of a landscape, such as Zone A in the GCF Forest of Fokontany D'Angalampona, and facilitating LDI Staff, DIREF staff, and COBA

members through the process over a 7 to 10-day period. This could then be used as a model "train-the-trainer" exercise. Additional forest management planning observations highlight the following areas:

- Development and implementation of a monitoring plan
- Detailed work on how to move from the 6 month plan for the GCF Forest of Fokontany D'Angalampona to a long-term plan (as discussed above).
- Continue an emphasis on the development of communal management plans

Finally, the need for a natural forest management plan coordinator who can develop templates, facilitate the process, and review products is high. A likely location for this position would be Fianarantsoa.

# APPENDIX 1

## Abbreviated Natural Forest Management Plan for Zone A, Forest of Fokontany D'Angalampona - Commune of Miarinarivo

### Natural Forest of Fokontany D'Angalampona

Duration of Forest Management Plan

This natural forest management plan is limited to an initial three-year period following the approval and signing of the GCF Transfer Plan. Following three years implementation, a review of the natural forest management plan will be undertaken. The management plan may be extended following appropriate modifications, if necessary.

Delineation of Natural Forest

For the purposes of the GCF transfer and the natural forest management plan, the natural forest of Fokontany D'Angalampona is delineated by the following boundaries:

Northeast to South:
Trangamahody, Iharandratsy, Vohitrakoho, Ampitsinjovana, Ambohidrakapy, Vatosoa, Analamay

Northwest to South:
Agricultural lands

These boundaries are considered preliminary and will be refined during the initial three-year implementation period of the natural forest management plan.

Desired Condition for Natural Forest

The desired condition over the long-term for the forest of the Fokonotany d'Angalampona is the protection of the natural forest and the maintenance of a sustainable supply of water for irrigation of rice fields and other agricultural uses.

Existing Condition for Natural Forest

Within the period of the initial forest management plan the natural forest has been classified into three structural classes. These structural classes will be modified as inventories and mapping are implemented within the boundary of the GCF. The structural classes are detailed below in Table C1.

Table C1
Initial Structural Stage Classification for Forest of the Fokonotany d'Angalampona

| Structural Stage | Location | Characteristics |
|---|---|---|
| A | • The hillside of Vohidambo<br>• Tetezandrery<br>• Izarambola | Grasslands and brush fields (Early successional and fire dominated areas) |
| B | The springs of<br>• Ambodiarandratsy<br>• Bevelatra<br>• Andohaisaha<br>• Andohamanandrena | Dense natural forest |
| C | The remaining forested areas | Deep interior natural forest |

For the initial three-year period of the natural forest management plan, the boundary of the GCF will be divided using three zones with distinct management emphases. Zone delineations will be revised as inventories and mapping are implemented within the boundary of the GCF. Zones may be repeated across the landscape. Subdivisions of the three zones will be undertaken based issues of ownership, management activities, or resource conditions. The initial management zones are displayed below in Table C2.

Table C2
Initial Management Zones for the Forest Fokonotany d'Angalampona

| Zone | Management Emphasis |
|---|---|
| A | Reforestation |
| B | Conservation of Natural Forest and Water Yield |
| C | Sustained Management for Daily Needs of Villagers |

Overall Objective of the Natural Forest Management Plan

The long-term objective of management within the natural forest of the Fokonotany d'Angalampona is the protection of the natural forest within the sous-prefecture of Ambalavao. Protection of the natural forest will produce a sustainable supply of water for irrigation of rice fields and other agricultural uses. Management of the forest has been granted under GCF for a period of three years.

The natural forest management plan for the forest of the Fokonotany d'Angalampona is a joint effort of the DIREF, LDI, the commune of Miarinarivo, and the population at large surrounding the GCF.

General Conditions of the Natural Forest Management Plan

1. No cutting or deforestation of the natural forest may occur within the boundary or perimeter of the GCF without approval of the Chef Cantonnement.
2. Reforestation activities must be undertaken each year during the initial three years of the plan.
3. Soil conservations measures shall be integrated into agricultural activities within the perimeter of the natural forest boundary.

**Zone A of Natural Forest of Fokontany D'Angalampona**

Desired Condition For Zone A

The desired conditions for Zone A are based on discussions with villagers, COBA members, LDI, and staff of the DIREF. These conditions are developed in context of statewide laws, as well as communal concessions and dinas.

Desired conditions are as follows:

- The range of the natural forest within Zone A expands beyond its present boundary, ultimately occupying a larger percentage of the land base.
- Villagers who own property or implement agricultural activities within Zone A will no longer exploit fire wood directly or indirectly from the natural forest

- Villagers who own property or implement agricultural activities within Zone A will not develop new tavy on natural forest lands. The hectares devoted to tavy remains stable within the Zone.
- Across all areas within the Zone, including but not limited to agricultural, pastoral and forested, soil erosion is minimized to an acceptable level or eliminated.
- Soil fertility, particularly within agricultural lands, is increased and maintained over the long-term to facilitate crop production necessary to support village communities and provide a source of revenue.
- The expansion of the natural forest perimeter is by development of "cover" crop plantations that provide the necessary micro-sites for early successional stages to develop.
- Sustainable plantations of desirable, readily accessible fire wood exist within Zone A for use by the villagers. Growth rates within the plantations exceed the harvest rates, thus providing additional sources of revenue.
- The watershed, sub-watersheds, springs, and riparian areas are maintained in a condition that provides adequate irrigation to rice fields and domestic water supply.
- All villagers who own property or implement agricultural activities within Zone A abide by conventions and the guidelines established within the GCF and the forest management plan.

Existing Condition For Zone A

Currently all lands within Zone A are privately owned. Existing conditions within the Zone based on direct input from villagers, COBA members, and staff of the DIREF. These conditions do not reflect on any individual farmer or village. They are intended to be objective statements on the conditions that exist today within this particular zone.

- The range of natural forest is being reduced through tavy, fire wood cutting, and burning practices.
- A percentage of villagers who own property or implement agricultural activities within Zone A continue to exploit the natural forest for daily needs, including but not limited to fire wood, tavy, medicinal plants, and other non-timber forest products.
- The soil fertility, particularly within agricultural lands, is declining resulting decreased crop yields, expansion of tavy, expansion of rice fields, and decreased revenues of villagers.
- There are no fire wood plantations within Zone A that produce a supply sufficient to meet the needs of villagers, or provide sustainable fire wood supplies.
- Traditional use of brush fires on pastoral lands and in tavy fields causes exposure of mineral soil and results in soil loss and erosion.
- A percentage of villagers who own property or implement agricultural activities within Zone A do not abide by conventions and the guidelines established within the GCF and the forest management plan.

- Traditional use of brush fires continues on pastoral lands, and within newly expanded tavy fields, thus encroaching within and reducing the perimeter of the natural forest.
- Early succession of the natural forest is occurring slowly on lands left fallow for periods greater than three years.

Objectives (Need for Change) For Zone A

Through a comparison of the desired conditions and existing conditions for Zone A, the following objectives were developed for Zone A of the Natural Forest of Fokontany D'Angalampona:

- There is a decrease in exploitation of natural forests resulting from fire wood cutting and tavy.
- There is an increased and readily available supply of fire wood outside of the natural forest in Zone A for villagers who live in and adjacent to the zone.
- Within the hectare zone, of fast growing as well as locally preferred fire wood species are introduced at a rate that alleviate pressure on the natural forest corridor for fire wood in the short-term and long-term.
- Primarily on agricultural lands, there is an increase in soil fertility and a decrease in soil loss.
- Watershed protection practices are augmented to provide water for agricultural and domestic uses in sufficient quality and quantity.
- There is a measurable reduction in the disregard of conventions and the guidelines established within the GCF and the management plan

Possible Actions For Zone A

What follows is a listing of possible actions as they relate directly to the needs identified above. A separate action plan that includes the sequencing, timing, and responsibility for implementation of these activities shall be prepared.

- There is a decrease in exploitation of natural forests resulting from fire wood cutting and tavy.
  - Extension work (environmental education) at the individual villager level on the elements of the management plan and the need for conservation of natural forests will be increased to reduce encroachment into the natural forest corridor.
  - Delineation of the perimeter of Zone A.
  - Fire wood plantations are immediately established.
  - Stricter enforcement of conventions and dinas will be undertaken immediately.
- There is an increased and readily available supply of fire wood outside of the natural forest in Zone A for villagers who live in and adjacent to the zone.
  - Establish nurseries providing a ready and continuous supply of seedlings for fire wood plantations.
  - Fire wood plantations are immediately established.
  - Data on locally implemented species trials is reviewed and integrated into nursery stock decisions and ultimately plantation establishment.

- Within the hectare zone of fast growing as well as locally preferred fire wood species are introduced at a rate that alleviate pressure on the natural forest corridor for fire wood in the short-term and long-term.
    - Establish nurseries providing a ready supply of seedlings for fire wood plantations.
    - Fire wood plantations are immediately established.
    - Data on locally implemented species trials is reviewed and integrated into nursery stock decisions and ultimately plantation establishment.
- Primarily on agricultural lands, there is an increase in soil fertility and a decrease in soil loss.
    - Extension work at the individual villager level will be increased to increase the use of composting systems.
    - New Agroforestry systems are introduced through extension work. In coordination with this, Agroforestry demonstration plots are established.
- Watershed protection practices are augmented to provide water for agricultural and domestic uses in sufficient quality and quantity.
    - At risk sub-watersheds and associated streams are identified and their perimeters are mapped.
    - Agroforestry systems are used to increase soil fertility and reduce soil loss, particularly adjacent to streams
- There is a measurable reduction in the disregard of conventions and the guidelines established within the GCF and the forest management plan.
    - Extension work (environmental education) at the individual villager level on the elements of the management plan and the need for conservation of natural forests will be increased to reduce encroachment into forest.
    - Stricter enforcement of conventions and dinas will be undertaken immediately.
    - The presence of local level field staff from the DIREF, and the COBA will be increased. The capacity of these forestry agents is reinforced.

# SECTION 2: PROTOTYPE PRIVATIZED MANAGEMENT PLAN AND SILVICULTURAL SCENARIOS: MANDARATSY PINE PLANTATIONS, FIANARANTSOA, MADAGASCAR

## EXISTING SITUATION

### Potential of the Haute Matsiatra Pine Plantations

Other than the Mandaratsy Pine Plantation, the team did not visit other plantations within the Haute Matsiatra. However, growth and inventory data provided by EASTA Iboaka, and information gleaned from conversations with employees of Eaux et Forêts suggest that other pine plantations within the Haute Matsiatra are at least as productive as those within the Mandaratsy area. Pine sites within the Haute Matsiatra are extremely productive, being capable of producing merchantable wood fibre on par with the best sites in the Pacific Northwest of the United States. Economic potential for the pine plantations is explored within the report provided by Dr. Ingram (chapter 3 of this report), and the Excel spreadsheet tool can be used to test various investment assumptions.

The pine plantations represent a physical and biological asset that has significant potential to generate substantial economic returns for the benefit residents of Fianarantsoa and surrounding communities. To fully realize the economic potential of this asset various forms of investment are necessary, as are discussed later in this chapter. The pace at which investments are made will necessarily influence the potential returns. However, even modest investments can, as is shown in the very rough yield approximations, provide large returns that can be re-invested in either infrastructure or in further yield-increasing silvicultural treatments.

Current practices within the pine plantations are depreciating the value of the resource. Uncontrolled burning during the dry season reduces the value of wood by hardening the bole near the ground line. Typically, the highest value is in the bottom log. Burning increases pitch within the wood, makes it difficult to saw, and encourages operators to cut off and discard the affected portions of the bottom log. This results in potentially large amounts of waste and reduced economic returns. Low utilization also increases the amount of fuels left on site. Hand felling and low technology manufacturing typically leaves most of the bole, and all of the top in the forest. This in turn exacerbates fire risk, and results in further loss of value in the mature trees. Regeneration after fire is prolific. In the absence of thinning the dense forest grows poorly, resulting in very substantial reductions in future harvestable volume. While the existing road system appears to have been designed with long-term management needs in mind, it has not been maintained to a standard sufficient to allow for efficient exploitation of the pine resource. Roads need investment in surfacing and drainage for efficient harvest operations and subsequent silvicultural operations to occur.

### Information

#### Available Data

Very little quantitative data appears to be available regarding vegetation conditions and infrastructure conditions within the Mandaratsy Pine Plantations. Information such as the current forest inventory, an inventory of forest roads, statistics on recent land clearing, and information about past and current exploitation of the pine resources is not currently available. A recent inventory of pine resources was completed for the Haute Ranomainty Pine Plantation located a few kilometers from the Mandaratsy Pine Plantation by EASTA Iboaka. This inventory is for standing volume only. No growth data were collected during the inventory of the Haute Ranomainty forest. The inventory provides helpful insights into the likely condition of the Mandaratsy Pine Plantations.

Excellent cartography of pre-1990 plantation parcels is available from Eaux et Forêts, however it has not been updated to reflect changes that have resulted from cyclones, agricultural land clearing, commercial harvest, and illegal exploitation. Maps indicate the order of planting, and not necessarily the site potential or the pine stocking and structure that developed after planting.

Geographic Information System (GIS) coverages for the Fianarantsoa area are of very large scale (1:250,000 and larger). GIS coverages of forest vegetation at the stand level do not exist. Fine scale coverages are also not available for land use, administrative jurisdictions, irrigation systems, hydrology, and transportation systems.

GIS personnel at MIRAY, an NGO operating in Fianarantsoa, indicate they are acquiring satellite imagery from 1993 and 2000 to do change analysis for the Corridor. Based on information provided it is probable that the resolution for this analysis will not address fine scale needs for planning and monitoring within the Mandaratsy Pine Plantation and Lac Antarambiby watershed.

The French developed a large amount of literature regarding exotic pine culture during the colonization period. This literature appears to be largely unavailable to the current generation of forest managers.

Discussions with stakeholders who have expressed interest in the Mandaratsy Pine Plantation and management of the Lac Antarambiby watershed suggest that access to available data varies among stakeholders. Available information appears to be well dispersed.

## OPTIONS FOR MANAGING PINE PLANTATIONS

Two concepts are being considered for management of the pine plantations of the Haute Matsiatra. One option is to use a community based approach where local communities become responsible for management of the plantations. The other option is to implement management under the supervision of Eaux et Forêts through long term private permits. Several aspects of the community based management were discussed in a prior report and will not be reiterated here.

The current approach to management employs a system of short term harvest concessions. Based on a review of two successive permits issued to Les Scieries du Betsileo it appears that the focus of the existing concession instrument is on harvest exploitation. These instruments are designed to exploit an existing resource that has economic value. In their present form, the system of concessions captures value by virtue of the pre-harvest inventory, and through taxes on manufactured products. This approach allows considerable flexibility to the managing entity to harvest specific, well defined areas. Where the administrative infrastructure (accounting systems, cadre, budgets, etc.) are in place, short term concessions can be used to achieve excellent resource management. In the absence of any of the key administrative infrastructure components, desirable outcomes may be difficult to attain. Without a strong accounting system, professional cadres, and adequate budgets, concessions are not unlikely to encourage investments that would yield long term enhancement of the value of the pine resource, nor are they likely to encourage practices that would improve utilization of the existing resource. Short term concessions, generally two years or less, do not provide the necessary stability for potential investors to encourage economic outlays because of the relatively long term (15-25 year) time horizon for forestry investment. Forestry and natural resource investments argue for tools that

encourage developing increased long term profitability and returns. Opportunities for community capacity development associated with the concession approach are incidental, rather than primary outcomes of exploitation.

While this report will discuss the option of a privatized management under a long term permit with Eaux et Forêts as the entity with whom ultimate management responsibility resides, many of these same concepts could be considered under a community based option. For example, under community based management, the communities would want to assure through some mechanism that periodic inventories of resources are conducted, harvest schedules are developed, that implementation is monitored, and stakeholders involved appropriately, etc. Where the necessary management infrastructure exists at the community level to develop and administer complex agreements it is possible that a privatized approach to management, similar to what is presented here, might be considered to gain access to capital and expertise. Privatized approaches to resource management have yielded good results where proper incentives are in place to encourage attainment of short- and long-term social and economic objectives.

## CONSIDERATIONS – SUGGESTED ITEMS TO ADDRESS IN PRIVATIZED MANAGEMENT AGREEMENTS/PERMITS AND MANAGEMENT PLANS

### Establish the Purpose and Need for the Project

It is helpful to clearly describe why a project or plan is needed. This helps all stakeholders understand the project/plan.

For example, the *purpose* of a management plan for the Mandaratsy Pine Plantations is to provide a framework for sustainable exploitation of the pine resource over time, for the benefit of surrounding communities.

Some examples are also provided for the *need* for the project. The *need* for a management plan exists because the pine plantations are severely degraded as a result of successive cyclones, fire, illegal harvest, and poorly executed exploitation. A further *need* might be to reduce overstocked conditions in juvenile pine stands and to reduce shrub cover in order to control excessive evapotranspiration that unduly diminishes the water yield from the Lac Antarambiby watershed. There is also a *need* to exploit the accumulated economic value, as well as future economic values to benefit community residents. A *need* exists to provide raw materials to manufacturers to benefit residents of Fianarantsoa. A *need* exists to generate revenues to fund necessary management activities by Eaux et Forêts.

### Agree upon Goals and Objectives

Clearly defined objectives are very helpful. Objectives are most helpful when they are specific to what the Team wishes to address. Objectives define a desired result, and may include a time by which the result will be attained. It is helpful, though not absolutely necessary, for objectives to be quantitatively defined. A management plan is a roadmap into the future. "Objectives" are a description of the desired outcome of implementing the plan. Objectives necessarily flow from the purpose and the need for the plan/project.

The following objectives may be appropriate for the Mandaratsy Pine Plantation, and for other plantations in the Haute Matsiatra. The Team offers them for further consideration. The conversations and discussions during the past two weeks suggest they are of interest to at least some of the many stakeholders who have interests in the Mandaratsy Pine Plantations. There

may be additional objectives that should be addressed. On the other hand, some of these may be found to be unnecessary and they will be discarded.

Example objectives are offered in paragraphs 1 through 6 below.

**Sustainable Exploitation**
A fundamental objective of management is to assure that exploitation of the Mandaratsy Pine Plantations is sustainable over time. Sustainable in this context means that basic productivity of the resources (land, water, vegetation) are not diminished by the current generation to the detriment of future generations. It is desirable that future harvests will be at least as great as current harvest levels.

**Community Benefits**
Communities that exist around and within the Mandaratsy Pine Plantations have strong and abiding interests in the land upon which the plantations are established. These communities must therefore benefit directly and substantively from exploitation of the plantation resources. Economic and other benefits should begin to accrue to members of adjacent communities immediately upon granting of permits to exploit the Mandaratsy Pine Plantation resource. At least half of the wages produced during harvest operations involved in exploitation of the pine resource should be paid to community residents.

**Capacity Building**
The Mandaratsy Pine Plantations are a valuable capital asset. Exploitation of this resource must provide for substantive measures that will improve the social, economic, and political capacity of communities surrounding the plantations. Within a specified and agreed upon time following granting of permits to exploit the resource, appropriate investments must be made by the Permittee in roads, education infrastructure and opportunities, or other community infrastructure. Investments must be made on a continuing basis throughout the duration of the permit.

Capacity building investments are desirable that will develop new facilities, maintain existing facilities, improve the social and intellectual capacity of community residents, and strengthen social structures such as schools and community governance. Social capital (leadership skills and social cohesion) of communities surrounding the Mandaratsy Pine Plantations should be strengthened through meaningful employment opportunities. Employment opportunities must be provided to community residents throughout the duration of the permit. Appropriate investments in training to increase skill levels and develop personnel must occur throughout the duration of the permit.

**Broad Support by Stakeholders**
Stakeholders in the Mandaratsy Pine Plantations include first and foremost the local communities who have long term interests in the land, and Eaux et Forêts who created the plantations and has cared for them since their inception. Additional stakeholders include rural and urban water users, JIRAMA, and entities who have depend upon the pine plantations to provide raw materials for their livelihoods. To the extent that is feasible and practical, stakeholders should be involved at the appropriate level in decisions regarding management of the Mandaratsy Pine Plantations. During the duration of the permit, appropriate mechanisms should be developed and implemented to allow

consideration of stakeholder interests. Stakeholder interests will be considered during periodic reviews of the permit, and to the extent that it is feasible and practical, accommodations in management practice will address these interests.

**Economically Efficient Exploitation of the Pine Plantation Resource**
Exploitation of the Mandaratsy Pine Plantations must be accomplished in an economically efficient manner. Fair and equitable charges must be received for economically valuable raw materials, and exploitation must be accomplished without unduly diminishing rents paid by the Permittee, now and in the future. Rents paid by the Permittee must be periodically reviewed and adjusted to reflect current costs of production, current markets, products produced, generally accepted profit margins, and other factors. Initial rents paid by the Permittee must be commensurate with the true economic value of the resource.

**Protection of Watershed Values and the Production of Water**
The watershed of Lac Antarambiby must be maintained in excellent condition. Adequate vegetation must be present at all times to prevent unacceptable siltation of the lake. Excess vegetation that reduces water supplies should be controlled. Roads and facilities must be maintained to prevent unacceptable erosion and resulting siltation of water ways. Excess pine stocking in juvenile stands should be reduced to the extent feasible in order to reduce transpiration demand. During the duration of the permit, the Permittee should conduct thinnings of juvenile pine forest in association with harvest of mature forest.

**Decide upon the Desired Condition of the Pine Plantations, the Antarambiby Watershed, and of the Surrounding Communities**

The Desired Condition is the 'target' toward which management will aim. It should include qualitative, and if possible, quantitative descriptions of how the pine plantations will look in the future. The Desired Condition is determined by considering the objectives, social context, as well as the biological and physical potential of the area. The Desired Condition describes the biological, physical, economic, and sociological situation that the community and other stakeholders would like to see result from management activities. It is quite possible that the Desired Condition will evolve over time as new information becomes available, or social needs and desires change, or where there are changes in the biological or physical situation of the plantations.

A suggestion for the Desired Condition might be:

Within stands where pine management will occur, trees will have thrifty, well developed crowns, and will fully exploit site potential. Ultimately, stands will have from 300 to 400 trees per hectare at the time of final harvest. Thinnings will occur as scheduled in order to reduce excessive stocking, reduce evapotranspirative load, and to capture maximum growth. Initial non-commercial thinnings will occur early enough to eliminate the need for expensive slash treatments. Commercial thinnings will be accomplished in a manner that does prevents undue damage to reserve trees and does not diminish growth potential. The final harvest will occur at or near rotation age, and will result in prompt regeneration of pine species on the site. Rotation ages are suggested in the report titled "Silvicultural Scenarios for Series A, B, C, and D of the

Mandaratsy Pine Plantation". As additional market information is obtained, silvicultural practices will be adjusted where economically feasible to result in the highest economic return consistent with fully preserving the productive potential of the land.

Age class distributions will be balanced across the Mandaratsy Pine Plantation so the highest possible levels of harvest can be sustained over time. Balanced age distributions will also mediate effects of changes in canopy cover on water yield. A balanced age distribution will facilitate approximately even flow of forest products.

Revenues from exploitation of the pine resource will provide capital for improving and maintaining infrastructure such as roads, schools, and medical facilities.

The transportation system will be well designed, well maintained, and adequate to serve the needs of the communities while efficiently transporting product to external markets.

The Lac Antarambiby watershed will be in excellent condition. Roads and other human infrastructure will be designed and maintained to minimize sediment production. Vegetation will be managed to maintain necessary flows of high quality water.

Surrounding communities will be substantively involved in management of the pine resource through direct employment, continued involvement in decisions affecting the Mandaratsy Pine Plantation, and in other ways.

**Terms of the Permit**

The terms of the permit should flow from and implement the objectives. Ultimately the terms should address the purposes and the need for the plan/project. There is a progression, a flow, that links the 'why', the 'what', the 'when' and the 'how'. The terms of the permit are the 'when' and the 'how' of the plan/project. A clearly understood need with an unambiguous purpose facilitates easily understood objectives. These clear objectives are easily translated into terms and conditions within the permit. The terms of the permit should move the pine plantations toward the Desired Condition.

For the purposes of explanation and example, a possible permit within the Mandaratsy Pine Plantation is described. Suggested terms for the permit are discussed below. As with the objectives, it may be determined that some of these are unnecessary, while it may be desirable to include additional terms or conditions.

Several stakeholders have expressed interest in testing a private permit-based management arrangement for the Mandaratsy Pine Plantations. Under this approach, the Permittee would enjoy certain rights and privileges, including long tenure. The community and Eaux et Forêts would be assured professional management of the resource as well as economic, social, and infrastructure benefits.

As with any contract, it is extremely important that all changes to the initial agreement be completed in writing over the signatures of the Permittee and a designated representative of Eaux et Forêts.

**Area Included in the Agreement**
The location of parcels (stands) included in the permit must be unambiguously enumerated. For example, the specific Series and Parcels within the Mandaratsy Pine Plantation that are included within the permit should be listed.

When the area included in the agreement is determined, parcels can be identified and excluded from the permit that might be desirable for agricultural exploitation, for providing wood harvesting opportunities for local communities, or for other reasons.

Parcels where Permittee operations are constrained, or where special management is desired should be listed. For example, for some reason it may be desirable for the Permittee to expedite thinning or to complete road reconstruction at an accelerated pace in certain areas.

**Period of the Agreement**
The period of the agreement will have substantial bearing upon the level of investment that can be demanded of the Permittee. Regulatory certainty, as well as certainty of supply is essential for attracting private investment necessary to fully exploit the pine resource. A relatively long period of time, possibly as long as twenty years, will be necessary for a Permittee to recapture investments made in juvenile stand treatments such as thinning. Since there are substantial startup costs associated with exploiting the pine resource (equipment, physical infrastructure, training, etc.) a long permit period will allow full amortization of investments.

**Scheduled Review and Re-negotiation**
Periodic review of the permit is desirable to address changed conditions such as fluctuating markets, changes in the management environment, improvements in technology, catastrophic events, and so forth. Items that require mutual consent for changes should be identified, as well as items that can be changed unilaterally by either party. Scheduled reviews are typically planned to occur at three to five year intervals. When scheduled reviews will occur should be specified in the agreement, as well as the process to be used to convene the reviews, the location of the reviews, and the roles and responsibilities of the parties involved. For example, since Eaux et Forêts is the party responsible for management of the permit the Director or his delegate might have responsibility to convene the review. The stated location for meetings could be in the DIREF offices in Fianarantsoa, or a mutually agreeable location. Agenda items for any periodic reviews would be agreed upon in advance of the meeting by Eaux et Forêts and the Permittee. Where there are other stakeholders, such as JIRAMA, local communities, or other groups, the permit should address the process by which they can suggest agenda items, whether they will participate directly in the meetings, or whether Eaux et Forêts will represent their interests.

Contract terms that might be subject to mutual agreement include changes in the area of the permit (additions or deletions to the permit area), payments to communities, investments in community infrastructure, the expectations for employment of community residents, extensions of the length of the agreement, and so forth.

Contract terms where one party might unilaterally act might include increased rates of payment for taxes where the taxes rates are assessed against <u>all</u> permit holders and industrial forest operators, and updates to the stumpage price schedule where there are

published indices or other unbiased price information. Typically these items would be reserved to the Grantor (in this case Eaux et Forêts). Examples of areas where the Permittee would typically have the unilateral right to decision include whether or not to employ new technologies, hire/fire employees, modify management structure at will subject to providing required expertise, enter new markets, and to exploit the resource in new or innovative ways. The specific issues that might fall into either category are subject to local practice and usual business customs. It is very desirable that they be clearly understood by all parties at the time the agreement is executed. Of course, it is always good policy to require that any changes to the permit be made in writing, with appropriate signatures and notary affirmations. Signed copies of all changes should be distributed to all parties to the permit.

**Permit Extensions**

The scheduled review may also be used as a time to discuss extensions of the permit. For example, if at the first five year review all is going well, the permit may be extended for an additional period of years as an outcome of meeting. For example, assuming the original permit is for 20 years, if the review occurs on the fifth year of the 20-year permit term, an outcome of discussions might be to extend the remaining 15 years to a full 20 years. This process might, at the option of the involved parties, be repeated in subsequent periodic reviews.

**Harvest Schedule**

The harvest schedule represents the desired level at which the pine resource would be exploited over time. Because there are economic and capacity realities, it may also be interpreted as the maximum level of exploitation and growth over time. In many situations it is not possible to fully realize the potential harvest because of constraints on capital, infrastructure, markets, or other factors.

A harvest schedule should be included in the permit. Because it is a projection it is merely a guide for what is possible, i.e. an estimate of the potential volume and value that will result from exploiting the resource.

Where a minimum income stream is desired the permit may require minimum amounts of harvest annually. Where this is a stipulation a minimum harvest amount should be determined that can be accomplished by the Permittee even when market conditions are temporarily unfavorable. Where the Permittee is poorly capitalized, the minimum annual harvest may be zero, and the maximum harvest level may be allowed to exceed the average annual harvest for the period so long as the average harvest for the period is no larger than the projected amount.

Land Stratification and Inventory

A harvest schedule is based upon the distribution of volume across strata and over time. The schedule provides a plan of action for the Permittee, and is a tool for Eaux et Forêts and the communities to project revenues and other benefits. It can also be used by other stakeholders, for example the agency responsible for managing public roads, to evaluate their workloads and to evaluate harvest/haul impacts.

Strata are defined based on existing forest conditions. Typically strata represent significant differences in growth potential (in $m^3$/ha/yr), management direction, forest types, or other factors that may have a determining affect on timber harvesting opportunities.

Therefore the following information must be known or estimated to develop strata for the purposes of projecting harvests:

- Surface area within each strata expressed in hectares.
- Existing volumes per hectare;
- Current volume growth on a per hectare basis;
- Silvicultural practices that can be applied within each strata;
- Approximate costs and revenues associated with possible silvicultural practices;
- Management considerations that may influence the selection of silvicultural practices. For example: Within the Lac Antarambiby Watershed there may be a preference for thinning juvenile forest as early as possible to reduce potential interception of precipitation and to minimize evapotranspiration load.
- Accessibility issues that may affect operational decisions and the application of silvicultural practices. For example, current harvesting equipment may not be well suited for steep slopes (over 45%), and therefore volume in these areas may not be immediately available for exploitation.
- Merchantability criteria.
- Suitability of the surface area to be used for growing other forest species.

Of course, the area within each strata will change over time as harvest, fire, or cyclone damage creates a new age class, and as existing age classes grow older. Surface area may also change if there are land use changes that either remove forest from production (as when there is agricultural clearing) or when new area enters production (as when agricultural fields are abandoned). Periodic inventories are needed to assure surface areas for each strata are correct. Likewise, periodic inventories are necessary to adjust volume and growth estimates.

Several computer models are available that will develop optimized harvest schedules, provide estimates of harvest, and estimate economic return. All of these models require detailed information on growth, area, current inventory, and potential silvicultural regimes. The models are somewhat complex, and require a trained technician to use them with acceptable results.

In the absence of an accurate inventory of surface areas and vegetation conditions, a very rough schedule was developed based upon projected volumes harvested over time for several alternative silvicultural regimes (see Silvicultural Scenarios, Appendix A). Basically, assumptions built into the harvest schedule can vary according to the objectives and desired condition for the forest. In this case, for the purposes of this prototype plan, it is assumed that "sustainable exploitation" means developing a schedule that would provide for the highest possible level of volume removed over time. It is also

assumed that future declines in harvest volume are not desirable because that would result in reductions in revenue, and therefore potential investments in infrastructure, social capacity, and so forth.

The harvest schedule outlined below is very approximate. It appears to be attainable given the information available at this time, and can be used to provide a starting point for management. Since it is necessarily approximate, there is good reason to place a high priority on acquiring the necessary data to develop a well supported, accurate harvest schedule. Efficient exploitation demands investment in an accurate inventory, as well as detailed mapping of the pine stands. Therefore acquisition of more accurate data would be a wise investment.

When Eaux et Forêts established the Mandaratsy Pine Plantation the parcels were organized into six Series labeled A through F. At the present time the option of contracting for private management of Series A, B, C, and D is being discussed.

The current condition of Series A, B, C, and D is represented below for the purposes of this exercise. To simplify growth projections, the age classes are arranged into four strata. The strata labeled "0-4", "5-7", and "40+" correspond with the three situations discussed in Appendix A (Silvicultural Scenarios for Series A, B, C, and D of the Mandaratsy Pine Plantation). The fourth strata labeled "Agricultural" represents an estimate of the area within these four Series that no longer support forest.

The surface areas shown in Table 1 are highly approximate, and are at best very rough approximations of actual area within each strata. While they may be useful for illustration purposes, and for initial operations under a prospective permit, they should be updated with current information at the earliest opportunity.

**Table 1. Estimated Area in Hectares within Series A, B, C, and D by approximate age class.** [4, 5]

| | **Age Classes** | | | | |
|---|---|---|---|---|---|
| | **Strata 1** | **Strata 2** | **Strata 3** | **Strata 4** | |
| | **0-4** | **5-10** | **40+** | **Agricultural** | **Total** |
| **Series A** | 107 | 426 | 106 | 71 | 710 |
| **Series B** | 87 | 348 | 87 | 58 | 580 |
| **Series C** | - | 350 | 176 | 58 | 584 |
| **Series D** | - | 416 | 209 | 69 | 694 |
| **Total** | 194 | 1535 | 578 | 256 | 2,568 |

Only the mature (40+) age class in Strata 3 is assumed contain harvestable volume during the first two periods of the harvest schedule for the purposes of this exercise. It is also assumed that 10% of the Strata 3 would be clearcut each year during Periods 1 and 2.

[4] Estimated area in each class is based on very rough proportions provided by Ratsinbazaty and Beuche (2001). These figures are 'first order' approximations suitable for illustration of the process and to serve as a starting point for discussion. Surface areas for each series are summations for the perimeters shown for individual parcels in the Enseignment Monographique: dated 7 August 1992.

[5] Series are as shown in the Eaux et Forêts map of the Mandaratsy: Plan du Primetre de Reboisement. This map was prepared in 1970 and updated in 2000.

Thus all of Strata 3 would be harvested by the end of ten years. Thereafter harvesting will occur within second growth (naturally regenerated pine forests). Harvesting in the second growth forest would be by both commercial thinnings and by clearcutting, as described below.

For the purposes of this illustration, the total surface area available for pine harvest is assumed to be static at 2,312 hectare. This is the sum of the areas in Strata 1, Strata 2, and Strata 3 for Series A, B, C, and D as shown above in Table 1.

Also, it is assumed that for every hectare of mature forest harvested during the initial two periods, one hectare of the youngest age class will be thinned as projected in Scenario B, Appendix A. Initially non-commercial thinning will occur within the Strata 1, labeled "0-4". This is because Strata 1 contains all of the surface area that is presently stocked with trees aged 0-4 years old. However as time passes trees in this strata will age and non-commercial thinning will shift to the youngest age class created by the ongoing clearcutting of Strata 3 (not shown in Table 1). Essentially, clearcuts within Strata 3 will create a new strata of young trees each year. After about four years all of the non-commercial thinnings would be in these newly created strata that is truly defined by age class.

When considering the harvest schedule, it is helpful to realize that beginning in Period 3 harvest will depend upon growth within the Strata 2, the current 5-10 year age class, as well as growth in the non-commercially thinned stands that were treated during Period1. The rate at which stands that are currently in juvenile age classes mature becomes extremely important for maintaining the steady increase in outyear harvest levels.

In practice it is desirable to iteratively consider economic criteria when developing a harvest schedule. Refer to the tools presented in the economics section of our report for some of the cost and revenue considerations that would be included. Selection of strata to harvest are determined by the economic return of harvests discounted over time, and by evaluating the non-economic contributions harvest will make toward meeting the objectives of the plan. In some situations, such as when there is an urgent need for cash, or when there are over riding needs to rehabilitate a landscape to assure long term sustainability of resource production, it may be desirable to select a harvest schedule that will do other than maximize the economic return on investments.

Again, it is helpful to be aware that the harvest schedule displays the maximum attainable volume harvested for each period. As discussed earlier, several circumstances may combine to result in an actual harvested amount that is less than the schedule projects. Any reduction in actual harvest compared to the projection will have obvious implications for revenue, for growth on growing stock, as well as for volumes available for future harvest.

Period 1: Schedule for years 0-4

During the 5 year period beginning with implementation of the permit, approximately 58 ha of mature forest in Strata 3 would be harvested each year. In the absence of an optimization model that iteratively considers economic effects, a total of 290 ha of mature forest in Strata 3 would harvested over the five year period. During this same period 58 ha of juvenile forest in Strata 1 would be non-commercially thinned. Based on the large difference in cost for conducting non-commercial thinnings in Strata 2, the

current 5-10 year age class, it is recommended that these stands be allowed to develop as projected in Scenario C, Appendix A. During Period 1 approximately 25,000 $m^3$ would be harvested.

Period 2: Schedule for years 5-9

Management of the pine plantations would proceed as in Period 1. Volumes harvested from mature pine forest in Strata 3 would remain unchanged or perhaps decline slightly. Non-commercial thinnings would occur within stands that have regenerated following clearcut harvests made during Period 1.

The importance of reliable inventory data is illustrated here. As of this date, non-commercial thinning has occurred on approximately 5 ha within Series A and Series B. This work was done by Les Scieries du Betsileo under the terms of their current concession. While thinning retained more trees than might be considered optimal in the scenarios presented in Appendix A, positive growth effects are anticipated. Also, some of what is now 5 to 7 year old forest is relatively widely spaced and growing very well. It is therefore probable that these areas would produce merchantable trees (trees that have at attained a size of at least 20 cm at Dbh) sooner than projected in Scenario C. However, the absence of reliable data obscures these facts and prevents their full consideration in this preliminary harvest schedule.

Period 3: Schedule for years 10-14

Beginning in Period 3 harvest would be totally dependent upon the naturally regenerated pine forest as the original plantations would now be liquidated. Harvest levels can increase substantially as commercial thinning extracts volume from previously non-commercially thinned stands. Approximately 290 ha of forest that was non-commercially thinned under Scenario B during Period 1 will be commercially thinned during Period 3 resulting in yields of approximately 60 $m^3$ per ha, or 17,400 $m^3$. This results in a short fall of about 7,600 $m^3$ compared to harvests in Periods 1 and 2. The shortfall can be overcome by beginning to regenerate (clearcut) stands in Strata 2 that have developed under Scenario C (no non-commercial thinnings). These stands, though not yet fully mature, contain substantial amounts of volume that can be harvested in Period 3. Since there are over 1,500 ha in this age class, each supporting approximately 110 $m^3$ per hectare, harvest levels can begin to increase dramatically. This schedule assumes approximately ¼ of the surface area in Strata 2 would be harvested during period 3, with another ¼ harvested in period 4. Harvesting 25% of the surface area in Strata 2 during Period 3 would yield approximately 43,000 $m^3$, for a total harvest during the period of approximately 60,400 $m^3$. This is approximately 250% of the projected first period harvest.

Continuation of the requirement that for every hectare regenerated a corresponding hectare would be non-commercially thinned assures that volume growth will continue to accelerate, and that future harvest levels can continue to increase.

Period 4: Schedule for years 15-19

Harvest levels would be expected to continue to accelerate during Period 4. During Period 4 commercial thinning volume from stands that were non-commercially thinned in Periods 1 and 2 according to Scenario B will provide approximately 33,600 $m^3$. In addition, forests in Strata 2, that are today in the 5-9 year age class, will be mature and

ready to regenerate at full yield. Approximately 130 $m^3$ per hectare could be harvested from those stands that were not clearcut in Period 3. If another 25% of these stands are clearcut during Period 4, an estimated 49,800 $m^3$ would be harvested. Thus the total harvest (commercial thins and clearcuts) during Period 4 would be approximately 83,400 $m^3$. This volume is nearly 350% of the projected first period harvest.

**Distribution of Revenues**

Any ambiguity regarding distribution of revenues is a potential source of conflict. Therefore the Team suggests that the distribution of revenues to taxes, payments to communities, and required investments in education and infrastructure be very clearly specified. Assessments against revenues can provide funds to do needed management and to develop community infrastructure and social capital. Assessments required of the Permittee must be carefully set to allow the Permittee sufficient profit to both continue operations and to make investments that will ultimately appreciate the resource.

The terms of the permit can enhance fiscal accountability if specific accounting mechanisms are specified for funds that would be used to finance infrastructure or social capital improvements. Perhaps devices such as general ledger or trust fund accounts might be used to provide transparent accumulation, management, and expenditure of funds collected from exploitation of the pine resource. Trust fund accounts might be managed by the Permittee, subject to periodic financial audits by an independent third party. Alternative arrangements are also possible, though independent audits are highly recommended regardless of who is trustee for investment and development funds. Trust funds should be segregated from trustee operations so there is a high degree of assurance they will be available for the intended purposes.

Stumpage Payments

Stumpage payments based upon a pre-harvest inventory specifically designed for this purpose are an excellent means for encouraging the Permittee to improve utilization and therefore to maximize the value of the pine resource.

Other Payments

The permit should list all other payment categories, and the basis upon which payments are made, and the required distribution of payments.

Since Eaux et Forêts is determining pre-harvest volume for the purpose of assessing stumpage payments, it is suggested that all other payments be expressed as a percentage of stumpage. Examples of other payments that might be addressed through a stumpage assessment include an assessment to invest in infrastructure improvements (such as roads, schools, or medical facilities), an assessment to invest in educational scholarships for community residents, or an assessment to perform non-commercial thinnings within the permit area (above and beyond what would be required in the permit).

**Permittee Obligations to Communities**

An advantage of engaging a private entity to manage exploitation of the pine resource is the opportunity to ally with the innovation and entrepreneurial energy a private company can often bring to the table. A long term permit provides strong incentives for the Permittee to view the relationship as a partnership wherein investments in the community

will ultimately result in appreciation in the value of the permit. To clarify responsibilities, as well as to allow for frank discussion of the opportunities the Permittee has to participate in capacity building within the community, the permit might address specific areas where Permittee contributions are desired.

Capacity Building

The forest resources of the Mandaratsy Pine Plantation are a valuable asset. Exploitation of these resources may contribute in very real ways toward improving the social capital of surrounding communities. Employment opportunities, infrastructure improvements, support for organizations such as Eaux et. Forêts, and investments in education and training are all examples of how capacity building may result from exploitation of the pine plantations.

*Infrastructure Improvements*

Many infrastructure improvements are equally desirable to the Permittee and to the communities. For example, improvements in the road system will facilitate extraction of Permittee raw materials, while enhancing access communities that lie within the plantation. Contributions by the Permittee in support of school and medical facilities ultimately improve the quality of the workforce.

The Team suggests that the permit address the Permittee's responsibilities to improve community infrastructure. Responsibilities might be address in terms of monetary support for projects, or in terms of specific projects that will be completed by the Permittee as a part of the pine resource exploitation operation. Where monetary contributions are to be made, it may be helpful to address exactly how payments will be may, to whom, and whether escrow accounts or other devices will be used. It may be helpful to specify the specific infrastructure enhancements that would be accomplished concurrent with Permittee operations, as well as a time frame for accomplishment.

*Training and Education*

As with infrastructure improvements, the Permittee may be able to support training and educational opportunities for community residents. Support may be provided in many forms. Perhaps the Permittee could establish or participate in scholarship grants to worthy students, contribute to the support of workshops or community extension services designed to improve agricultural practices or health and sanitation practices, or materially assist in other ways that would improve the social capital of communities.

Employment of Residents

Perhaps the most direct benefits from Permittee operations will be through employment of community residents. The permit may contain requirements that address employment of residents. Examples of requirements that might be included are minimum numbers of Full Time Equivalent (FTE) employees who are residents, or minimum amounts of wages paid to community residents. These requirements may also be expressed as proportions. For example, the permit might contain a requirement that a certain percentage of the Permittee's workforce be community residents, or a certain percentage of the total payroll be made to community residents.

**Permittee Responsibilities and Management Infrastructure**

The Permittee will need certain skills in order to meet all of the objectives of the permit. Discussing the skills the Permittee must provide clarifies expectations, and improves the probability that the results will meet expectations of all parties.

Expertise

Forestry is a technically rigorous professional discipline. Maximizing the value of the pine resource for the benefit of communities is more likely to be successful if trained and experienced foresters are directly and affirmatively involved in management decisions. The Team suggests considering a requirement that the Permittee have professional forestry staff involved in key aspects of the harvest, silviculture, and valuation, and milling operations. Depending on the terrain, the need for engineered roads, and other resource issues, other disciplines may be necessary to assure efficient and sustainable exploitation of the pine resource.

In addition to forestry skills, certain business management skills may also be necessary to facilitate an efficient operation that will maximize financial returns. It may be desirable to address business management skills in the Permittee's organization within the permit to improve the likelihood that community financial objectives are realized.

Infrastructure Investments and Maintenance

Adequate roads and bridges are essential elements of any exploitation strategy. Other infrastructure may also be needed to maximize the value of the pine resource. Clearly defining within the permit what the Permittee's obligations will be for maintaining existing infrastructure, as well as developing new infrastructure will reduce ambiguity.

*Transportation Systems*

The most obvious infrastructure asset is the transportation system. Without good roads, appropriately located on the landscape, efficient exploitation cannot occur. Both the Permittee and communities have a strong interest in maintaining an efficient transportation system. A complete inventory of existing roads, bridges, culverts, and ford crossings is an important starting place. The Team suggests that Permittee responsibilities for maintenance, improvements, and new construction be detailed in the permit. Where a current transportation asset inventory is not available, one of the Permittee's responsibilities might be to develop one within a specified time. To improve communication, it would be helpful if individual road segments within the Mandaratsy Pine Plantation are uniquely identified by number. It is desirable to map individual road segments and list them in the transportation system inventory. The elements of the transportation asset inventory can either be specified in the permit, or the permit might merely state that the inventory would be completed within an agreed upon time and to an agreed upon standard. For example, it is estimated that approximately 50 km of existing road will need to be opened to exploit pine resources in Series A, B, and C. The schedule for opening these roads should be specified, along with required maintenance of roads once they are open. A requirement might be included in the permit for the roads to be numbered and mapped within a certain period of time.

Plantation Value Added Silvicultural Inputs

As was seen in the example harvest schedule, silvicultural treatments can substantially influence the flow of volume, as well as the revenues from the pine plantations. Where volume and minimum revenue projections are based upon certain silvicultural inputs, mandatory minimum inputs should be specified in the agreement. This would assure that baseline projections are met over time and that exploitation will continue in a sustainable manner. Of course, the Permittee always has the option to exceed those minimum inputs. Since expansion of Permittee operations is dependent upon volume growth as well as standing inventory, silvicultural treatments, such as non-commercial thinnings will enhance the flow of volume and provide opportunities to expand Permittee revenues in later periods. Appropriate economic tools should be used in conjunction with the silvicultural growth models to determine the minimum surface area required for value added silvicultural inputs by the Permittee.

As exploitation of the plantations proceeds it may be desirable to evaluate other silvicultural inputs, such as fertilization or genetic tree improvements, to determine whether they would add positively to net revenues and to meeting other objectives. It may be desirable to consider requiring the Permittee to accomplish some minimum number of hectares of non-commercial thinning and other silvicultural value added inputs, regardless of market conditions, and regardless of whether the Permittee harvests significant amounts of wood during any given year.

Permittee Obligations to Eaux et Forêts

The Permittee must discharge certain obligations to Eaux et Forêts in order to facilitate efficient exploitation and to assure accountability to the terms and conditions of the permit.

*Annual Operating Plans*

Operating plans are a tool for communication between the Permittee and Eaux et Forêts. An annual operating plan details the specific units within which the Permittee intends to operate during the next year. To be useful, the plan should provide details on the timing of operations, the order in which they will occur, and whether there will be road construction or reconstruction. Eaux et Forêts may need the annual operating plan to schedule pre-harvest inventories for the purposes of stumpage assessment. It may be helpful to specify the content, due dates, update procedures, and other details for the annual operating plans within the permit. Where the Permittee proposes operation on several parcels during the course of the year it may be desirable to allow the Permittee to submit quarterly or semi-annual updates to the Annual Operating Plan to assure that Eaux et Forêts has current information for conducting pre-harvest volume inventories needed to assess stumpage payments.

Compliance and Accountability

Stakeholders have an interest in both the physical resource and in the monetary value of the resource. Stakeholders have an abiding interest in assuring that exploitation of the pine resources are accomplished efficiently, and according to the terms of the agreement.

*Accomplishment Reporting*

Stakeholders have a strong interest in knowing the status of exploitation operations. For example, the information is needed by communities to plan for development, and it is

needed by persons interested in the Lac Antarambiby watershed to understand water balance issues associated with vegetation.

It is desirable that the Permittee provide information annually to Eaux et Forêts about what activities have occurred during the past year. A very preliminary list of reportable items which might be considered is provided toward the end of this document in Table 2, Suggested Monitoring Indicators.

*Independent Audits of Financial Records*

It is desirable to periodically have an independent audit of financial records and accomplishments. The Team suggests that 3rd party review distribution of receipts and accomplishments (surface area harvested, area non-commercially thinned, road infrastructure maintenance/improvements, investments and contributions to the community vis à vis permit requirements). A 3rd party audit may enhance the credibility of the permit process with stakeholders by assuring that financial and operational issues are transparent to the extent deemed desirable by stakeholders and parties to the agreement. Independent audits may be particularly desirable where the permit will convey long term rights to exploit the pine plantations, and require a number of fiduciary obligations of the Permittee.

Harvest Considerations

Several harvest operational issues are of interest to stakeholders, particularly to Eaux et Forêts and to the communities. Both have an interest in assuring that the resource is efficiently utilized according to accepted utilization standards. It is likewise desirable that methods used by the Permittee will preserve the productivity of the land and not have an undue negative affect on other resources such as Lac Antarambiby.

*Utilization*

Since a high level of utilization is desirable in order to provide the greatest potential for revenue, it is desirable to specify minimum acceptable utilization. Standards may be included in the permit for items such as minimum stump height, minimum sawlog Dbh and piece size, minimum top diameter (where the utilized log is severed from the top), and minimum acceptable defect (crook, sweep, or other defect that would prevent sawing a straight board. Again, these should be expressed as 'minimums' for the purposes of required utilization. The Permittee retains the option to choose to be even more efficient and utilize more of the resource.

Protection of Resources

*Water*

It is desirable that Permittee operations be conducted to minimize adverse effects on water quantity or regimen. Because there have been no studies or calculations completed to date that address the water balance for the Lac Antarambiby watershed, it is not known what silvicultural practices, if any, may need to be managed in time and space to achieve desired effects. To address this eventuality, the permit might include language that would require, subject to mutual agreement, consideration of appropriate measures to protect the watershed, water flows, and water regimen.

*Soil and Basic Productivity*

Protection of basic productivity of the land is a key consideration for the permit. Since the permit may be for a long period, the cumulative effects of harvest operations over successive entries should be considered. For example, it may be desirable to require that the Permittee manage harvesting and manufacturing operations to minimize soil compaction and loss of organic material. A workable standard of compliance might be that within each parcel, no more than 20% of the surface area would be in a heavily compacted condition. Heavily compacted areas might be considered to include skid trails, roads, landings, and portable saw mill locations.

*Pine Growing Stock*

The current value of the pine plantations is in the standing live trees. Sustainable production of value requires that the trees be protected from damage or loss.

**Fire**

The permit may include several provisions that would require the Permittee to protect the forest from damage. For example, the Permittee should promptly and vigorously respond to any forest fires within or adjacent to the Series or Parcels included in the agreement.

It may also be desirable to discuss whether the Permittee should maintain any minimum fire suppression equipment on site to facilitate prompt and effective fire suppression action. Equipment to maintain on hand at the site of harvest and milling operations might include shovels, axes, or other tools sufficient to equip Permittee's employees.

**Damage from Operations**

It is desirable that purchaser operations be conducted to minimize damage to the reserve stand of trees. This is particularly important where thinning operations will remove merchantable volume. It is also very desirable that purchaser operations be conducted to improve, rather than depreciate, the genetic potential of the pine plantations. As discussed in Appendix A, Silvicultural Scenarios, poor selection of trees to harvest or retain during commercial thinning operations can have significant cumulative negative effects on growth potential of the pine growing stock.

It is desirable that the permit specify a maximum amount of damage permissible to leave trees caused by falling and yarding operations during commercial thinnings. For example, the permit might require that no more than 5% of reserve trees would have bark damage where the cambium or underlying wood is expose or be pushed over so the bole leans at an angle of $10^{o}$ or more from vertical.

The permit might also include a requirement that all thinnings be conducted 'from below', i.e. remove only trees in the lower crown classes, preserving the larger and better trees on site for later harvest and seed production.

**Eaux et Forêts Responsibilities**

Just as the Permittee's responsibilities and obligations are detailed in the agreement, so should the responsibilities of Eaux et Forêts. The most effective agreements are those

that address all of the important points. Since the agreement may cover several years, it is very desirable that ambiguity be managed for all parties.

Inventory

A properly conducted inventory is a critical component for developing accurate harvest schedules. An inventory is also an important tool for monitoring Permittee performance. It is suggested that Eaux et Forêts bear the responsibility to conduct periodic inventories of the forest resources within the permit area. The inventories should be conducted so that estimates of volume, growth on growing stock, and other important parameters can be calculated for each strata with specified confidence limits. Sampling methods should be reviewed by experts in statistical sampling to assure the design is sound. Typical confidence limits for estimations of volume are +/- 5% with p=0.05. It is recommended that inventories be conducted about two years prior to when the permit is scheduled for review and re-negotiation.

To assure that funds are available to conduct the inventory it may be desirable for the Permittee to place funds in an escrow account for the sole purpose of conducting periodic inventory of the forest resources within the permit area. If this approach is used, it may reduce ambiguity if the exact data elements that will be collected at each inventory is specified as an addendum to the permit.

Estimation of Harvest Volumes

Under the current system, it is understood that Eaux et Forêts conducts a pre-harvest inventory of each parcel scheduled for harvest to determine volumes and to assess stumpage payments. The Team sees many benefits from this approach, and suggests that the practice be continued in the future.

Eaux et Forêts should receive an annual 'plan of operation' from the Permittee. Based upon this plan, it is suggested that pre-harvest inventories be conducted to determine merchantable volume for the purposes of assessing stumpage and other payments.

Maintaining Confidentiality of Permittee Financial Disclosures

Through the process of complying with monitoring, re-negotiation of permit responsibilities, and in other interactions with Eaux et Forêts, the Permittee may need to share sensitive financial and operational information. Since this information could potentially be damaging to the competitive stance of the Permittee and would normally be considered 'proprietary', it should be protected from disclosure. Where the Permittee has no assurance of confidentiality, there is understandable reluctance to disclose information that may be essential to assuring fair and equitable rents are received for wood resources.

It is recommended that the agreement contain a non-disclosure clause, with sanctions that would apply to Eaux et Forêts in the event of unauthorized disclosure of sensitive information. The specific information covered by this clause, as well as the specific sanctions would be items to be addressed during permit negotiations. Sanctions may be monetary, may involve a requirement to exempt certain previously presented financial information from future disclosure to Eaux et Forêts, or may involve other actions that would protect the proprietary information of the Permittee.

Protection of Resources from Loss by Fire

Eaux et Forêts is ultimately responsible for preserving the value of the pine resources. In the past it has taken an active role in suppression of fires that threatened the accumulated value of the plantations. To the extent that funds are available for the purpose of conducting fire suppression activities, it is desirable that Eaux et Forêts accept responsibility for assisting the Permittee with protecting the plantations fire.

Monitoring

Eaux et Forêts, as the Government's Agent responsible for the beneficial exploitation of the pine resource has substantial interest in assuring that the terms of the permit are met, and that stakeholder needs are addressed.

The Team suggests that Eaux et Forêts have the principal responsibility for receiving monitoring reports from the Permittee. Once reports are received, Eaux et Forêts would be well positioned to compile the information, evaluate the data, identify trends, and share the information with stakeholders. It is also suggested that an open book policy with regard to monitoring information would be important to assure stakeholder support for the permit. Eaux et Forêts should consider adopting a policy of sharing monitoring data as well as the resultant evaluations and trend analysis.

We suggest that specific items that will be reported by the Permittee should be enumerated in the agreement to assure all parties understand and concur with the reporting requirements. Additional discussion on monitoring is offered under the section titled "Issues that Warrant Further Consideration".

**Changed Conditions**

There may be circumstances that arise, such as catastrophic damage from cyclone or fire that would invalidate the harvest schedule. Under these circumstances both Eaux et Forêts and the Permittee have an interest in renegotiating the permit. It may also be desirable to include provisions for canceling the permit should a significant proportion of the total surface area receive substantial damage. For example, during negotiations on the permit it is desirable to discuss what is the minimum amount of surface in each age class or strata that is necessary for the Permittee to have a viable commercial harvest operation during the length of the agreement. Questions to discuss include: Will the permit remain in effect if harvestable volume drops below this amount? Will it be modified in some way (such as by temporarily reducing some of the stumpage assessments, community responsibilities, etc.) or will it be terminated?

**Disputes**

Unfortunately, disagreements occur even with the most carefully crafted agreement. It is suggested that the permit include a clause that addresses how disputes will be resolved. It is our experience that litigation is seldom resolved satisfactorily. Regardless of the outcome, the underlying relationships will suffer damage. The permit might include provisions for alternative dispute resolution measures (mediation, arbitration) as a first alternative to litigation. Where alternative measures are not fruitful, the option of litigation should be the choice of last resort.

The dispute clause should address payment for counsel, as well as other costs association incurred in achieving resolution.

**Termination of the Agreement**

There may be circumstances where termination of the agreement is deemed necessary. The Team suggests including clauses that will address the circumstances under which termination may occur, and the responsibilities of each party once the permit is terminated.

Conditions for Termination

There are normally at least four conditions under which a permit may be terminated: (1) As a result of the failure of the Permittee to comply with the agreement; (2) by mutual agreement where both Eaux et. Forêts and the Permittee mutually agree to terminate the permit; (3) Unilaterally by Eaux et Forêts and the Government of Madagascar; and (4) Unilaterally by the Permittee.

*Default*

Termination may be necessary where the Permittee fails to faithfully execute the terms of the agreement. The agreement should specify what constitutes default, and what procedures would be followed to place the Permittee in a condition of default. Where the Permittee fails to cure the default within a reasonable period of time the Eaux et Forêts would have the latitude to unilaterally terminate the agreement.

For example: Default may be defined as failure by the Permittee to comply with one or more terms of the agreement. Eaux et Forêts would determine the Permittee is in default through ongoing monitoring of permit implementation and by monitoring financial information. When Eaux et Forêts determines the Permittee is in default on any provision of the agreement it would notify the Permittee in writing, and verbally if appropriate (as with an operational issue), of the specific provision or provisions that are in default. The notice of default should (1) discuss the reasons Eaux et Forêts believes the Permittee has failed to comply with the agreement, (2) specify what must be done to correct or 'cure' the default, and (3) indicate a deadline (due date) for correcting the default. The agreement may discuss reasonable time frames for correcting defaults. Failure to correct the default within the specified time will constitute grounds for termination of the agreement.

*Mutual Agreement*

Conditions change over time, and both the Permittee and Eaux et Forêts may mutually agree to terminate the permit at any time. This would apply only where BOTH parties to the agreement wish to terminate.

*Unilateral Decision by Eaux et Forêts*

Where there is a change in Law circumstances may arise where Eaux et Forêts must terminate the permit based on unilateral decision. While this may be unlikely, the permit may be for a long period of time. Therefore it is desirable that this eventuality be considered and addressed. Any situation that would allow Eaux et Forêts to unilaterally terminate should be discussed in detail within the agreement.

*Unilateral Decision by Permittee*

Provisions should be included for the Permittee to unilaterally terminate the permit. Where circumstances change, as with catastrophic loss of volume and value associated with cyclone, fire, or other agents beyond the control of the Permittee it may become uneconomical to continue operations within the permit area. Political turmoil may also prevent the Permittee from enjoying the benefits and privileges conferred by operating within the terms of the permit.

Damages and other Payments

Damages may be warranted in specific circumstances. For each of the situations under which Termination may occur, different damage or payments may be necessary. It is very desirable that any payments or damage assessments assessed against either party be addressed within the permit.

Where the Permittee is in default of a provision there may sometimes be a measurable monetary loss experienced by Eaux et Forêts or communities. Where default is not satisfactorily cured there may be a resulting financial loss that should be corrected upon termination of the agreement. For example, should the Permittee fail to complete non-commercial thinning as agreed, there may be a reduction in both volume and value within the pine forests. Failure to complete the required minimum area of non-commercial thinnings would be grounds for declaring the Permittee in Default. Eaux et Forêts and adjacent communities might reasonably expect compensation for the diminished value of the pine resource, as well as for the loss of investment (thinning) in the pine plantation.

Termination by mutual agreement may include provisions that would forgive some payments due from the Permittee, or may include some compensatory payments by the Permittee to Eaux et Forêts. Since the agreement would be terminated by mutual action any damages or payments would necessarily be address by both parties during any termination negotiations.

Where Eaux et Forêts unilaterally terminates the agreement the Permittee may reasonably expect some compensation for investments made in the infrastructure or in silvicultural activities that have appreciated the value of the resource. Any compensation would necessarily be within the bounds of extant law.

Unilateral termination by the Permittee may or may not require some monetary payment. It is desirable to consider and specify the circumstances under which any payments would be made by either party.

**Notices**

It is helpful if the permit specifies how communication will occur between parties. Where there is a long term relationship that may involve changes in personnel, it may help clarity of communication if the agreement states who will be authorized to speak for each party in negotiations. Specific details may be included in the permit that address the location where notices will be sent concerning the permit, and how written notices will be delivered and received.

**Transfer of the Permit**

The permit confers rights and responsibilities that cover many years. It is very desirable that the permit address issues of transfer of ownership of these rights. It is reasonable that the Permittee be able to transfer ownership through a sale or other transaction involving the underlying business. Eaux et Forêts and communities have a material interest in the entity who holds the permit, so conditions on the sale or transfer may be appropriate. For example: Sale or transfer may be contingent upon presentation of satisfactory evidence that the recipient has adequate financial resources and management expertise to fully redeem permit responsibilities. In addition, transfer of ownership may be made contingent upon presentation of satisfactory evidence that the proposed recipient of the transfer has a record of accomplishment in all principal areas in the permit, and that the recipient's history of relationships with grantors has been generally positive. Stakeholders may identify other conditional contingencies that would apply to sale or transfer of the permit.

The permit agreement should explicitly address the disposition of any trust funds managed by the Permittee in the event of a transfer of ownership occurs. It may be desirable to address ownership of GIS coverages, inventory records, records of treatments, and other operational records that would provide important management history for planning future operations. For example, the Permittee may be required to surrender certain records to Eaux et Forêts, or to demonstrate satisfactory transfer of original records to the new permit holder has taken place. Key records might include, in additional to trust accounts and other financial records, information and records of contributions toward building social capacity, maps and records of harvest and thinning activities, maps and records of the transportation infrastructure, and so forth.

## ISSUES THAT WARRANT FURTHER CONSIDERATION

### Monitoring Indicators

Efficient and reliable monitoring is necessary to assure all parties that all is proceeding as expected. Efficient monitoring indicators are related to the objectives. They measure progress toward meeting objectives. To the extent possible, monitoring indicators should be quantitative and data should be collected within a statistically valid protocol. While monitoring for a single year will provide interesting information about the current situation, several years of consistent data collection are needed to determine trends and to assess progress toward the desired condition and toward attaining objectives. To be useful, monitoring should compare actual results with expected results. It is recommended that annual monitoring reports be available to any interested party.

For a private concession within the Mandaratsy Pine Plantation suggested monitoring indicators might include those listed below in Table 2. All monitoring is suggested to occur on an annual basis. Data would be reported by the Permittee to the administering agency, in this case Eaux et Forêts. Eaux et Forêts would have responsibility to compile, publish, and periodically analyze the data. It is suggested that trend analysis of the entire monitoring data set be accomplished at least every three years, and possibly every two years where conditions are in a rapid state of change.

An important element of monitoring will be periodic re-evaluation of the standing inventory within the Mandaratsy Pine Plantation. Given the rapidly changing nature of the forest, inventory statistics should be collected at least every 5 years. Maps and GIS coverages of stand structure should reflect conditions extant at the time of the inventory, as they will be used to refine and update strata. As has been discussed elsewhere, accurate mapping of the current stands is critical to efficient exploitation of the pine resource. It is also a necessary prerequisite to developing and inventory, harvest schedule, and schedule of stand tending (primarily NCT) activities.

Monitoring can also be accomplished by other entities only indirectly connected to the permit. For example, JIRAMA will likely collect data on water flows through the lines that serve Fianarantsoa. This information, in combination with harvest data provided by the Permittee, and other data collected by other stakeholders in the Lac Antarambiby watershed may be used to evaluate effects of land uses on water flows. The specifics of water balance monitoring remain to be determined.

Stakeholders may identify additional elements that should be monitored. Some of the elements suggested in Table 2 may be discarded upon further evaluation by stakeholders. Efficient monitoring requires that the minimum number of elements be selected that will provide adequate information to assess progress toward the Desired Condition and the attainment of the plan goals.

**Table 2. Suggested Monitoring Indicators for Private Management of the Mandaratsy Pine Plantation.**

| Type of Data, units | Description of Data | Media | Planned Amount | Actual | Acceptable Variation |
|---|---|---|---|---|---|
| Polygon | Maps of harvest area showing type of harvest | Paper (eventually GIS coverage) | XXX | YYY | All units mapped |
| Numeric, $m^3$ | Regeneration Harvests: $m^3$ harvested from each area | Digital (spreadsheet, DB) | XXX | YYY | +/- 30% |
| Numeric, ha | Hectares harvested by each method (thinning – indicate $1^{st}$, $2^{nd}$, etc. or regeneration) | Digital … | XXX | YYY | +/- 35% |
| Polygon | Maps of areas thinned | Paper … | XXX | YYY | All units mapped |
| Numeric, ha | Hectares NCT[6] Differentiated by stand age | Digital … | XXX | YYY | +/- 5% |
| Numeric, km | Road construction and Reconstruction, km | Digital… | … | … | +/- 10% |
| Vector | Maps of roads constructed or Reconstructed | Paper… | … | … | All roads mapped |
| Numeric, fmg | Expenditures on road construction/reconstruction | Digital… | … | … | +/- 5% |
| Numeric, FTE[7] | Employment of Community Residents | Digital | … | … | +/- 10% |
| Numeric, fmg | Investment in schools, training, or other capacity building as agreed… | Digital | … | … | +/- 5% |
| Numeric Cm, m | Minimum Dbh, Dob[8], and piece size utilized | Digital | … | … | Minimum Utilized |
| Numeric $m^3$ | Volume utilized that is below the minimum Merchantable Dbh | Digital | … | … | Volume Utilized |
| Numeric $m^3$ | Volume utilized that is at or above minimum Merchantable Dbh. Differentiate by harvest | Digital | … | … | Volume Utilized |

[6] NCT – Non-commercial thinning of juvenile forest that does not generate revenue.
[7] FTE -- Full Time Equivalants, a measure of the number of person months of employment.
[8] Dob – Diameter outside bark measured on the small end of a merchantable piece.

| | | | | | |
|---|---|---|---|---|---|
| | method. | | | | |
| Numeric $m^3$ | Volume harvested that is at or above minimum Merchantable Dbh. Differentiate by harvest method. | Digital | … | … | Volume Harvested |
| List | List of wood products produced | Digital | | | List |
| Market Prices fmg | Market Prices of various wood products produced from the Mandaratsy Pine Plantation | Digital | … | … | High, Low, Average |
| Etc. | Etc. | … | … | … | … |

**Data and Analysis**

Data resolution is driven by the scale, scope, and precision of necessary analyses. For example, data needed to conduct meaningful analysis of ecosystem scale questions ($10^5$ to $10^6$ $km^2$) may be entirely adequate when collected at scales of 1:250,000 or even 1:1,000,000. This information is woefully inadequate, however, when there are questions posed at the Watershed ($10^1$ to $10^2$ $km^2$) level. Data needed to answer stand or parcel level questions must be at an even finer resolution.

Unfortunately, data collected at a scale appropriate to ecosystem questions cannot be disaggregated to answer questions posed at the stand, ore even watershed scales. For example, gross mapping of native forest conditions designed to do trend analysis of deforestation within the Corridor would not provide the level of resolution needed to assess watershed conditions surrounding Lac Antarambibiby.

Data collected to represent large scales such as 1:1,000,000 is less costly than data collected at 1:12,000. Basically, sample strata are very large and only a few sample points are needed. Also, strata suitable for large scale analysis are coarsely defined when compared to strata appropriate for fine scale analysis. For illustration purposes, approximate resolution scales for various levels of analysis are shown below.

| **Physiographic Scale** | **Scale of Resolution** | **Map Scales for Analysis Purposes** |
|---|---|---|
| Ecosystem | $10^6$ $km^2$ | 1:1,000,000 + |
| River Basin | $10^4$ $km^2$ | 1:250,000 |
| Watershed | $10^2$ $km^2$ | 1:100,000 |
| Project | $10^1$ $km^2$ (and smaller) | 1:20,000 (and smaller) |

Much of the recently collected data that has been shown to this Team appears to be to be collected at the Ecosystem or River Basin scales. Coincidently, the questions the Team has been asked to assist with are posed at the project, and smaller scales.

It is clear that excellent fine scale data exists. For example, Eaux et Forêts has detailed maps of the original plantation parcels at 1:20,000 scale. These maps provide very useful information on a number of issues. The scale is very appropriate for addressing questions about Lac Antarambiby and water supplies. Unfortunately, much has changed during the past decade. Within the pine plantations significant fine scale heterogeneity has been introduced as a result regeneration that has established following the 1994 cyclone damage subsequent fires. Dense sapling and pole sized pine regeneration has replaced the well stocked groves of mature trees on perhaps 60% of the Mandaratsy Pine Plantation. Presumably, similar changes have occurred throughout the Haute Matsiatra. To respond to questions of the moment it is critical that data be as current as possible.

The following data may be useful to address some of the questions posed to the USFS Team. Data are needed at the finest scale indicated. It is suggested that fine scale data be collected throughout the Haute Matsiatra region using similar protocols so pooling data (aggregation) is possible. GIS coverages in particular can be easily aggregated to respond to questions posed at multiple scales.

Geographic Information Systems (GIS) coverages are urgently needed that display the current condition of the Mandaratsy Pine Plantation. Similar information is needed for other plantations within the Haute Matsiatra. Our experience suggests that coverages created from aerial photo interpretation (photo scales 1:12,000 or 1:16,000) are of the most appropriate resolution for forestry operations at the stand (parcel) scale. For purposes of planning, approximately one photo per $km^2$ of area would be needed. Because of the very fast growth rates observed on pines within the Haute Matsiatra, it is recommended to procure recent color photos taken within the past 1 or two years for this purpose. Photo interpretation can be used to identify remaining polygons with mature pine; polygons with 7-12 year old pine regeneration; recently harvested/burned areas; recently established agricultural clearings, and other important features. Once photo interpretation is complete, standard methods for Manuscripting, digitizing, and attributing polygons can be used to develop the necessary GIS coverage. Our experience suggests that the task of photo interpretation, manuscripting, scanning, and editing would require approximately 1 person month of a trained technician for an area the size of the Mandaratsy Pine Plantation. Once coverages are developed at this scale, polygons can be aggregated into strata to respond to questions posed at larger scales. In concept, small scale data collected using consistent protocol "nests" to form data useful at larger scales.

It is cost prohibitive to collect fine scale information for all areas within a ecosystem. However, data collected for selected, high value projects such as management of Mandaratsy and other pine plantations within the Haute Matsiatra can be used to infer stand conditions in unsampled areas, thus leveraging the fine scale data and extending it across a broader landscape.

Once polygon coverage is complete for the pine plantations, plot data collected on a uniform (unbiased) grid may be used to estimate the parameters of interest. It is suggested that inventories within the pine plantations collect growth data as well as information on current conditions. Growth data may include tree core measurements of diameter increment as well as height growth measurements. In its most simple form, a growth model can be constructed based on mapped strata, the current standing inventory of forest trees, and an estimate of growth for each tree component. The potential value of the Haute

Matsiatra Pine Plantations is quite high. The development of a more sophisticated, regression based growth model as a high priority should be considered.

Several questions have been posed regarding water yields from Lac Antarambiby. The Team has not discussed water resource information with JIRAMA. Based on the field trip to Lac Antarambiby several stakeholders believe stream flow data are not available, nor are data available to indicate withdrawls from canals located below the dam. Information on precipitation, stream flows into the lake, withdrawls by the JIRAMA water lines, and withdrawls along the various canals located down stream of the lake will be needed to establish a water balance for the watershed. The Team suggests that stakeholders conduct a census of all data that is available as a preliminary step to identifying specific data needs. Until available data are known it will be very difficult to partition water consumption and identify opportunities for flow enhancements.

Much of the discussion within the past two weeks has revolved around jurisdictions, administrative boundaries, and related topics. The Team suggests developing GIS coverages of all of the various administrative boundaries, jurisdictions, communes, etc. at the 1:20,000 scale.

## OBSERVATIONS AND SUGGESTIONS FOR FURTHER ACTION

1) Observation: Stakeholders in the Haute Matsiatra Pine Plantations and in efforts to preserve the Corridor exhibited a high degree of interest in creating constructive solutions to difficult resource issues. Several individuals and organizations contributed substantially to educating the USDA Forest Service Team regarding the key issues.
   a) The high level of commitment is evidence of a strong desire on the part of all stakeholders to invent acceptable management strategies. The Team acknowledges the tremendous investment of time and resources in the search for solutions.
2) Observation: Current data available to resource managers may not be at the appropriate scale to address site specific management problems. Much of the data that exists at scales appropriate for site specific management is old. It is possible that current data exists, however it is not known to stakeholders in the resource issues which were discussed since arriving in Fianarantsoa.
   a) Suggested Further Action: Survey all stakeholders and develop an inventory of available data. Items that might be included in the inventory are: A description of the data (e.g. map of pine parcels for Mandaratsy Pine Plantation); Date the data was created (e.g. 1978); Updates (e.g. updated in 1992, 1995); Scale (e.g. 1:20,000); Custodian (e.g. Eaux et Forêts, Fianarantsoa, Cartography); Medium (e.g. paper and blueline); Availability (e.g. copies may be obtained from Eaux et Forêts); Is data available digitally? (e.g. No). Other items that might be addressed are whether data is of high quality, i.e. was there a systematic process in place to assure data accurately reflects the condition of the environmental parameter being represented or measured?
   b) Suggested Further Action: Prioritize data that is in hard copy media for digitizing if map data or input into a db or spreadsheet if numeric data. When setting priorities consider

the immediacy of need for the data to answer key resource questions, as well as the difficulty and expense of input compared to available staff and computer resources.

c) Suggested Further Action: A fundamental data need is accurate characterization of vegetation resources and land use patterns at the stand level (1:12000 to 1:16000 scale). These data can be obtained from aerial photo interpretation (PI) using standard techniques that are easily taught to persons who have some formal schooling in resource management. Once PI is completed, polygons must be manuscripted, scanned, and attributed. Polygon attributes that will be most useful are likely to include crown closure (in increments of 10%); species of dominant vegetation (Pine; Eucalypt; agricultural tree crops; rice fields; pastureland; water; marsh; residents/dwellings/villages). A minimum polygon size of about 1 hectare is attainable when working with this scale. To assure accurate and consistent PI, a careful and well designed quality assurance/quality control (QA/QC) protocol is essential. Effective protocols include clearly written PI instructions, training for photo interpreters, supervision, and provisions for independent audit of the PI work by a photo interpreter other than the person who did initial work. Similar QA/QC protocols are important during the manuscripting, scanning, and attributing processes.

3) Observation: Arterial road systems may be challenged by increased road traffic associated with intensified exploitation of the Pine resource.

a) Suggested Further Action: Evaluate options to improve main arterial roads to expand capacity to handle traffic. Involve stakeholders in the discussion. Consider options for converting some of value of existing pine plantations to needed infrastructure improvements.

b) Suggested Further Action: Establish an ongoing dialogue with the State entity responsible for transportation system design, maintenance, and upgrades to alert them to possible increases in use and to anticipate bottlenecks. Consider cooperatively working with them to forecast demand and develop solutions.

4) Observation: Internal road systems on the Mandaratsy Pine Plantation may require investment in order to efficiently handle increased heavy truck traffic associated with intensive mechanical/industrial exploitation. This may also be true with other pine plantations within the Haute Matsiatra.

a) Suggested Further Action: Eaux et Forêts, with Permittees and other stakeholders, might consider initiating an evaluation of internal pine plantation transportation system capacity. The evaluation might include design adequacy for log truck traffic, surface conditions, maintenance needs, drainage, and other factors. Internal roads might be prioritized according to potential volume to be hauled, resource issues (such as siltation of streams or wetlands), and immediacy of use.

5) Observation: Inventory information sufficient to project volume growth is not available. Inventory data is not available for all pine plantations in the Haute Matsiatra.

a) Suggested Further Action: Eaux et Forêts, with Permittees and other stakeholders should consider implementing a systematic inventory of forest resources on all plantations. Inventory statistics should be compiled at least at the Plantation level, and should include appropriate spatial information. The inventory should include sufficient growth data to make reasonable projections of volume for strata within each plantation.

b) Suggested Further Action: Eaux et Forêts may consider developing, in cooperation with Permittees and other stakeholders, a common set of definitions for inventory strata, as well as common inventory protocols that will provide information needed to make management decisions. As a minimum, data collected should address substantive differences in stocking, average within stand tree size, structure of vegetation, growth, and damage/defect. It is desirable that the inventory be at sufficient intensity to provide estimates +/- 5% at p=.05.

c) Suggested Further Action: Eaux et Forêts may consider developing and publishing, in cooperation with stakeholders, inventory statistics for the pine plantations in Haute Matsiatra. Information would be very helpful in attracting investors who may provide needed capital and expertise to exploit the pine resource.

6) Observation: Hydrologic data may not be available to adequately respond to water quantity issues in the Lac Antarambiby watershed. The location of existing data is not well known by stakeholders. Hydrology expertise may not be adequately engaged in efforts to resolve key water resource issues.

a) Suggested Further Action: Stakeholders should consider locating hydrology expertise to provide technical expertise in evaluating possible changes in water yield from the Lac Antarambiby watershed.

b) Suggested Further Action: Stakeholders should consider conducting an inventory of hydrology data. Among the data that might be included in the inventory are JIRAMA flow records from at least each of the past ten years; JIRAMA records of the numbers of households served for at least each of the past ten years; climatological records from any source for at least the past twenty years; Eaux et Forêts records of changes in stand condition (through harvest, fire, cyclone, agricultural clearing, etc.) within the Lac Antarambiby watershed; JIRAMA records of canal maintenance; estimates of current and past in rice field area, as well as the area in other forms of agricultural production within the Lac Antarambiby watershed; estimates current and past area of rice fields and in other agricultural crops for communities down stream of the lake; an inventory of all currently active canals that carry water to or from the lake, or from the stream that is fed by Lac Antarambiby; data on water loss from canals thorough infiltration or evaporation. Data should be loaded into appropriate digital media to facilitate analysis.

c) Suggested Further Action: Consider seeking a Masters student from a reputable university who might address one or more of the data needs discussed above.

7) Observation: Skilled labor necessary to successfully intensify exploitation of the pine resources of the Haute Matsiatra may not be available.

a) Suggested Further Action: Stakeholders may consider options for establishing a technical school in Fianarantsoa that would provide technician training in forestry. Consideration might be given to providing training in basic forestry skills in rural communes located near the pine forests. Training might include skills such as chainsaw operations and maintenance, basic record keeping, and basic forest inventory work.

b) Suggested Further Action: Stakeholders may consider seeking entrepreneurs who can contribute private capital and expertise to address immediate management needs.

8) Observation: Funds are highly constrained. While there may be general recognition of the need for action, financial resources may be unavailable to accomplish necessary work. In many ways this situation is mirrored by the need for skilled labor.

   a) Suggested Further Action: See (7) (b) above. Consider developing long term instruments that will provide the necessary investment environment to encourage long term commitments by outside parties. It will be important to foster conditions so potential investors will have sufficient 'certainty' to have reasonable expectations of returns on their investment.

   b) Where there are significant unknowns, as with the viability of long term permits or the availability of venture capital, consider establishing "pilot projects" that will test concepts for later application on a broader scale. One such concept might be that of a long term private management permit for selected pine plantations. Key to the success of this approach is selection of appropriate private enterprises. Enterprises might be most usefully considered "partners" in efforts to achieve community capacity development while enhancing the value of the pine resource.

9) Observation: Stakeholders in the Haute Matsiatra Pine Plantations and in efforts to preserve the Corridor exhibited a high degree of interest in creating constructive solutions to difficult resource issues. Several individuals and organizations contributed substantially to educating the USDA Forest Service Team regarding the key issues.

   a) The high level of commitment is evidence of a strong desire on the part of all stakeholders to invent acceptable management strategies.

10) Observation: Current data available to resource managers may not be at the appropriate scale to address site specific management problems.

   a) Suggested Further Action: Survey all stakeholders and develop an inventory of available data.

   b) Suggested Further Action: Prioritize data that is in hard copy media for digitizing if map data or input into a db or spreadsheet if numeric data.

   c) Suggested Further Action: A fundamental data need is accurate characterization of vegetation resources and land use patterns at the stand level (1:12000 to 1:16000 scale).

11) Observation: Arterial road systems may be challenged by increased road traffic associated with intensified exploitation of the Pine resource.

   a) Suggested Further Action: Evaluate options to improve main arterial roads to expand capacity to handle traffic.

   b) Suggested Further Action: Initiate dialogue with the State entity responsible for transportation system design, maintenance, and upgrades to alert them to possible increases in use and to anticipate bottlenecks.

12) Observation: Internal road systems on the Mandaratsy Pine Plantation may require investment in order to efficiently handle increased heavy truck traffic associated with intensive mechanical/industrial exploitation. This may also be true with other pine plantations within the Haute Matsiatra.

a) Suggested Further Action: Eaux et Forêts, with permittees and other stakeholders, should consider initiating an evaluation of internal pine plantation transportation system capacity.

13) Observation: Inventory information sufficient to project volume growth is not available.

a) Suggested Further Action: Eaux et Forêts, with permittees and other stakeholders should consider implementing a systematic inventory of forest resources on all plantations.

14) Observation: Hydrologic data may not be available to adequately respond to water quantity issues in the Lac Antarambiby watershed.

a) Suggested Further Action: Stakeholders might consider locating hydrology expertise to provide technical expertise in evaluating possible changes in water yield from the Lac Antarambiby watershed.

15) The location of existing hydrology data is not well known by stakeholders.

a) Suggested Further Action: Stakeholders should consider conducting an inventory of hydrology data.

16) Hydrology expertise may not be adequately engaged in efforts to resolve key water resource issues.

a) Suggested Further Action: Consider seeking a Masters student from a reputable university who might address one or more of the data needs discussed above.

b) Suggested Further Action: Future USDA Forest Service teams may include hydrology expertise as well as expertise in conducting vegetation inventories and assessing vegetation conditions.

17) Observation: Skilled labor necessary to successfully intensify exploitation of the pine resources of the Haute Matsiatra may not be available.

a) Suggested Further Action: Stakeholders may consider options for establishing a technical school in Fianarantsoa that would provide technician training in forestry.

b) Suggested Further Action: Consideration might be given to providing training in basic forestry skills in rural communes located near the pine forests.

## APPENDIX 2

### Silvicultural Scenarios for Series A, B, C, and D of the Mandaratsy Pine Plantation

Projections of stand growth are based on field observations of stands at various ages, structures, and stocking conditions, and reference materials provided by LDI[9]. Field observations were made within Series A, B, and C of the Mandaratsy unit of the Haute Matsiatra Pine Plantations. Species of interest are *Pinus patula* and *Pinus keysia*, both exotic trees established in Madagascar beginning in the 1950's. The Mandaratsy Pine Plantations were originally planted at 2200 TPH, except for a small number of hectares planted in the 70's that were planted at 1300 TPH (Ratsinbazaty, 2001).

No growth models are available for the pine stands of the Haute Matsiatra Pine Plantations. Therefore desired stocking levels and anticipated tree response at the stand level to various silvicultural treatments were estimated by visiting various stands located in the Mandaratsy Plantation on July 6 and July 11, 2001 and collecting empirical data to adjust volume tables available from other areas. Stands within the Mandarasty Pine Plantation that represented different ages (recent regeneration following harvest or fire; regeneration following the 1994 Cyclone event and subsequent fires; and standing remnant plantation from the 1960's era) and stocking levels were informally examined to evaluate growth, ingrowth, and relative effects of inter-tree competition on tree growth. Stand growth was evaluated by coring several trees with an increment bore, by examining tree growth history on recently cut stumps, and by visual examination of leader elongation on juvenile trees. Tree density was measured on several plots with ocular estimates of pine stocking on $^{1}/_{100}$ ha plots for small trees (less than 15 cm Dbh) and using an angle gauge to determine basal area for larger trees (Dilworth, 1970). Trees in each stand type were also evaluated for relative stability based upon observed height/diameter ratios.[10]

As has been observed in other areas, the potential for pine regeneration following disturbance (fire, logging, stand destroying windthrow events) is quite high within one year following the event. Serotinous cones in *P. patula* make this species particularly adept at exploiting newly available growing space with a minimum of delay. *P. keysia* also appears to be a prolific seed producer, though it does not exhibit cone serotony. As a result, most stands that experienced significant cyclone related windthrow in 1994 have a dense layer of 6 to 7 year old regeneration beneath a sparse residual overstory of mature planted pines. Natural regeneration is typically 5 to 10 times as dense as the original plantations. Many of the cyclone damaged stands subsequently burned as a result of fires set by adjacent farmers. These fire damaged stands have also regenerated to extremely dense stands of sapling and small pole sized trees. Near the margins of the pine plantations some of the area has also been cleared for culture of manioc. Abandoned manioc fields are regenerating to pines.

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[9] Landscape Development Interventions. Growth estimates, standing volume in mature pine plantations, stocking estimates, and other data were provided by LDI personnel. Sources are not fully cited.

[10] Various authors have described trees that have height/diameter ratios approaching 100 as unstable. Trees with height/diameter ratios approaching this threshold are very likely to experience highly elevated rates of breakage and windthrow. The height/diameter ratio is calculated by dividing the height of the tree by the diameter measured at Dbh (in the same units of measure). For example: A 15 m tall tree with a diameter of 20 cm would have a height/diameter ratio of 75, and would be considered at moderate risk of wind damage.

Based on the information obtained from field observations stand volume tables developed for pine plantations near Fanalamanga (DFS Deutsche Forstservice GmbH, unknown) and other areas (Abraham, 2001) were adjusted following consultation with foresters familiar with growing conditions in the Mandaratsy Pine Plantation (Ratsinbazaty and Beuche, 2001). In general, growth rates, basal areas per hectare, and volumes per hectare were estimated to be 25% *less* than on sites within the Fanalamanga Pine Plantations that support similar levels of growing stock. Further adjustments for non-uniform stand conditions are made as described below. Non-uniform conditions can result where there is partial canopy destruction resulting from fire or wind events that kill a portion of the existing stand sufficient to allow regeneration to establish. However, conditions are less than optimal, and overstory trees exert substantial influence on the site.

Volume projections based on the methods used here are necessarily 'rough approximations' intended to provide a starting point for developing meaningful plans for pine plantations within the Haute Matsiatra. While these methods may be appropriate for short term use, accurate inventory data properly incorporated into statistically sound models is urgently needed to provide reliable growth projections upon which long term investment decisions should be based. Growth models based upon a rich data set of stand conditions are highly desirable tools for long term planning.
Three situations are examined for the purposes of developing volume projections:

1. Stands that have been regenerated as a result of burning or harvesting within the past four years.
2. Stands that have been regenerated following burning of cyclone felled forest between 7 and 8 years ago; and
3. Relatively intact stands where cyclone damage is minimal.

In the situations and scenarios presented below, all thinnings are assumed to occur from below. When thinning from below larger trees are always retained because they are most capable of fully exploiting the site. Should the initial thinning, or a subsequent thinning be from above (i.e., largest trees are removed and smaller trees are retained) yields are likely to be less over the rotation. Further, thinning from above has well known dysgenic effects where reforestation at final harvest is from natural regeneration. Dysgenic effects have been shown to result in very substantial reductions in growth and yield in future rotations. Dysgenic effects of incorrect harvest practices are cumulative.

While some of the Mandaratsy Pine Plantation has been cleared by farmers to grow manioc, fields are abandoned after only one year and the area in this condition is believed to be insignificant (Ratsinbazaty and Beuche, 2001). Informal observations by Eaux et Forêts suggest approximately 60% of the original plantations are in Situations 1 or 2, while about 30% of the original plantations remain relatively intact throughout the Mandaratsy Pine Plantation. Within Series A and B the amount of regeneration is somewhat higher because of the history of commercial harvest. Informal estimates of intact original plantation are about 15% for Series A and B.

Age classes are relatively simple and these three situations adequately address the variation in stand types found within the area. Very little harvesting of timber occurred prior to the 1994 cyclone that caused extensive damage in the Mandaratsy Pine Plantations (Ratsinbazaty, 2001).

Excessively dense, unmanaged forests are consumptive users of water when compared to forests that have been thinned. Water losses occur through elevated transpiration and evaporation of intercepted precipitation. Crown volumes are substantially reduced by thinning, resulting in less interception of precipitation when compared to an unthinned forest. It is well known that removal of forest cover from a large proportions of a watershed can result in increased peak flows. While much of the Lac Antarambiby watershed is included within the Mandaratsy Pine Plantation, it is unknown whether changes in forest cover associated with thinning, harvest, fires, or agricultural clearing have a measurable effect on stream flows. The magnitude of any change in water consumption (and therefore stream flows) resulting from thinning pine plantations is also unknown. The Team speculates that changes in water yield attributed to changes in forest cover are likely to be small when compared with other effects.

Operational efficiency will vary substantially depending upon the technology used to exploit the resource. In general, mechanical/industrial operations of the kind observed during visits to the concession of Les Scieries du Betsileo are expected to realize approximately the volumes projected for each scenario. Labor intensive manual/industrial operators are not expected to utilize the resource efficiently because of increased wastage involved in high stumps left as a result of falling technique, excessive long butting, as well as preferential selection of trees within diameter classes that are more easily felled and manufactured with available tools. Labor intensive manual/industrial operations are also expected to result in increased amounts of slash distributed through the forest that will create elevated fire risk as compared to a mechanical/industrial operation.

Based on limited observations from the Mandaratsy Pine Plantations and surrounding areas, volume recovery from intensive manual/industrial operations is estimated to be approximately 25% of the recovery of intensive mechanical/industrial operations for each entry. Faller training is expected to be much less with the intensive manual/industrial operators as well, and selection of reserve stocking at thinning steps is expected to be far less than optimal when compared with faller performance under the intensive mechanical/industrial model. Tree selection by poorly trained fallers under the intensive manual/industrial model is much more likely to result in inappropriate harvest preference of larger crop trees during intermediate entries illustrated in Scenarios B and D than would occur with an intensive mechanical/industrial operation. This would have potentially significant long term dysgenic effects on the pine plantation resource.

**Situation 1: Burned or harvested within past four years.**

**Description**

Abundant natural regeneration has occupied the disturbed area. The majority of the area (80% or more) of the area is densely stocked. Small openings where regeneration is sparse (of less than $^{1}/_{20}^{th}$ ha) occur throughout the stands. The stand in the photo is Mandaratsy Series C, parcel C1. It was harvested about eighteen months prior to the photo.


Scenarios

Two scenarios are examined for silvicultural management of recently regenerated forest stands:

- Scenario A: No silvicultural management (thinnings).
- Scenario B: Scheduled thinnings that will allocate growing space appropriately to allow individual crop trees to fully exploit the site.

**Scenario A: No precommercial thinning; no commercial thinning. Note: It is likely that stands will suffer severe cyclone damage after age 15 because of unstable height/diameter ratios. This will exacerbate clumpy distribution and result in highly variable growing conditions. Subsequent cyclones may result in further damage. A second canopy of dense regeneration is likely to initiate following cyclone damage. In the absence of thinning, dense unstable stand are likely to develop that will likely repeat the cycle. Fire hazard is expected to be quite high. The probability of total stand replacement through fire subsequent to cyclone damage is also expected to be high. Only trees currently occupying the site are shown in these projections. Probable damage due to windthrow and fire is not evaluated. For the purposes of analysis, final harvest is assumed to occur at age 22. Over**

**the rotation approximately 130 $m^3$ per hectare of total volume is projected to be harvested under this scenario. While operationally final harvest could occur later, total wood volume is unlikely to increase, and may in fact decrease substantially where final harvest is deferred.**

| | **Current**[11, 12] | **2010** | **2020** |
|---|---|---|---|
| *Trees/ha* | 18,000 | 8,000 | 2,000 |
| *Average Ht (m)* | 4 | 8 | 11 |
| *Average Dbh (cm)* | 3.8 | 10 | 17 |
| *Average Age* | 3 | 12 | 22+ |
| *Volume ($m^3$/ha)* | 0 | 90 | 130 |
| *Commercial Thin Volume Harvested ($m^3$/ha)* | 0 | 0 | 0 |
| *Volume Growth (MAI $m^3$/ha)* | --- | 7.5 | 5.9 |
| *Volume Growth (PAI $m^3$/ha/yr)* | --- | 9.0 | 4.0 |
| *H/D Ratio* | 105 | 80 | 65 |

Explanations for PAI and MAI are provided in Scenario B.

[11] In similar conditions the EASTA Iboaka inventoried the Haute Ranomainty Pine Plantation and determined there were on average 18,000 TPH in recently regenerated stands. This is consistent with informal field observations in the Mandaratsy Pine Plantations.
[12] Current conditions are estimated from informal observations in Mandaratsy Pine Plantation Series A, B, and C.

**Scenario B: Non-commercial Thinning at age 3-4; Commercial Thinnings at ages 12, 17. Non-commercial thinning at ages 3-4 is not expected to require treatment of resulting slash. Regenerate at age 22. For the purposes of analysis, final harvest is assumed to occur at age 22. Over the rotation approximately 228 $m^3$ per hectare of total volume is projected to be harvested under this scenario, including two thinnings and final harvest. While operationally final harvest could occur later, total wood volume is unlikely to increase, and may in fact decrease where final harvest is deferred.**

| | **Current**[13] | **2005** | **2010** | **2015** | **2020** | **2025** |
|---|---|---|---|---|---|---|
| *Trees/ha* | 18,000 thinned to 1300 | 1300 | 1270 thinned to 600 | 590 thinned to 350 | 340 | 300 |
| *Average Ht (m)* | 4 | 7 | 10 | 10 | 11 | 11 |
| *Average Dbh (cm)* | 3.8 | 14 | 17 | 26 | 32 | 36 |
| *Average Age* | 3 | 7 | 12 | 17 | 22 | 27+ |
| *Standing Volume ($m^3$/ha)* | 0 | 25 | 118 reduced to 60 | 140 reduced to 80 | 110 | 110 |
| *Commercial Thin Volume Harvested ($m^3$/ha)* | --- | 0 | 58 | 60 | --- | --- |
| *Volume Growth (MAI $m^3$/ha/yr)*[14] | --- | 3.6 | 9.8 | 11.7 | 10.4 | 8.4 |
| *Volume Growth (PAI $m^3$/ha/yr)*[15] | --- | 5.0 | 17.6 | 16.0 | 6.0 | 0.0 |
| *H/D Ratio* | 105 | 50 | 59 | 39 | 34 | 31 |

[13] Current conditions are based on limited field observations in Mandaratsy Pine Plantation Series A, B, and C.
[14] Mean Annual Increment (MAI) is calculated by adding all previously harvested volume to the current standing inventory, then dividing by the current age. For example, in 2015, at age 17 the pre-thin volume is 128 $m^3$ and prior thinnings have captured a total of 60 $m^3$. Therefore the $MAI_{Age\ 17}$ is (128 + 60)/17 = 11.1 $m^3$.
[15] Periodic Annual Increment (PAI) is calculated by dividing the difference between the current volume (before thinning) and volume at the beginning of the previous period (and after thinning), and dividing by the length of the period. Therefore the $PAI_{Age\ 17}$ is (138-63)/5 = 15 $m^3$/ha/yr.

**Situation 2: Regenerated following 1994 cyclone damage and subsequent burning.**

**Description**

Abundant natural regeneration occupied the disturbed area promptly after the cyclone or post cyclone fires. The majority of the area (80% or more) of the area is densely stocked. Small openings where regeneration is sparse (of less than $^{1}/_{20}^{th}$ ha) occur throughout the stands. Inventories conducted by EASTA Iboaka in the Haute Ranomainty Pine Plantations suggest juvenile stands are stocked with an average of 18,000 saplings per hectare are common.

**Scenarios**

Two scenarios are examined for silvicultural management of forest stands that regenerated following disturbance by the 1994 cyclone and subsequent fire:

- Scenario C: No silvicultural management (thinnings).
- Scenario D: Thinning at age 7-10, a commercial thinning at age 16, and regenerate at age 21. Note that the first thinning may be either commercial or non-commercial, depending on markets for small wood. At this time no market exists for small wood such as would be removed in the initial entry at ages 7-10.

**Scenario C: No precommercial thinning; no commercial thinning. Note: As was discussed in Scenario A, above, it is likely that stands will suffer severe cyclone damage after age 15 because of unstable height/diameter ratios. This will exacerbate clumpy distribution and result in highly variable growing conditions. Subsequent cyclones may result in further damage. A second canopy of dense regeneration is likely to initiate following cyclone damage. In the absence of thinning, dense unstable stand are likely to develop that will likely repeat the cycle. Fire hazard is expected to be quite high. The probability of total stand replacement through fire subsequent to cyclone damage is also expected to be high. Only trees currently occupying the site are shown in these projections. The probable damage due to windthrow and fire is not evaluated. For the purposes of analysis, final harvest is assumed to occur at age 22. Over the rotation approximately 130 $m^3$ per hectare of total volume is projected to be harvested under this scenario. While operationally final harvest could occur later, total wood volume is unlikely to increase, and may in fact decrease substantially where final harvest is deferred.**

| | **Current**[16] | **2007** | **2017** |
|---|---|---|---|
| *Trees/ha* | 12,000 | 8,000 | 2,000 |
| *Average Ht (m)* | 6 | 8 | 11 |
| *Average Dbh (cm)* | 6 | 10 | 17 |
| *Average Age* | 6 | 12 | 22+ |
| *Volume ($m^3$/ha)* | 23 | 90 | 130 |
| *Commercial Thin Volume Harvested ($m^3$/ha)* | 0 | 0 | 0 |
| *Volume Growth (MAI $m^3$/ha)* | 3.8 | 7.5 | 5.9 |
| *Volume Growth (PAI $m^3$/ha/yr)* | --- | 11.2 | 4.0 |
| *H/D Ratio* | 100 | 80 | 65 |

[16] Current stand information is extrapolated from Fanalamanga inventory data developed by DFS (Deuche Forstservice GmbH) provided by LDI, and from limited field observations, and from limited informal observations within the Mandaratsy Pine Plantations Series A, B, and C. Additional insights were drawn from inventory information collected by EASTA Iboaka from the Haute Ranomainty Pine Plantation.

**Scenario D: Thinning at age 7-10 (non-commercial); Commercial Thinning at age 16. Non-commercial thinning conducted as the first management input will require additional investments to abate slash. Regenerate at age 21. For the purposes of this analysis the first thinning is assumed to be non-commercial as there are no known markets for material of this size, particularly since thinnings are assumed to be from below with only smaller trees removed. For the purposes of analysis, final harvest is assumed to occur at age 21. Over the rotation approximately 203 $m^3$ per hectare of total volume is projected to be harvested under this scenario. While operationally final harvest could occur later, total wood volume is unlikely to increase, and may in fact decrease substantially where final harvest is deferred.**

| | **Current** | **2005** | **2010** | **2015** | **2020** |
|---|---|---|---|---|---|
| *Trees/ha* | 12,000 thinned to 1,300 | 1,170 | 1,110 reduced to 550 | 540 | 510 |
| *Average Ht (m)* | 6 | 9 | 10 | 11 | 11 |
| *Average Dbh (cm)* | 6 | 15 | 23 | 30 | 32 |
| *Average Age* | 7 | 11 | 16 | 21 | 26+ |
| *Standing Volume ($m^3$/ha)* | 23 reduced to 18 | 103 | 175 reduced to 90 | 118 | 118 |
| *Commercial Thin Volume Harvested ($m^3$/ha)* | 0 | 0 | 85 | 0 | 0 |
| *Volume Growth (MAI $m^3$/ha/yr)* | 3.3 | 9.4 | 11.6 | 9.7 | 4.5 |
| *Volume Growth (PAI $m^3$/ha/yr)* | --- | 17.0 | 16.6 | 5.6 | 0.0 |
| *H/D Ratio* | 100 | 60 | 43 | 37 | 34 |

Thinning in Scenario D occurs in stands that have developed under very dense conditions. It is very likely that there will be much more wind related damage in these stands than will be experienced in Scenario B. This will be particularly true in the five year period following the initial entry. Windthrow losses of 10% (breakage, tip overs, and stem damage) are assumed in the first period, and 5% in the second period following the initial thinning.

**Situation 3: Intact forest from the original pine plantations.**

**Description**

Approximately 15% to 30% of the Mandaratsy Pine Plantation survived the 1994 cyclone and subsequent fires. Trees are well past maturity, being 40 to 45 years old. Many trees have 'hard wood' in the butt log from accumulated pitch, a physiological response to low intensity fires and to wind stresses. This reduces the recoverable volume under commonly used manufacturing and harvest technologies, as the butt log is often utilized. Studies in other forest types show that a high percentage of total recoverable saw timber volume is in the butt log. Several trees also have sustained bole damage from wind thrown neighbors. Growth is declining, and stands are breaking apart. Some natural regeneration is present in gaps formed by within the canopy, however it is unlikely to develop as a long-term component of the stands. Instead it is likely that regeneration within gaps will create fuel ladders that will further accelerate the destruction of the remaining mature pine forest.


**Scenarios**

One scenario is examined for silvicultural management of forest stands that are from the original plantings within the Mandaratsy Pine Plantations:

- Scenario E: Regenerate by clearcut. Fall all cull trees from the original plantings.
- Reforestation will be from natural regeneration.

**Scenario E: Regenerate by clearcutting all merchantable trees, and falling all mature cull trees. For the purposes of analysis, final harvest is assumed to occur immediately. Stands are well past rotation, and are deteriorating at an unknown, but probably significant rate. Approximately 86 $m^3$ per hectare of total volume is projected to be harvested under this scenario, if harvest occurs within the next five years. Harvestable volume is assumed to decline at 5% per year thereafter due to the ravages of successive cyclones, illegal harvests, fires, and other factors. Abundant natural regeneration of pine is anticipated following clearcutting.**

| | **Current**[17] | **2005** | **2010** | **2020** |
|---|---|---|---|---|
| *Trees/ha* | 600 | 600 | 470 | 367 |
| *Average Ht (m)* | 11 | 11 | 11 | 11 |
| *Average Dbh (cm)* | 25 | 25 | 25 | 25 |
| *Average Age* | 40 | 45 | 50 | 55 |
| *Standing Volume ($m^3$/ha)* | 86 | 86 | 67 | 52 |
| *Commercial Thin Volume Harvested ($m^3$/ha)* | --- | --- | --- | --- |
| *Volume Growth (MAI $m^3$/ha/yr)* | 2.2 | 1.9 | 1.3 | 1.0 |
| *Volume Growth (PAI $m^3$/ha/yr)* | 0 | 0 | -3.8 | -3.0 |
| *H/D Ratio* | 44 | 44 | 44 | 44 |

[17] Data from the recent EASTA Iboaka inventory for Haute Ramomainty for intact forest (strata 2) indicate current stocking is approximately 600 trees per hectare, with approximately 86 $m^3$ of total volume. Saw timber volume is approximately 73 $m^3$, or about 85% of the total volume on the intact pine plantations.

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# SECTION 3: ECONOMIC ANALYSIS OF PINE PLANTATION MANAGEMENT IN HAUTE MATSIATRA

# ECONOMIC ANALYSIS OF PINE PLANTATION MANAGEMENT STRATEGIES

## Mission Objectives

The following section includes a detailed analysis of five pine plantation management scenarios for low and high technology operations in the Haute Matsiatra of Fianarantsoa, Madagascar. The analysis provides estimates of economic and financial measures, costs of maintenance for equipment, costs of transportation infrastructure, investment costs and sensitivity analysis of the impact of efficiencies on revenues for public agencies. The spreadsheet model approach that is used for the analysis can be adapted as a methodology for training interested plantation managers and partners, especially the Eaux et Forêts staff and local non-governmental organizations that are responsible for the development of resource forest management plans in Madagascar. The popularity and effectiveness of the spreadsheet model approach is that variables are easily defined and manipulated without complicated, non-linear adjustments. All of the operational aspects of resource exploitation can be defined and constrained to reflect the variety of social, environmental and economic demands in the region.

The management scenarios were developed by the silvicultural specialist and are outlined in the previous section of the overall team report. These management scenarios reflect the current distribution of pine plantations in the watershed and allow for the calculation of the financial value of stands of different densities. Also, the approximate costs of rehabilitating these stands, based on the silvicultural analysis, are provided. This report includes some initial thoughts on training and capacity building steps that are crucial to the development and application of resource management planning. In particular, an important next step will be training workshops that transfer the computable analytic approaches in this report to the appropriate agencies and staffs.

## Introduction

The pine plantations of the Haute Matsiatra consists of approximately 36,000 hectares of highly productive, naturally regenerated *Pinus patula* and *Pinus keysia*. According to the evaluations of the silviculturalist during this mission, the potential yields of wood fiber from this resource under sustainable management range from 90 to 230 cubic meters per hectare every 15 to 20 years. The social, environmental and economic values of sustainable production from the pine resources has yet to be realized for the local communities as well as the surrounding public and private sectors. The Haute Matsiatra pine resources have been underutilized and neglected since their establishment, possibly contributing to environmental losses through impacts on water quality and quantity, higher net resource damage from climatic shocks (e.g., cyclones, landslides, wind storms) and increased susceptibility to fire from excess ground fuel build-up.

Concrete economic losses have occurred from reduced wood fiber production resulting from high-density stand development that constricts significantly optimum wood production. These losses translate into restrictions on the private sector to provide adequate supplies of wood products for the populations in Fianarantsoa and Madagascar, restrictions on the public sector to extract appropriate rents for their management and administration of the resources, and restrictions on the local communities to achieve optimum social values from the integration of resource outputs into their subsistence needs.

The observations and analysis from this mission contain indications of shared management and development potential of the pine plantations among communities, the private sector and public agencies. Community and private sector producers (e.g., low and high technology operators) have dynamic roles to play in the management of the pine plantations. They are not mutually exclusive social or economic agents in resource management. The ultimate distribution of management responsibilities is an internal one for the stakeholders of Fianarantsoa to determine. Nevertheless, it is rare to find successful monolithic resource development and management approaches in any country. Successful management will be achieved from reflection of the biophysical characteristics of forest resources and the social and economic demands that are met by the diversity of the development of those forest resources.

Although this mission does not supply a detailed evaluation of all of the complex interactions within the pine resources of the Haute Matsiatra, there are clear indications of the challenges that face the stakeholders of the this region in sustainably managing their forest resources. The following analysis, in the context of the overall mission, will present examples of the economic potential of the pine plantations in the Haute Matsiatra with recommendations for further development, training and forest sector analysis.

### Site Visits

The economic analyst participated in the majority of the visits of the silviculture specialist as described in Section 2. In addition to the overall watershed visits by the entire team, the economic analyst conducted several informal interviews of three forest concession holders and wood processing establishments to discuss market structures and production data. The inputs from the wood processing operators were invaluable in providing current average cost of production and stages of operations in the pine plantation areas. The operators also provided insight into the market limitations and concerns that they have regarding forest resources and investment in the Fianarantsoa region.

### Existing Conditions

The wood market in Fianarantsoa consists of numerous and fragmented small-scale enterprises for individual segments of wood exploitation and processing. Thus, there does not appear to exist a well-organized association or support of wood industry investment and marketing. The potential value of the raw material resource is not reflected in adequate investment in the wood sector.

There is little to no vertical integration of wood enterprises in Fianarantsoa. This element creates an environment of disparate and insufficient tracking of market activities and their associated costs and values. The extent of integration occurs most commonly in two stages: forest exploitation (logging and crude forest sawing of cants) and primary wood processing of sawn wood in Fiarnarantsoa. The few businesses that were visited by the team all have a concession contract for harvesting and processing in the forest as well as an in-town sawmill.

Only one example of a highly technical and vertically integrated entrepreneur was encountered during the visit. This operation is the only known user of mechanical logging and advanced machinery for semi-finished and finished sawnwood products in the Fianarantsoa region. The high degree of vertical integration of this operation certainly leads to advantages of economies of

scale that are missing in other operations that are currently in the region. The level of investment of such an operation reflects also the need for long-term tenure security issues to be addressed in future adjustments to the permit or tenure systems for forest resources management[18]. Nevertheless, the overall sustainable management of the pine resources does not require that all operations have the same level of integration. In fact, one alternative future to pine plantation and market development in Fianarantsoa would probably include a small number of vertically integrated operations that are supplied from their own harvesting tenures as well as a larger number of efficient low technology operators that have small-scale, in-town processing mills or no mills at all.

The following analysis reflects the value of the trees "on the stump" and the ability to process and market value-added products in the domestic market. The majority of the businesses stated that there is excess demand in this market. And although the Fianarantsoa market is growing, a significant amount of their production is transported to other cities in Madagascar, with one of the primary markets being the city of Tulear in southwestern Madagascar. One of the challenges for the Fianarantsoa wood market in the next 5 – 10 years will be to maintain a sustainable supply of wood products that will be dependent upon the sustainable management of the pine and eucalypt resources.

The scarcity of pine products, however, is due primarily to insufficient investments in processing, prohibitive transportation costs (from forest to mill), and lack of sustained management of the standing volumes. There is a considerable standing resource of pine timber in the Haute Matsiatra watershed. Given the high levels of productivity in the region, there are many opportunities to capitalize on the value of the pine resource through sustainable management and investments in wood processing.

Each of the management scenarios in the economic analysis is based on the silvicultural scenarios that are discussed in the previous section. These silvicultural scenarios are defined by the current state of the pine plantations and the management regime associated with that current state.

**Scenario A:** Young high density stands, average age of 3-4 years, that will receive no silvicultural treatment. A harvest of about 130 m3/ha occurs at around age 22 years.

**Scenario B:** Young high density stands, average age of 3-4 years, that will receive one pre-commercial thinning immediately and two commercial thinnings of 58 m3/ha and 60 m3/ha at ages 12 and 17 years, respectively. A harvest of about 105 m3/ha occurs at around age 22 years. ***This scenario serves as an example of a sustainable management scenario, or management for the DESIRED CONDITION, that is applied to all of the other scenarios, in perpetuity, after the first cycle of treatments.***

**Scenario C:** Similar in condition and treatment as Scenario A.

[18] See discussion of **Terms of the Permit** in Section 2, "Prototype Privatized Management Plan and Silvicultural Scenarios: Mandaratsy Pine Plantations, Fianarantsoa, Madagascar" of the mission report.

**Scenario D:** Young higher density stands, average age of 7-10 years, that receive one pre-commercial thinning now and one commercial thinning at age of 16 years. A harvest of about 118m3/ha occurs at around age 21 years.

**Scenario E:** Mature stands ready for harvest immediately, average age of 40 years and probably declining in rate of growth. A harvest of about 86m3/ha is available immediately.


***Recent exploitation of pine plantations in Haute Matsiatra: logged November 2000.***

## Methodology for conducting economic analyses of pine plantation management

The objectives of the mission include the development of a simple methodology to conduct a basic economic analysis of managed pine plantations in the Haute Matsiatra watershed. The model should also be applicable to other forest management opportunities within the planning developments of the Eaux et Forêts and other partners in forest resource management in Fianarantsoa.

The methodology for the economic and financial analysis of forest management operations is presented as components of a spreadsheet model[19]. The underlying functions of the spreadsheet model are data intensive, to reflect the detail requested by the mission; yet, the model is based on standard equations of economic and financial calculations. The simplicity of the approach is the use of a spreadsheet tool that can be easily manipulated for a variety of management scenarios.

[19] The spreadsheet model for this analysis will be provided to the LDI team on a compact disc with a basic instruction manual on operating the model primarily as a training tool. The potential users of the model (LDI, USAID, DIREF, and non-governmental organizations) may choose to further develop this spreadsheet model or develop a new model as a component of forest resources management in Fianarantsoa .

**Step-by-step Analytical Approach**

A discussion of the model's components reflects the importance of data collection and the identification of appropriate inputs, costs and prices. The following discussion highlights specific issues from the Haute Matsiatra plantations. The major stages of conducting the analysis are:

1. Identify silvicultural treatments and harvest schedule for each parcel or combination of parcels under management (see Section 2).
2. Identify the specific stages of harvesting and processing operations in detail that can be adequately represented by the data.
3. Collect data on inputs and costs of the harvest and processing operations.
4. Collect market data on prices for intermediate and final products.
5. Input management options, harvesting, process and market data into the spreadsheet model.
6. Validate the spreadsheet model based on current conditions.
7. Define alternative harvesting and processing options based on different assumptions of costs, prices, interest rates, royalties and management options.

**A Spreadsheet Analytical Tool to Investigate the Economics of Pine Plantation Management in Haute Matsiatra**

A spreadsheet model (See Quick Operating Guide for Haute Matsiatra Plantation Model, *in press*) was developed because of the relative availability and universal knowledge of this type of software. This report provides a summary of sample analyses of pine plantation test sites as well as further details on the data and methods used in the analysis. The scope of the application of the model is for management unit areas ranging size from 18 to 36 hectares. The parameters of the model are strictly for the exploitation of pine plantations that are common in the Haute Matsiatra watershed [20]. The operation of the model consists of loading a single file that contains the six sub-components of the model. The initial values that can be modified and carried throughout the model include: the size of the managed area, the rotation length or period between final harvests, the current average age of the pines in the management area, and the prevailing discount rate. All other variables are input and manipulated in the six sub-components of the model.

**Model components**

1. Single and Infinite Series Analysis
2. Estimation of stumpage value
3. Estimation of transportation costs
4. Estimation of labor costs
5. Estimation of processing costs

[20] This spreadsheet model was developed for the primary purpose of providing analysis according to the mission objectives. It is a quick example of a tool and methodology that can be used by LDI and its partners in the Haute Matsiatra watershed with further development and refining. The data assumptions in the model are based on only a few unscientific, informal interviews and reviews of past studies in the region. It is not, however, intended as a definitive product for distribution or further use outside these parameters. The spreadsheet and model have not been peer-reviewed nor have they undergone statistical review.

## 6. Estimation of total investment costs

### 1. Single and Infinite Series Analysis

The model uses standard discounting formula to estimate economic rents based on the net present value (NPV) of future streams of income and costs in perpetuity[21]. The net present value is calculated for the first series of management activities for the current condition of the plantation. The second series of management activities are assumed to be sustainable and desirable activities that will be applied to the management area from that time in perpetuity. By this method, the decision-makers are able to see the cost or investment required to "correct" the condition of the current plantation. These results can also be considered the cost of forgone revenues from the lack of management of the pine resources over the last 40 years.

An internal rate of return (IRR) is calculated when possible for each management scenario. Although this measure does not always coincide with the best economic regime, it is important to determine if the rate of return will at least cover the cost of capital to manage the pine plantations. The IRR may be helpful in guiding the decisions of potential investors that may have access to a choice of capital at different discount rates.

The data needs for generating the basic measures of the economic analysis include:

- Number of hectares in the management area
- Estimate of the stumpage value (value of wood in the forest before harvesting)
- Estimate of the volumes removed for each activity
- Length of the management period or rotation
- Approximate age of the stand (for existing stands)
- Fixed costs of each management activity
- A measure of the cost of capital (discount factor)

The volume component of the analysis is critical to the estimation of revenues in the NPV calculations. Total revenues are dependent upon accurate estimation of potential volumes as outlined in the previous section on silvicultural activities.

### 2. Estimation of stumpage value

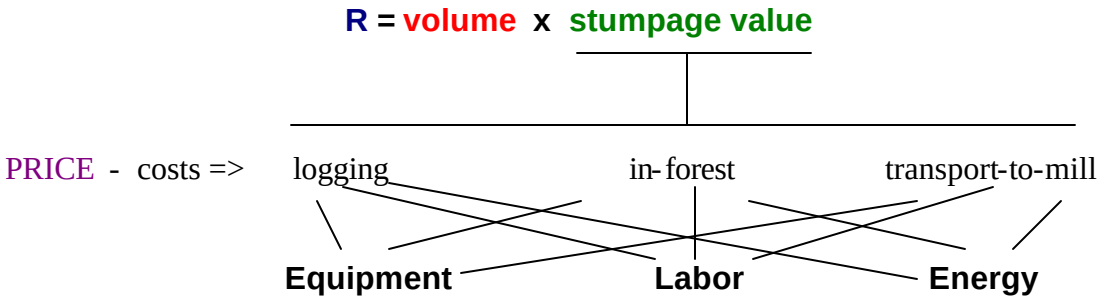
The second critical data input into the analysis is stumpage value. The annual revenues are calculated from the product of the commercial volumes of trees harvested times the stumpage value. Since the stumpage value itself represents the difference between the market price for the final product and the costs of logging and processing the wood, almost all of the sensitivities of the variables in the management operation are expressed in the stumpage value.

The majority of the data that are required for the economic analysis feed directly into the estimation of the stumpage value. Therefore, the evaluation of alternative policy decisions reflects a range of investment choices, capital and labor inputs, and management activities. Additional variable costs (inventory costs, road clearing costs and non-commercial thinning costs) and fixed costs are subtracted from the net stumpage revenues before discounting.

[21] See a sample input sheet for economic analysis from the spreadsheet model in Appendix 3a.

Standard estimations of the value of standing trees on the stump are based on the market value of the final product minus the cost of logging and processing:

$$NPV = \frac{? R - C}{(1 + D)^n - 1} \qquad (C = \text{fixed costs})$$




All of the values in the final summary are in francs Malagasy *(fmg)*[22]. Since all of the data for the analysis are taken from interviews, discussions and recent documents during the mission, all values are considered to be in *fmg* 2001.

The minimum variable components required to estimate the stumpage value of standing trees for the analysis of pine plantations in Haute Matsiatra[23] are:

- Market unit price of sawn lumber (planks) or roughly-squared
- Logging or harvesting costs
- The cost of processing rough-sawn boards or cants in the forest
- The cost of transporting wood products from the forest or roadside to an in-town mill
- An estimate of the rate of recovery for harvest volumes and for product volumes during processing in the forest
- A reasonable assumption of profit margin for the investor

[22] All calculations in the model and this analysis assume an exchange rate of 6,200 *fmg* per U.S. dollar.

[23] See a sample estimate of stumpage values from the spreadsheet model in Appendix 3b.

3. Estimation of transportation costs (TC)

Transportation costs *(TC)* are expected to comprise a significant portion of the total costs of producing final products from the available resource. A recent study by Freudenberger et al of the LDI project provides estimates of road construction and maintenance costs in the Fianarantsoa region[24]. The variable costs of operating vehicles to haul the roughly squared logs or sawn boards from the roadside to the mills in town are estimated from the following data:

- Maintenance or depreciation cost of operating a hauling truck
- Fuel costs (rates of consumption, fuel prices and the distance of the management area or roadside to the mill in Fianarantsoa)
- Full salary and benefits of a truck driver

In the region of Fianarantsoa, the transportation costs are critical as a limiting factor to potential investment in the logging and wood-processing sector. The rural road structures are extremely eroded and damaged. These conditions increase travel time, decrease load-bearing options, and add costs that decrease incentives for removing lower value raw material. Accurate measures of transportation costs will be critical for future, site-specific analysis in order to estimate the full potential value of forest management returns.

4. Estimation of labor costs

Labor costs are of considerable interest to the partners in Fianarantsoa forestry sector. The estimations of employment and potential income from pine plantation management in the region have implications for socio-economic considerations within a rural development framework. In general, the more technologically advanced operation utilizes fewer labor inputs, per unit of volume produced, in order to run an efficient, sustainable and profitable operation. The choice of management between the community sector and the private sector may have significant implications with regard to employment.

***In-forest processing of pine sawn boards in the Haute Matsiatra.***

[24] See a sample estimate of road maintenance costs from the spreadsheet model in Appendix 3c.

On the one hand, the income from employment in the logging and in-forest processing sectors may provide alternative benefits for rural families that will relieve them, at least part of the year, from cultivation and expansion of tavy production. On the other hand, unless the communities or families are managing the forest directly, there may be critical land tenure concerns that may not be satisfied with simply direct employment in the forest sector. A more active role for community management of plantations could diminish some of these concerns. Community management would engage also a larger number of individuals in the forest management and exploitation activities, thus spreading out the benefits among a larger number of families.

Direct employment in the private sector as labor for plantation management (i.e., thinnings), harvesting and processing would give, in theory, a fewer number of individuals higher per capita incomes. Choosing the optimum combination of community and private forest management across the various communities represents a key policy challenge that must be made in the very short-term.

The critical components of labor costs[25] for all stages of the harvesting and processing activities include:

- Gross hourly or monthly wage
- Benefits as a percentage of wages
- Number of employees per activity
- Volume of production for given number of employees
- Number of production days per year

5. Estimation of processing costs

Perhaps the most difficult component of this analysis is the estimation of the in-forest processing costs. This limitation is due primarily to the lack of precise and sufficient data for the wood-processing sector in Fianaranatsoa. Although the model contains a component for in-town processing cost calculations, this analysis estimates stumpage values based solely on the production of sawn boards in the forest and sold at the roadside (for low technology operations) or sold in Fianarantsoa before further processing (for high technology operations).

The variables required for the estimation of processing costs in the model fall into three basic categories: labor, equipment and energy. Labor inputs are fairly dependable based on previous studies and estimates provided by local operators during the mission. Daily equipment maintenance costs and energy (fuel and utilities) costs are much more difficult to determine. Energy costs are assumed to be 6% of total processing costs for this analysis based on previous national studies of wood processing in Madagascar.

The in-forest processing for the low technology operations is actually a combined logging and processing operation. It consists of either manual or mechanical sawing of round logs, after harvest, into rough logs or cants (squared dimensional pieces)[26] and the hauling of the cants to the roadside. The cost components of manual processing in the forest are almost entirely labor intensive, including:

- Labor for felling and sawing into cants or boards
- Labor for moving (hauling) the cants from the stump to the roadside
- Cost and maintenance of saws

[25] See a sample estimate of labor costs from the spreadsheet model in Appendix 3c.

[26] The slash or waste from this first round of processing is significant and future studies on utilization could provide recommendations for considerable resource improvements and efficiencies.

The cost components of mechanical processing or the high technology operation include a higher proportion of equipment costs and maintenance as a total of the overall operation. Mechanical processing in the forest is more clearly separate from the logging (skidding) component and the in-forest milling component of the processing, particularly in the division of labor. The cost components of mechanical processing in the forest include:

- Labor for chainsaw operation
- Labor for skidder operator
- Depreciation or operating costs of chainsaw and skidder
- Labor for operating portable sawmill
- Labor for loading and stacking cants and finished boards
- Labor for wood treatments (drying and fungicide)
- Labor for loading finished boards into truck
- Labor for guards and security
- Depreciation or operating costs of sawmill
- Energy costs

The overall values of the low and high technology operations are clearly impacted by the choice of labor and capital inputs. The inefficiencies of the manual operations will reflect, to some extent, rent seeking behavior of the investors through negotiations on taxes and fees, high-grading harvest selections, and faster expansion of exploitation through higher labor costs. The expected trade-offs between labor costs and capital costs are reflected in the choices of the operators.

6. Estimation of Total Investment Costs

The last, but not least, of the measures that are requested of the analysis is an estimate of the total investment cost required to start-up and maintain a pine plantation management and processing operation. The total investment cost is calculated by adding the real discounted variable and fixed costs used to determine the stumpage value calculations PLUS the start-up costs of purchasing equipment, buildings, roads, infrastructure, training, and contracts[27].

In the case of forest operations in the Fianarantsoa region, there are no fixed costs for licenses, permits or contracts. There are only variable royalty or tax payments to the commune[28] and to the Eaux et Forêts based on volume production at various stages of the operations. These costs are based on the percentage of standing commercial production in the forest (to the Eaux et Forêts) and the percentage of processed product in the forest (to the commune). Additional value-added taxes are paid to the province for further processed wood, but these costs are not covered in this analysis because the value of the product reflects in-forest processing only.

The start-up costs in this analysis do not include training costs because comparable estimates for the two types of operations were unavailable at the time. In fact, based on visits to some of the operations, the assumption is that little training occurs, especially for the low technology operations. The high cost of training in the high technology operations will be required for the in-town processing analysis that can be conducted with future work.

[27] See sample estimate of start-up and total investment costs from spreadsheet model in Appendix 3d.

[28] A commune is the lowest unit of governance and administration in Madagascar.

The cost of roads is treated as a variable cost in this analysis for two reasons. Firstly, the operators (high and low technology) are likely to invest in road clearing or maintenance only at times when there will be commercial volumes removed. Currently, commercial volumes are removed only during final harvest of high-valued mature pine areas. If management regimes are adopted in the future, road maintenance will most likely occur only for commercial thinnings and final harvests.

Secondly, the initial road structure for the pine plantation area has already been cut. No new roads are required for providing delivery of the logging and in-forest processing volumes. Therefore, only maintenance or clearing costs are assumed for the road costs in this analysis. These costs are included in the variable costs estimates in the final net present value calculation when commercial volumes are removed.

### Analysis of Haute Matsiatra Pine Plantations

Each of the management scenarios that are outlined in the silvicultural section of this report is evaluated under two sets of assumptions:

1. The owner of the concession and forest processor is a private business. (Although the majority of the pine exploitation is currently under private management, there is also one scenario analyzed under the assumption that the management responsibilities will be at the community level.)

2. The forest operator utilizes either high (mechanized) or low (manual) technologies to harvest and process the trees in the forest into sawn boards or planks. The high and low technology scenarios represent high and low efficiency operations, respectively.

The initial assumptions for the high and low technology operations are defined as:

| **Assumptions for high and low, private operators and community management of pine plantations in the Mandaratsy, Haute Matsiatra.** | | |
|---|---|---|
| *Criteria* | **High Technology** | **Low Technology/ Community Management**[29] |
| | | |
| *Size of concession (ha)* | 18 | 36 |
| *Commercial harvest recovery rate (%)* | 100 | 25 |
| *Product recovery rate (%)* | 50 | 30 |
| *Delivered product volume produced* | | |
| *in the forest (m3)* | 7 | 9 |
| *Stumpage value ('000 fmg)* | 252.50 | 150.06/142.50 |
| | | |
| *Equipment type and operating* | | |
| *cost ('000 fmg/m3):* | | |
| *Handsaw* | 3.54 | 2.76 |
| *Chainsaw* | 1.77 | Not used |
| *Tractor* | 21.26 | Not used |
| *Portable sawmill* | 19.49 | Not used |
| *Truck* | 29.49 | Not used |
| | | |
| *Labor (# workers):* | | |
| *Logging* | 2 | 24 |
| *Processing* | 16 | 10 |
| *Transport to town* | 1 | 1/0 |
| *Wages ('000 fmg per month)* | 210 | 175 |
| *Discount rate* | 25% | 25% |

The general assumptions concerning the differences between the two operations are that the high technology operator invests more capital in modern equipment than the low technology operator. While using fewer laborers, the high technology investment is expected to increase the efficiency of the operation, particularly in the forest where the largest levels of waste are occurring. The desire to increase

[29] The community management criteria include the assumption that the communities will only supply their pine plantation volumes of sawn boards or cants to the roadside nearest their management area. Thus, transportation costs are held to zero.

raw material recovery is a very rational approach when the operator is paying the required royalties to Eaux et Forêts at the stump, as is the case in the Fianarantsoa region.

Another consideration that is reflected in the assumptions of the analysis is that the low technology operators are not harvesting the same levels of volume from the thinnings, nor from the final harvests, as that of a more efficient and mechanized operation. As discussed in the previous chapter on silvicultural management, the low technology operators are removing fewer trees per hectare, impacting higher levels of degradation on the residual stand, increasing risks of fire and leaving the forests more vulnerable to windthrow and cyclones. And of considerable importance is the fact that the low technology operators are exploiting more forest area (i.e., high-grading) at a faster rate than more efficient operators in order to supply similar volumes of wood to in-town mills. For these reasons, it is assumed that the silvicultural treatments, if applied by the low technology operators will still result in lower volumes available at each removal as well as reduced volumes actually removed per management cycle. A 75% reduction in thinning and harvest volumes, compared to the high technology assumption, defines the low technology analysis.

The data in these assumptions are based upon interviews, site visits, discussions and several recent documents concerning the pine plantations and wood processing in Haute Matsiatra and Fianarantsoa. The data are only one set of assumptions selected at the discretion of the author and do not reflect any particular operation or concession. These initial assumptions were made primarily to provide examples of the sensitivities of the variables of cost in potential forest operations in the region.

Estimates of daily product volumes delivered to Fianarantsoa are based on interviews with low and high technology operators. On average, the lower technology operators are modeling slightly more volume per day, but of lower quality than a mechanized operation. However, the low technology operators seem to use more workers. The higher labor costs offset the absence of modern equipment with slightly higher daily production of boards and planks.

The assumptions regarding equipment are critical to the final economic analysis between the low and high technology operators. The cost of operating a chain saw, tractor and portable sawmill greatly exceed the costs of operating only a hand saw and a few axes. The gains in lower labor costs by the high technology operation are only about 50% of the gains in the low technology's operating costs of equipment.

The assumption of higher wages paid by the high technology operation reflects the investment in training that would be necessary in order to operate modern equipment. Higher skilled employees would be paid higher wages. The analysis is based on the assumption that the low technology operators pay employees a minimum wage.

The analysis described in this report uses a discount rate of 25% that falls within the range of current costs of capital in Fianarantsoa. There are opportunities however to obtain investments in pine plantation management through various sources, many of which will not face the same costs. Sensitivity analysis on the discount rate would give intuitive results, thus it is not included here. The choice of the discount rates impacts, however, the total investment costs and should be considered by those decision-makers that face a variety of funding options.

**Summary of Results**

Net present value of the single-series and infinite-series of management activities starting, with the existing stand conditions

This measure provides the present value of revenues and costs for the management operations, assuming a given cost of capital (discount rate). Although the analysis does not include multiple results for different discount rates, the intuitive result is that if capital is available at lower rates of interest, those sources will provide higher present value returns. For each management scenario, the silvicultural specialist outlined an initial series of management activities that could be considered "corrective" management through the first harvest period. The NPV of this first single series of activities is estimated.

After the forest "corrective" action, each scenario is prescribed a sustainable series of forest management actions that would be applied repeatedly over the long-term. This measure adds some additional value by assuming that the preferred management regimes will be applied continually over the long-term in order to "simulate" a steady or sustainable management of the resource, as well as sustainable and dependable supplies of wood. The final analysis of the net present value estimates indicates the potential gains that are available to the region if investments are made in sustainable forest management.

The range of net present values for the single-series of management activities in the high technology scenarios range from about 295,000 *fmg*/ha to as high as 6,232,000 *fmg*/ha, for no management treatments to operations that harvest mature stands immediately, respectively. The lower values for the "no treatment" operations reflect the lack of early revenues from commercial thinnings within the first 5 to 10 years from now. The analysis also uses a high discount rate of 25% that means that any revenues gained and costs incurred after about ten years have very low values in present terms. This explains also the significantly higher net present values for Scenario E (harvesting mature stands immediately), even though the volumes removed are only 70 – 80% of the final volumes that would be available with intermediate treatments over the next 15 to 20 years.

The value of the pine plantation management increases considerably when long-term, sustainable management is included. For each scenario, the additional values are 4 to 20 times higher with sustainable, long-term management of the resource.

| *Management Scenario*[(a)] | **ECONOMIC AND FINANCIAL RESULTS** | |
|---|---|---|
| | **Single Series NPV** | **Infinite Series NPV** |
| | **('000 *fmg*/ha)** | **('000 *fmg*/ha)** |
| | | |
| Scenario A High | 295.47 | 3,016.34 |
| *Scenario A Low* | -15.09 | 441.75 |
| *Scenario A Low +50%*[(b)] | 118.45 | 892.29 |
| | | |
| *Scenario B High* | 730.11 | 2,816.61 |
| *Scenario B Low* | -675.64 | 420.71 |
| *Scenario B Low +50%* | -244.92 | 851.42 |
| | | |
| *Scenario D High* | 1,634.64 | 6,825.04 |
| *Scenario D Low* | -566.57 | 923.37 |
| *Scenario D Low +50%* | 538.64 | 1,974.92 |
| | | |
| *Scenario E High* | 6,232.60 | 125,082.78 |
| *Scenario E Low* | -1,972.12 | 1,7265.84 |
| *Scenario E Low +50%* | 92.74 | 36,393.44 |

(a) Scenario C is not shown in the results because of its similarity to Scenario A.
(b) +50% assumes harvest recovery increased from 25% to 75% for low technology operators.

The negative net present values for the low technology operations of Scenario E suggest that the assumptions regarding costs are too high or that the assumptions regarding prices are too low. For example, the actual royalty payments received from the operators may be close to zero, the cost of road maintenance may be significantly lower or the cost of labor may be lower than the minimum wage assumed in this analysis.

Another possibility for the negative net present values is that recovery factors for harvesting of 25% are too low. In other words, actual stumpage values are higher than the initial assumptions of this analysis. Overall, however, it is assumed that the operators would not be investing in wood extraction and production unless their net values for their current operations are, at a minimum, greater than or equal to zero. More importantly, the analysis demonstrates the potential gains for the operators if they improve the efficiencies of their production. For example, if the low technology operators increase harvest recoveries from 25% to 50%, then all of the management scenarios show positive net values, under the assumptions of this analysis.

Internal rates of return of the various management scenarios for high and low levels of technological inputs

The internal rate of return is one measure of the profitability that can be expected from the investment in management treatments for the pine plantations. A measure of the rate of return

does not necessarily lead to the best economic management decision, but it is helpful in determining if the operations will provide a return, at a minimum, that is equal to or above the cost of capital.

In this analysis, the rate of return on the investment for all of the management options rarely covers the current cost of borrowing capital in the Fianarantsoa region at 25 percent. Only Scenario A under the high technology option provided a higher return. These results suggest that most investors begin forest harvesting and processing operations with cash investments of their own or from other lower cost sources. At the same time, all of the returns from 5% to 25% may be quite competitive with the opportunities available to donor agencies or non-governmental organizations.

Comparison of the major cost components: logging costs, in-forest processing costs, and transport costs from the forest to mills in Fianarantsoa

When comparing the pine plantation options in this report, it is helpful to understand the various cost components of the operations that impact profitability. This information is especially valuable when considering the feasibility of investments in forest management from limited funds.

| *Level of harvesting and processing technology* | **Harvesting and Processing Costs ('000 *fmg*/ha)** | | |
|---|---|---|---|
| | **Logging** | **In-forest processing** | **Forest-to-town transport** |
| | | | |
| *High technology* | 13.31 | 54.94 | 62.64 |
| *Low technology* | 8.40 | 15.29 | 56.60 |
| **Note:** Additional costs include royalty payments, road clearing costs, thinning costs and inventory costs. | | | |
| | **Harvesting and Processing Costs (% of three cost components)** | | |
| *High Technology* | 10.2 | 42.0 | 47.8 |
| *Low Technology* | 10.5 | 19.0 | 70.7 |

Initial expectations for the analysis were that the amount of waste and higher employment costs would lead to less profitable operations than the more efficient high technology operations. Indeed, the negative NPV of the low technology operations, under the assumptions of this analysis, suggest that costs must be actually lower or offset by additional benefits that are not captured in the data.

The impacts of transportation costs on both types of operations can be seen in the estimates above. Particularly for the low technology operators, the transportation cost component represents the most significant cost at three to four times more than logging or in-forest processing. The advantages of economies of scale and the benefits of value-added production are reflected in the more balanced distribution of costs for the high technology operation.

Total Investment Costs for Start-up and Operation of Pine Plantations

One of the critical issues for the pine plantation management in Haute Matsiatra is whether to continue to use primarily private management of the plantations or to transfer management to the surrounding communities. Although some management transfers have already occurred for

broad-scale developments and watershed management, the question remains of whether the pine plantation elements of the watershed would be more beneficial (income, employment, land tenure) if applied by the private sector. The initial costs of investment may provide assistance in answering this question, particularly if capital is limited for support of the start-up of logging and processing operations and for the maintenance of the management activities.

One of the primary limiting factors to increased efficiencies in the pine plantation management in Fianarantsoa seems to be the cost of capital for technological improvements. This lack of adequate capital or investment leads to rent-seeking behavior that creates external costs to the operators, as well as unsustainable practices that are eventually applied to the resource. These estimates of start-up costs should be viewed with caution due to the informal nature of the data collection on this issue during the mission. The values may be used, however, as a fairly good yardstick of the relative level of capitalization that must be considered to utilize the fullest potential of the pine plantations in the Haute Matsiatra.

| *Management Scenario* | **Start-up costs** | **Start-up costs + discounted variable costs** |
|---|---|---|
| | ('000 *fmg*/ha) | ('000 *fmg*/ha) |
| *Scenario A High* | 44,127.78 | 44,281.85 |
| *Scenario A Low* | 7,339.89 | 7,433.28 |
| | | |
| *Scenario B High* | 44,127.78 | 46,901.07 |
| *Scenario B Low* | 7,338.89 | 7,433.28 |
| | | |
| *Scenario D High* | 66,794.44 | 66,987.39 |
| *Scenario D Low* | 7,166.67 | 7,284.88 |
| | | |
| *Scenario E High* | 66,794.44 | 66,948.52 |
| *Scenario E Low* | 7,166.98 | 7,261.37 |
| **Note**: Scenario C is omitted due to its similarity to Scenario A. | | |

The most significant difference between the start-up costs of high-technology operations and low-technology operations is again the equipment requirements. The low technology scenarios have shown, however, that community level investments have considerable potential with increased efficiencies and could receive returns on the investment in several ways – rural employment, increased annual rural incomes, increased revenues for communal governance, and increased revenues for the Eaux et Foret responsibilities in resource management, conservation, and administration.

**Critical Issues Analysis**

This section of the report addresses several issues related to the potential gains that exist for individuals, communities, the Eaux et Forêts and investors through sustainable and more efficient pine plantation management in the Haute Matsiatra. The analysis, although based on optimistic assumptions for management, provides one view of the significant economic potential of the Haute Matsiatra pine plantations. The plantations have the potential to serve as a resource

for the communities as well as demonstrate the potential sustainable values from conserving the forests through management rather than through deforestation, neglect or conversion to other land uses.

The importance of early management intervention

Pre-commercial thinnings will often be the first management activity that incurs a cost that is not balanced by the generation of revenues. This early negative income stream serves as an important investment, however, in the overall performance of the plantation. Plantations that are not thinned early enough result in significantly reduced volume growth due to severe competition on the site and the development of stems that are less resilient to disturbances. The cost of the thinning operation includes the density of the stands and the ability of the workers to maneuver within the plantation. The more dense stands require a slower operation; thus, leading to increased costs for labor. The potential net loss in volume without thinning, and perhaps the entire stand, is too great to bear, however, in this region of frequent and severe climatic activity.

Below is an example of the spreadsheet calculation of the pre-commercial thinning costs for areas that differ in their stages of advanced regeneration. The cost of the pre-commercial thinning activity for stands that are only four years older is quadrapule that of younger stands.

| *Average Stand Age* | **# workers/ day** | **# hectares** | **Wages MFmg/ worker** | **MFmg/ day** | **Worker -days/ ha** | **MFmg/ ha** |
|---|---|---|---|---|---|---|
| *3 –4 years* | **1** | 18 | 12.6 | 12.6 | **5** | **63** |
| *7 – 10 years* | **1** | 18 | 12.6 | 12.6 | **20** | **252** |

The levels of waste represent potentially significant foregone benefits for the region.

The level of inefficient harvesting of the pine resources in the Haute Matsiatra are reflected in the amount of valuable and useable solid wood that remains on the forest floor after harvest. The waste is visible as well as implied by the fact that the Eaux et Forêts assumes a 30% recovery of processed wood products when estimating the inventory of future harvests. The low recovery factors for processing trees into sawn boards in the forest before transporting to the mills in town adds another level of waste, therefore lost revenues for the Eaux et Forêts and the communes.


***Examples of waste levels after harvesting of eucalyptus and pine in the Fianarantsoa region.***

Referring to the economic analysis above, the high technology operations recover approximately 100% of the commercial standing volume during harvest, but they only recover about 50% of the harvested wood in the form of sawn boards. On the other hand, the low technology operations are assumed to recover only 25% of the available commercial standing timber. This means that for every hectare exploited by a low technology operation, about 75% of the potential wood value is left in the forest. Some of the reasons for this behavior are that manual hauling of the largest trees to the roadside is difficult and slow. Also, the selection of only the best 1-2 trees requires that the operation exploit more hectares to obtain a desired daily volume of wood. The sum of this behavior is that large quantities of commercial volume are wasted in the forest. Another 30% of the actual harvests are lost through inefficient processing into manually-sawn boards by the low technology operator.

The losses from the pine plantation operations impact greatly the proportion of economic rent that the communes should reasonably expect to receive from forest exploitation. The Eaux et Forêts minimizes its potential losses by collecting royalties on the concession contract based on its own inventories of the standing timber before operators are allowed to begin exploitation. The royalty payment to the Eaux et Forêts is, say, 6,000 *fmg* per cubic meter of standing commercial volume. Even if the inefficient operators are removing only about 25% of the available volume, their inefficiencies result in higher per-unit costs that they pay to process the wood because of the waste left behind after payment of the royalty.

It was not clear, however, to the analyst if the royalties are fixed at a particular level for each contract. Perhaps if these costs are minimized through the contract process, this could explain the existence of operations given the negative values from this analysis. The Eaux et Forêts, however, should seek to set an appropriate royalty fee for the resource in order to adequately obtain their fair share of the economic rents they are due to cover their costs of management and administration of the forest resource for Madagascar.

The potential for foregone revenues by the communes is significantly higher. The two levels of inefficiencies by the lower technology operators have a multiplicative affect on the potential revenues that the communes might receive for products generated in the forests and transported to other areas. Firstly, only 25% of the commercial volume is removed for processing in the low technology operations. Secondly, the sawing of boards or planks in the forest recovers only about 30% of the harvested volumes. For example, the Commune governments receive 2,500 *fmg* for each cubic meter of processed wood that is transported from the forest to the roadside or directly to the mills in Fianarantsoa. If more efficient operations increased processing recovery to only 50%, this means an additional 125 *fmg* (0.25 x 0.20 x 2,500 *fmg*/m3) could be collected for each cubic meter of commercially available wood inventoried in the pine plantations.

The following table provides an estimate of the total potential revenues that are lost by the communes if the majority of the pine plantations continue under inefficient exploitation. In Chapter 2, the 36,000 ha of pine plantations in Haute Matsiatra were distributed across the management scenarios outlined in Chapter 2, according to current conditions. Given the potential volumes that would come from implementing these management scenarios across all of the pine plantation area, the total potential additional revenues that the commune would receive if more efficient production occurred is almost 629.8 million *fmg* over the next 20 years, given the assumptions of this analysis. Almost ¾ of the potential gains would occur on the areas available for management scenarios C and D that account for about 60% of the pine plantations.

Even if the assumption of 75% fewer volumes from manual operations is too strong, it is clear that for a 20% loss in efficiency in volume recovery during in-forest processing of the pine plantations, significant revenues are lost in benefits that should accrue to the communes.

| *Management Scenario* | **Potential distribution of the management area, by scenario[a]** | **Potential volumes from thinnings and harvests over 15 – 20 years** | **Potential losses in processed volumes from manual operations at 30% vs. 50% recovery[b]** | **Potential additional revenues for the Communes based on current royalty fees of 2.500 fmg per cubic meter of processed wood removed from the forests** |
|---|---|---|---|---|
| | **('000 ha)** | **(m3/ha)** | **(m3/ha)** | **('000,000 fmg)** |
| *A* | 2.7 | 130.0 | 6.5 | 43.875 |
| *B* | 2.7 | 228.0 | 11.4 | 76.950 |
| *C* | 10.8 | 130.0 | 6.5 | 175.500 |
| *D* | 10.8 | 203.0 | 10.2 | 275.000 |
| *E* | 5.4 | 86.0 | 4.3 | 58.050 |
| ***Total*** | **32.5** | | | **629.755** |

[a] Approximately 10% of pine plantations do not meet any of the management scenarios based on current conditions.
[b] These values assume that only 25% of the inventoried commercial volumes are removed by the low technology operators.

Lack of utilization opportunities for un-recovered wood

The forestry and forest products sector of the Fianarantsoa region could benefit greatly from a utilization study as well as increased investments for small businesses to process the un-recovered wood for value-added products. One operation in the pine plantation utilizes the slabs from the first saw cut of the round logs as fencing material. This material use could account for about 15% of the final harvested volume on most operations, thereby increasing wood recovery rates to 65% compared to 50% of a mechanized operation producing only sawnwood. The slabs would provide another benefit from the forest that would generate about 2500 *fmg* per m3 of processed volume as additional revenues to the communes as well as decrease the overall cost per cubic meter of raw material for the operator.

Other potential areas of utilization that were mentioned by some of the operators include chips for briquets or fireplace logs and wood chips/sawdust/shavings for chicken bedding. Areas that were not mentioned, but with some potential, could be a composite board or engineered wood product facility to utilize the abundance of low quality slabs, chips and smaller pieces currently left in the forest and on the mill floors.

The impact of transportation infrastructure costs on the profitability of potential pine plantation operations.

The cost of clearing or maintaining a CAP road to the forest was estimated at about 14 million *fmg* per kilometer. For a road length of 17 km and a management area of say 18 hectares, this leads to a cost per hectare of about 11.3 million *fmg*. If Scenario E is used as an example relating to the mature pine plantations that are most likely to be harvested currently, the potential impact of reduced road maintenance costs on the net present value of the first management application over the next two years can be estimated. If the road costs are cut in half to about 7 million *fmg* per kilometer, the gain in net present value of the operation could be more than 3 million *fmg* per hectare over the first management period in the next 15-20 years. If the sustainable management regimes are applied to these mature pine plantations in perpetuity, the net present value of gains could be as much as 2 million *fmg* per hectare. On just one 18-hectare management unit, that equals about 36.7 million *fmg* over 20 years.

Capital invested in harvesting and processing equipment.

Most of the current operators utilize manual labor for felling and sawing stems into squared cants or roughly sawn boards. Much of the processing waste occurs at this point and is left in the forest. The daily depreciated costs of a hand saw is assumed to be about 24,800 *fmg* per day or about 2,760 *fmg* per m3 for a 9m3 sawn wood volume operation in the forest. The costs of a mechanized operation that uses a chainsaw, motorized tractor for skidding and portable sawmill were estimated to be about 322,400 *fmg* or 33,100 *fmg*/m3 for a seven cubic meter daily sawnwood operation in the forest. As discussed in the analysis section earlier, the savings in equipment costs by the low technology operators far outweigh the additional costs using 1.5 to 2 times the number of workers over larger areas.

The importance of the equipment costs however is the limitation that it places on investment in more efficient volume removal and processing by the operators. The costs to the resource have been discussed in terms of increased risk to natural disturbances. The degradation of the plantation sights contribute to the environmental costs to the communes and surrounding villages

as well as the population of Fianarantsoa that is dependent upon the water supply. And also, but not the least affected, is the operator or current investor in pine plantation exploitation. The continued lack of more efficient technological usage contributes to the unsustainable supply of wood and their lack of optimum financial gain from the raw material inputs for which they have already purchased.

Potential employment and income generation

Based on the assumptions of the economic analysis provided in this report, the amount of annual income that might be generated from employment in the pine plantations of Haute Matsiatra could be substantial. A substitute income for part or all of the year could provide alternative subsistence support away from tavy production for many of the community populations. In a high technology operation, 18 workers drawn from the villages could be employed in the forest harvesting and processing activities per 18-hectare annual area operation. The number of workers employed in the low technology operations could be as high as 36 per 36-ha operation. At one worker per hectare of operations, an annual income based on a minimum wage of 175,000 *fmg* per month would be as high as 2.1 million *fmg,* per worker, of income annually for each hectare managed.

## Observations and Suggested Follow-up

- The analysis of the economics of pine plantations in Madagascar should be a continuous process that is implemented throughout the Eaux et Forêts and on a regular basis. An increase in the capacity of the Eaux et Forêts to conduct this analysis will contribute to the development of strategies to optimize valuation of the resource and receipt of appropriate rents by the public sector.

  **Suggested Follow-up: Conduct a workshop with Eaux et Forêts and non-governmental representatives on the application of the spreadsheet model (or similar tool) and analytical processes that can be incorporated into routine administrative and management responsibilities.**

- The potential revenues generated by the pine plantations in Haute Matsiatra are currently left on the forest floor from logging and in-forest processing. Standard applications of royalty fees and the distribution of those fees to the respective administrative levels could provide much needed funds for the development and management goals of the Communes and the Eaux et Forêts. This requires increased control of areas under exploitation through standard levels of fees for all operators that reflect the costs of administration, protection and management of the plantations by the Eaux et Forêts.

  **Suggested Follow-up: Investigate and determine appropriate levels of fees to charge concessions and enforce collection consistently with incentive adjustment factors for more efficient operations.**

- The forestry and forest products sector of the Fianarantsoa region could benefit greatly from a full utilization study of potential investments for small businesses, to process the un-recovered wood for value-added products.

  **Suggested follow-up: Conduct a utilization study of Fianaranatsoa wood products market with estimates of investment levels required for sustainable industries.**

- The potential socio-economic and environmental gains from pine plantation management regimes require specific analysis of the input-output affects of increased forest sector employment for the communities in the watershed.

  **Suggested follow-up: Conduct input-output analysis of plantation management investments on rural economies to determine likely benefits to pursue and possible contradictions to be avoided.**
- The environmental costs of inefficient harvesting and processing operations in the pine plantation forests to the watershed were not calculated in this analysis. These costs should be considered in terms of increased risk to fire and impacts on water supply and water quality.

  **Suggested follow-up: Estimate the impacts of inefficient resource exploitation on watershed values and reflect some proportion of these costs in royalties paid by the operators.**

### Suggested Follow-up for Training Activities

The spreadsheet model used in this analysis can be used in a variety of ways. It is suggested by this investigator that the model be used primarily as a teaching tool for future training components of LDI activities in Fianarantsoa. The training should consist of Eaux et Forêts staff, non-governmental organization staffs, LDI staff and other interested resource managers. A three- to five-day format would be sufficient to explore the analytic framework represented in the model as it reflects the current pine plantation exploitation activities in the region. Participants would be given the tools to develop the model further or refine the model to accurately reflect their forest resources management obligations.

# APPENDIX 3

Appendix 3a – SAMPLE input sheet and calculation of revenues and costs for pine plantation analysis.

***ECONOMIC ANALYSIS FOR PLANTATION MANAGEMENT***
***USAID/USDA-FS Forest Management Team Mission***
***Fianaratsoa, Madagascar: 1 - 21 July 2001***

SINGLE AND INFINITE SERIES ANALYSIS

***Location =*** ***Fianaratsoa***
***Mgmt unit =*** ***Mature stand***
***Product =*** ***Bois d'oeuvre***

***Avg. current age =*** ***3***
****Rotation =*** ***22 years***
****Unit Area =*** ***18 hectares***
****Discount rate =*** ***0.25***
****Standing volume =*** ***105 m3/ha***

| | | | TOTAL STUMPAGE REVENUE | | | | | TOTAL COST | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Calendar Year | Activity Year | MANAGEMENT ACTIVITY | AREA (ha) | Commercial Yield | Unit | Stumpage Unit Value (MFmg/unit) | Revenue (MFmg) | Total Revenue/ha (MFmg/ha) | Mgmt variable costs (MFmg/ha) | Royalty to E&F on standing commercial volume (MFmg/ha) | Other Fixed costs (MFmg/ha) | Total Other variable and fixed cost/ha (MFmg/ha) |
| BASE YEAR | | | | | | | | | | 6 | | |
| | | | | | | | | | | (MFmg/m3) | | |
| 2001 | 0 | inventory, clear road | 18 | | | | 0.00 | 0.00 | 22.22 | | | 22.22 |
| 2002 | 1 | precommercial thin | 18 | | | | 0.00 | 0.00 | 63.00 | | | 63.00 |
| 2003 | 2 | | 18 | | | | 0.00 | 0.00 | | | | 0.00 |
| 2004 | 3 | | 18 | | | | 0.00 | 0.00 | | | | 0.00 |
| 2005 | 4 | | 18 | | | | 0.00 | 0.00 | | | | 0.00 |
| 2006 | 5 | | 18 | | | | 0.00 | 0.00 | | | | 0.00 |
| 2007 | 6 | | 18 | | | | 0.00 | 0.00 | | | | 0.00 |
| 2008 | 7 | | 18 | | | | 0.00 | 0.00 | | | | 0.00 |
| 2009 | 8 | | 18 | | | | 0.00 | 0.00 | 22.22 | | | 22.22 |
| 2010 | 9 | commercial thin | 18 | 58 | m3/ha | 252.60263 | 719.17 | 14651.07 | | | 11333.33 | 11333.33 |

# Appendix 3b – SAMPLE estimation of stumpage values from the spreadsheet model

***ECONOMIC ANALYSIS FOR PLANTATION MANAGEMENT***
***USAID/USDA-FS Forest Management Team Mission***
***Fianaratsoa, Madagascar: 1 - 21 July 2001***

***Location =*** ***Fianaratsoa***
***Mgmt unit =*** ***Mature stand***
***Product =*** ***Bois d'oeuvre***
***Species =*** ***Pine***

STUMPAGE VALUE CALCULATION

| | In-town recovery factor | In-forest recovery factor |
|---|---|---|
| | 0.7 | 0.5 |

| Daily In-forest processed volume (m3) | Post-In-town mill Stumpage Value (MFmg/m3) | Post-In-town mill product Value (MFmg/m3) | Pre-In-town mill Stumpage Value (MFmg/m3) | Pre-In-town mill product value (MFmg/m3) | Value added tax | Profit margin | In-town Processing costs (MFmg/m3) | Forest to mill transport costs (MFmg/m3) | In-forest Processing costs (MFmg/m3) | Total Logging costs (MFmg/m3) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -437.83 | 600 | -406.77 | 450 | 0.2 | 0.15 | 348.20 | 311.50 | 384.57 | 93.20 |
| 2 | 127.16 | 600 | -15.88 | 450 | 0.2 | 0.15 | 174.10 | 159.50 | 192.28 | 46.60 |
| 3 | 313.82 | 600 | 112.74 | 450 | 0.2 | 0.15 | 116.07 | 110.50 | 128.19 | 31.07 |
| 4 | 405.90 | 600 | 175.81 | 450 | 0.2 | 0.15 | 87.05 | 87.25 | 96.14 | 23.30 |
| 5 | 460.15 | 600 | 212.65 | 450 | 0.2 | 0.15 | 69.64 | 74.30 | 76.91 | 18.64 |
| 6 | 495.48 | 600 | 236.37 | 450 | 0.2 | 0.15 | 58.03 | 66.50 | 64.09 | 15.53 |
| 7 | 520.00 | 600 | 252.60 | 450 | 0.2 | 0.15 | 49.74 | 61.64 | 54.94 | 13.31 |
| 8 | 537.77 | 600 | 264.15 | 450 | 0.2 | 0.15 | 43.53 | 58.63 | 48.07 | 11.65 |
| 9 | 551.04 | 600 | 272.58 | 450 | 0.2 | 0.15 | 38.69 | 56.83 | 42.73 | 10.36 |

Appendix 3c – SAMPLE calculation of other variable costs from the spreadsheet model.

***ECONOMIC ANALYSIS FOR PLANTATION MANAGEMENT***
***USAID/USDA-FS Forest Management Team Mission***
***Fianaratsoa, Madagascar: 1 - 21 July 2001***

***Location =*** ***Fianaratsoa***
***Mgmt unit =*** ***Mature stand***
***Product =*** ***Pulpwood***
***Species =*** ***Pine***

## Labor Costs Calculation

| Wages (MFmg/mo) | Benefits (percent) | Monthly gross wages and benefits (MFmg/mo) | Worker days per month (days) | Total daily employee cost (MFmg/day) | | Average daily employee cost (MFmg/day) |
|---|---|---|---|---|---|---|
| 220 | 20 | 264 | 20 | | 13.2 | 12.6 |
| 200 | 20 | 240 | 20 | | 12.0 | |

## Road Maintenance Costs Calculation

| Average cost to maintain CAP roads (MFmg/km) | Annual length of road to maintain (km) | Total annual maintenance costs (MFmg/yr) | Mgmt unit area (ha) | Annual maintenance per unit area (MFmg/ha) |
|---|---|---|---|---|
| 12000 | 17 | 204000 | 18 | 11333.33 |

Appendix 3d – SAMPLE estimate of total investment costs from the spreadsheet model.

***ECONOMIC ANALYSIS FOR PLANTATION MANAGEMENT***
***USAID/USDA-FS Forest Management Team Mission***
***Fianaratsoa, Madagascar: 1 - 21 July 2001***

***Location = Fianaratsoa***
***Mgmt unit = Mature stand***
***Product = Bois d'oeuvre***
***Species = Pine***

# TOTAL INVESTMENT COSTS

**Pine Plantations in Haute Matsiatra**

***Mechanical Option***

| Mgmt Unit Area (ha) | Chain saw purchase costs (MFmg) | Tractor purchase costs (MFmg) | Portable sawmill costs (MFmg) | Handsaw costs (MFmg) | Second-hand Purchase Hauling truck+trailer costs (MFmg) | Discounted variable costs (MFmg/m3) | Total discounted variable costs (MFmg) | TOTAL START-UP COSTS (MFmg) | TOTAL START-UP + ROTATION INVESTMENT COSTS (MFmg) | | TOTAL START-UP COSTS (MFmg/ha) | TOTAL START-UP + ROTATION INVESTMENT COSTS (MFmg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 3100 | 186000 | 341000 | 6200 | 258000 | 1.47 | 49919.19 | 794300.00 | 844219.19 | | 44127.78 | 46901.07 |
| 6.2 | 500 | 30000 | 55000 | 1000 | | | | | | USD | 7117.38 | 7564.69 |

MFmg/USD