Ex Post Evaluation Report

Brazilian Amazon Forest Research Project
Phase II

Japan International Cooperation Agency
JICA Brazil

January 2007

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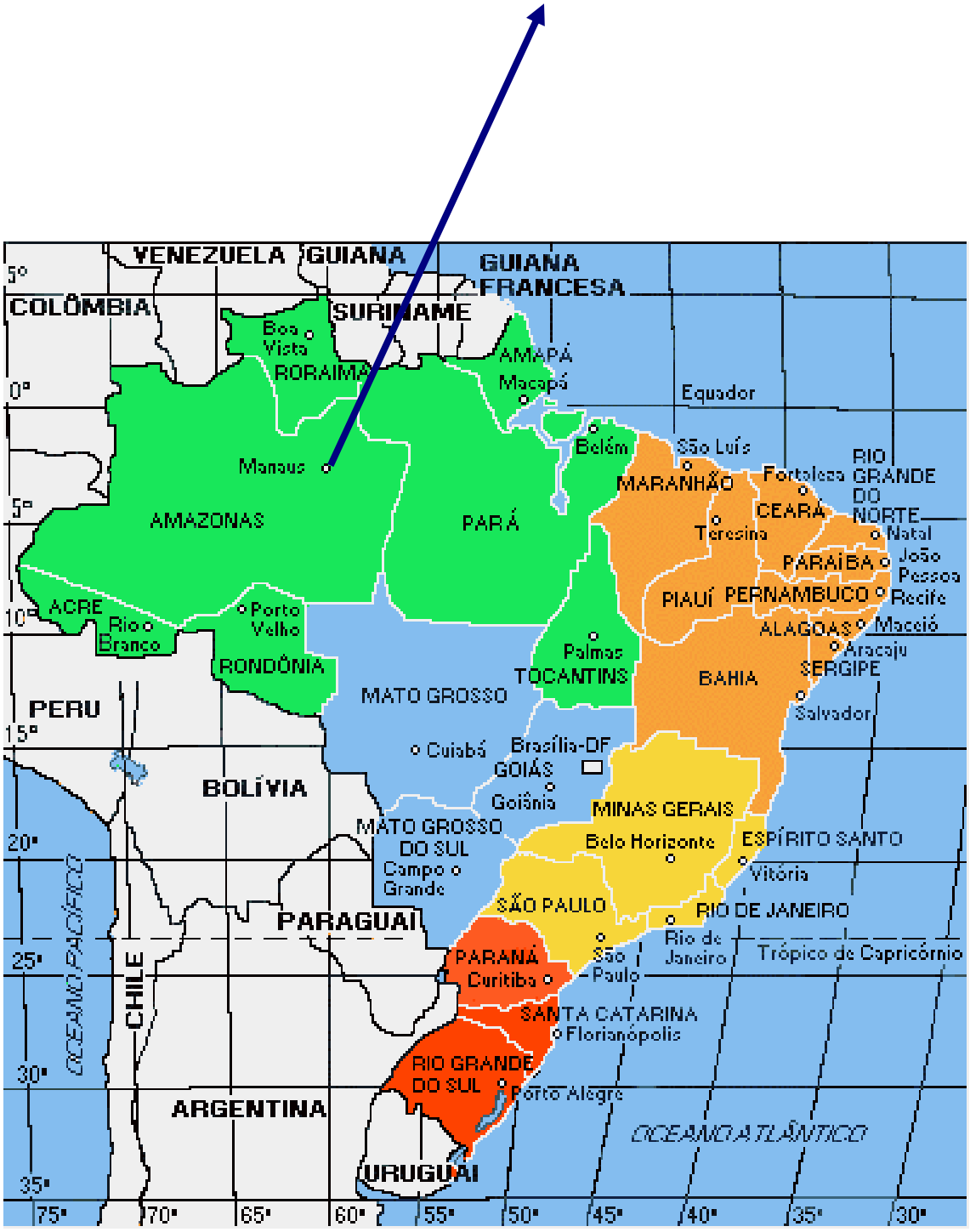
The Brazilian Amazon Forest Research Project Phase II



PHOTOS

Degraded land
formerly used as pasture

Rehabilitated land
(experimental plot)

Laboratory equipment
donated by JICA

Seed bed

Experimental plot

Abbreviations

CDM – Clean Development Mechanism

COIAB – Confederação de Organizações Indígenas da Amazônia Brasileira (Confederation of Indigenous Organizations of the Brazilian Amazon)

CPST – Coordenação de Pesquisas em Silvicultura Tropical (Department of Research on Tropical Silviculture)

DAC – Development Assistance Committee

GISLAB – Remote Sensing Laboratory

IBAMA – Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute of the Environment and Renewable Natural Resources)

INPA – Instituto Nacional de Pesquisas da Amazônia (National Institute of Amazon Research)

INPE – Instituto Nacional de Pesquisas Espaciais (National Institute of Space Research)

JICA – Japan International Cooperation Agency

MCT – Ministério da Ciência e Tecnologia (Ministry of Science and Technology)

ONF – Office National des Forêts (National Forestry Office)

PDM – Project Design Matrix

PMFS – Plano de Manejo Florestal Sustentável (Sustainable Forest Management Plan)

SEPCT – Secretaria de Políticas e Programas de Ciência e Tecnologia (Secretariat of Science and Technology Policies and Programs)

SIGLAB – Remote Sensing Laboratory

UC – Unidade de Conservação (Conservation Unit)

UNFCCO – United Nations Framework Convention for Climate Change

Summary

Evaluation conducted by: JICA Brazil Office

<table>
<tr><td colspan="3">1. Outline of the Project</td></tr>
<tr><td colspan="2">Country：Brazil</td><td>Project title：The Brazilian Amazon Forest Research Project Phase II</td></tr>
<tr><td colspan="2">Issue/Sector：Environment Forestry and Natural</td><td>Cooperation scheme：Technical Cooperation</td></tr>
<tr><td colspan="2">Division in charge：Forest and Natural Environment Department</td><td>Total cost：357 millions yen</td></tr>
<tr><td rowspan="2">Period of Cooperation</td><td>1 October 1998

30 September 2003</td><td>Partner Country’s Implementing Organization：National Institute of Amazon Research (INPA)

Supporting Organization in Japan：Forestry and Forest Products Research Institute (FFPRI), Tsukuba</td></tr>
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1-1. Background of the Project

The Brazilian government requested a project with the aim of consolidating a model of management for preservation and use of the tropical rainforest in the Amazon region. The Japanese government responded by approving a project to institutionally strengthen the National Institute for Amazon Research (INPA), in Manaus, and conduct research. The Amazon Forest Research Project (the Jacaranda Project), Phase I, was executed between 1 June 1995 and 31 May 1998, with a follow-up lasting from 1 June to 30 September 1998. The Phase II project began immediately afterwards. In September 1999, it was included as an associate project of the Pilot Program for the Protection of the Brazilian Tropical Rain Forests (PPG-7).

1-2. Project Overview

The project had five components: patterns of distribution of forest types (remote sensing), dynamics of the natural forest, site characteristics, seed ecophysiology and site adaptability. The Super Goal was "The Amazonian forest resources are used on a sustainable basis."

（1）Overall Goal

Effective technologies for forest conservation and rehabilitation of degraded area in the Amazon are in use by the people/organizations concerned.

（2）Project Purpose

Biological and ecological knowledge is increased and technologies are improved at INPA for forest conservation and the rehabilitation of degraded areas in the Amazon.

（3）Outputs

a) Updated information on land cover and land cover change is available.
b) The understanding of natural forest dynamics is increased.
c) Characterization of different sites in the natural forest and in plantations on degraded areas is improved.
d) Main seed characteristics necessary for seed management are known regarding important species for forest conservation and reforestation of degraded areas.
e) Planting techniques including seedling production is improved for rehabilitation of degraded areas in the Amazon.

（4）Inputs (as of the Project's termination)

Japanese side：

Long-term Expert	**10**	**Equipment**	**128 million Yen**
Short-term Expert	**19**	**Local cost**	**59 million Yen**
Trainees received	**16**	**Others**	**Yen**

Brazil's Side：

Counterpart	**30**
Equipment	**local currency (____Yen)**
Land and Facilities	**local currency (____Yen)**
Local Cost	**635,000 reais (27 million Yen)**
Others	**local currency (____Yen)**

2. Evaluation Team

Members of Evaluation Team	JICA Brazil Office Commissioned to: Mr. Robert K. Walker – National Consultant	
Period of Evaluation	**Day/ month/ Year - Day/ month/ Year** 14/07/2006 – 31/01/2007	**Type of Evaluation：Ex-post**

3. Results of Evaluation

3-1. Summary of Evaluation Results

(1) Impact

The project purpose, "Biological and ecological knowledge is increased and technologies are improved at INPA for forest conservation and the rehabilitation of degraded areas in the Amazon," has been achieved (effectiveness). However, the overall goal proved too ambitious for a research institution such as INPA, which lacks the institutional mission and capacity to ensure that "education of and the transfer of skills to local residents for sustainable development of forest resources are carried out in a broad area of the Brazilian Amazon" or "Tree planting activities are undertaken systematically in a considerable space of the Brazilian Amazon" (two of the indicators). Consequently, the super goal, "The Amazonian forest resources are used on a sustainable basis," continues to be far out of reach. INPA researchers have questioned the government's recent claim to have reduced deforestation rates.

(2) Sustainability

INPA continues financially and institutionally sound, although recent budget cuts may threaten its sustainability in the coming years; erstwhile project researchers and their advisees at its Department of Research on Tropical Silviculture (CPST) and the Remote Sensing Laboratory (SIGLAB) continue pursuing lines of research characteristic of the Jacaranda project, with minor adaptations to meet the requirements of the new projects (basically the only source of research funding).

3-2. Factors that have promoted project

(1) Impact

Experiments in a ranching area near INPA headquarters have produced important findings regarding forest replanting techniques and species selection. Private enterprise has supported a few reforestation projects, with some involvement of CPST researchers and students in investigation and extension work, producing small but theoretically significant impacts in terms of rehabilitation of degraded areas. Research by CPST and other INPA researchers has shown and publicized the relevance of forest conservation to carbon balance and its consequences for the global and Brazilian climate; this has contributed to policy proposals which, if adopted, may help prevent global warming and avoid other threats. However, the main factors restricting to some degree the rampant deforestation process (mostly along the "Arc of Deforestation" in the southern and southeastern Amazon region) have been the high Brazilian interest rates and consequent overvaluation of the national currency vis-à-vis the stronger currencies. Through the establishment of forest conservation units, mostly in the other parts of the Amazon, some protection is provided. CPST researchers have begun to show some promising results, such as the environmental and economic feasibility of planting tree species such as balsa wood, rosewood and kopie.

(2) Sustainability

Adequate funding for institutional maintenance, student fellowships and thesis advising, as well as some training of elementary and secondary students, has been forthcoming; and research continues to be supported in areas related to the project objectives (e.g., the current CT Petro Amazônia project, coordinated by INPA, which supports research on reforestation of clearings). Equipment donated by JICA has been maintained and put to good use; items that obsolesce more rapidly have been replaced. Organized post-project initiatives have included the training of Amerindians (owners of 20% of the Amazon forest) in remote sensing and the incorporation of maps based on local knowledge, as well as the publication of attractive explanatory brochures about seeds and on traditional extraction of the Guiana crabwood (Carapa procera D.C. and Carapa guianensis Aubl).

3-3 Factors that have inhibited project

(1) Impact

Except for the experiments mentioned above, no other attempts at reforestation of *pasture lands*, which are responsible for 75% of the deforestation of the Amazon, have been directly supported by INPA. Reforested lands still occupy only a tiny fraction of the Amazon, virtually undetectable by remote sensing. Furthermore, a widely cited INPA researcher has shown the limited potential of secondary forests (as opposed to primary forests) on former pasture land as a carbon sink. The contributions of the Amazon forest are seriously undervalued relative to slash and burn cattle ranching and soybean production, which are major sources of hard currency for Brazil. Failure to include the tropical forests in the Clean Development Mechanism, at least until after 2012, and the fact that few if any economically viable alternatives have been made available, have resulted in continued rampant deforestation and very little reforestation.

(2) Sustainability

One significant problem for project continuity seems to be a lack of institutional funding for support staff, e.g., hired hands and low level technical personnel to maintain the experimental plots. Re. the publications on seeds and extracts, distribution has been restricted by the limited number printed (1000 each). INPA researchers misunderstood JICA's restrictions on the sale of publications; in fact, non-profit sale is not prohibited.

3-4. Conclusions

The Jacaranda Project has proven to be sustainable in terms of the project purpose, which is the production and dissemination of relevant knowledge. Extension work and actual large scale restoration and conservation of the Amazon forest are incipient and very difficult to accomplish. Attempts by erstwhile project researchers and other INPA scholars to influence public policy locally, at the state and federal levels and globally have been significant, but have yet to bear fruit. Project relevance and impact have been limited by theory failure: unrealistic assumptions (e.g., "The Brazilian government implements a unified and effective policy on Amazon land use": the main problem here lies in enforcement) and failure to explicitly include economic considerations in the project document, as well as the largely untested hypothesis that restoration of degraded forest lands can be a major factor in environmental protection, relieving the pressure on the primary forest.

3-5. Recommendations

Close attention should be given to the adoption and enforcement of appropriate global and national policy on the tropical forests. In international forums, the Brazilian and Japanese governments should support immediate adoption of some form of carbon credits for forest recuperation and preservation. National and multinational corporations should be encouraged to support and publicize the reforestation of degraded areas in the Amazon and other tropical forests. Support for translation and widespread dissemination of INPA/Siglab maps and information from remote sensing, which are now being made available in Portuguese via Google, should be provided. The Brazilian government should guarantee continual basic support for research and site maintenance at INPA and its Department of Research on Tropical Silviculture (CPST), and consider adoption of networking arrangements in support of extension work.

3-6 Lessons Learned

Recovery of degraded tropical forests can only have a substantial impact on global warming and related matters if it is implemented through comprehensive policy initiatives. At that point, the kind of research published during and after the Jacaranda Project will be of great relevance. Whether or not this happens, the world urgently needs to put a stop to the destruction of tropical forests, of which the Brazilian Amazon is the prime example. Economic considerations must be taken into account from the outset. Although the weakest of the five components during project execution (1998-2003), remote sensing (Component 1), which got underway during Phase I of the Jacaranda Project, now provides very timely information, of relevance to local communities (as shown by the work with the Amerindians) as well as to the nation and the planet itself.

3-7 Follow-up Situation

Consult former project researchers regarding preparation of materials to be used in any future extension projects related to the Amazon forest.

１． 案件の概要

国名：ブラジル		案件名：アマゾン森林研究計画フェーズ２
分野：環境問題		協力形態：プロジェクト方式技術協力 （現：技術協力プロジェクト）
所轄部署：自然環境協力部森林環境協力課（地球環境部）		協力金額：３．５７億円
協力期間	ﾌｪｰｽﾞ **2: 98** 年 **10** 月 **03** 年 **9** 月 **F／U: 98** 年 **6** 月 **98** 年 **9** 月 ﾌｪｰｽﾞ **1: 95** 年 **6** 月 **98** 年 **5** 月	先方関係機関：国立アマゾン研究所
		日本側協力機関： 森林総合研究所、農林水産省、林野庁
他の関連協力：		

協力の背景と概要

ブラジル連邦共和国（以下、「ブラジル」と記す）のアマゾン地域は、世界でも有数の森林資源の宝庫である。しかし 1960 年代から急速に森林破壊が進み、1988 年までに森林面積の 1 割以上が失われた。

そのような状況に対して、ブラジル政府は自然環境プログラム「我々の自然」制定（1988 年）、ブラジル環境再生天然資源院（IBAMA）創設など、アマゾン地域の森林資源開発の規制にのりだした。その結果、森林破壊速度は一時的に減少したが、残された荒廃地の回復と持続可能な森林資源開発の規制にのりだした。その結果、森林破壊速度は一時的に減少したが、残された荒廃地の回復と持続可能な森林管理モデルの確立を目的とした技術協力を要請した。これに対して我が国は 1995 年 6 月から 3 年間の計画で技術協力（フェーズ1、1995 年 6 月 1 日―1998 年 5 月 31 日）、さらに引き続き 4 ヶ月間のフォローアップ協力（1998 年 6 月 1 日―9 月 30 日）を実施した。

これらの協力の結果、本格的な研究基盤が整った。しかし、実際のアマゾン地域の森林荒廃地回復と持続可能な森林管理技術の確立は遅れている。このためブラジル政府はフェーズ1の成果に基づき、荒廃地回復を目的とした技術協力（フェーズ2）を要請した。1998 年 8 月に JICA ブラジル事務所所長と科学技術省(MCT)との間で討議議事録(R/D)及び暫定実施計画(TSI)の署名交換を行い、同年 10 月から 5 年間のフェーズ 2 の協力を開始した。なお、本プロジェクトは 1999 年 9 月にブラジル熱帯雨林保全パイロットプログラム(PPG7)の一つの二国間プロジェクトとして位置づけられている。

１－２ 協力内容

本プロジェクトは、森林型の分布様式（リモートセンシング）、天然林の動態、立地特性、種子の生理生態、立地適応性の計5つの研究分野から成っており、」「アマゾン地域の森林資源が持続可能な形で活用される」ことをスーパーゴールとしている。

（1）上位目標

アマゾン地域における森林保全と荒廃地回復のために効果的な技術が関係者により活用される。

（2）プロジェクト目標

国立アマゾン研究所（INPA）において、アマゾン地域の森林保全と荒廃地回復を目的として、生物学的及び生態学的な知識が深められ、技術が改良される。

（3）アウトプット（成果）

1）森林の分布特性及び劣化様式に関する最新の技術の情報が得られる。
2）天然林の動態に関する理解が進む。
3）天然林及び荒廃地の立地特性がより解明される。
4）森林保全と荒廃地の回復に重要な樹種に関して、種子管理上必要な主な種子特性が解明される。
5）アマゾンの荒廃地回復を目的として、異なる環境条件に対する苗木の生育特性が明らかになる。

（4）投入（プロジェクト終了時）

日本側：

長期専門家派遣	10名	機材供与	１．２８億円
短期専門家派遣	19名	ローカルコスト負担	０．５９億円
研修員受入	11名	その他	億円

相手国側：

カウンターパート配置	30名	機材購入	
現地通貨		土地・施設提供	
ローカルコスト負担	０.２７億円		
その他			

２．評価調査団の概要

調査者	ＪＩＣＡブラジル事務所 Robert K. Walker（ブラジリア大学教授・ローカル評価コンサルタント）	
調査期間	2006年7月14日～2007年1月31日	評価種類：事後評価

3.評価結果の概要

3-1　評価結果の要約

（1）インパクト

プロジェクト目標である「国立アマゾン研究所（ＩＮＰＡ）において、アマゾン地域の森林保全と回復のために効果的な技術が関係者により活用される。」は達成された。しかしながら、ＩＮＰＡのような研究機関にとって組織のミッション及び本来持つ能力の違いから、「アマゾンの広範な地域で森林資源の持続的開発に関する教育および啓蒙普及活動が実施されている」及び「ブラジル・アマゾンの広範な地域で植林活動が体系的に実施される。」という上位目標指標のうちの２つを確実に満たすことは非常に挑戦的であった。結果として、スーパーゴールである「アマゾン地域の森林資源が、持続可能な形で活用される。」が達成される見込みは高くないと言えよう。なお、ＩＮＰＡの研究者は「森林破壊率が減少した。」という最近の政府の発表に対し疑問を持っていた。

（2）自立発展性

INPA は、近年の予算削減により次年度の持続性は危ういものの、元プロジェクトの熱帯林研究所（CPST）及びリモートセンシング研究室（SIGLAB）の研究者や指導学生はプロジェクト成果の研究を現プロジェクトの要件に合致する為に修正を加え、財政的・組織的に確保し、活動を継続している。

3-2　プロジェクトの促進要因

（1）インパクト発現を促進した要因

ＩＮＰＡ本部付近の農場での実験では植林技術及び樹種選定に関する重要な発見があった。民間企業がＣＰＳＴの研究者及び学生と連携し、いくつかの植林プロジェクトの研究及び普及活動を支援し、荒廃地の回復の観点から小規模ながら理論的に重要なインパクトをもたらした。ＣＰＳＴ及びＩＮＰＡの研究者による研究で、森林保全と炭素収支の関係、そしてそれによる地球規模及びブラジルの気候への影響が公表されたことである。その研究結果は、もし採択されれば地球規模の温暖化を防ぎ、その他多くの危機を回避することが可能となる政策提言の作成に大きく貢献した。しかしながら、激しい森林破壊の進展（南部及び南東部アマゾン地域における森林破壊曲線と大きく関係している）を制限している大きな要因としては　ブラジルの高い金利と現地通貨（レアル）の価値高騰が挙げられる。また、森林保護区の設置も（大部分はその他アマゾン地域に設置されているが）熱帯林の保護に貢献している。

なお、CPST の研究者はバルサ、紫檀、Kopie などの植樹が、環境的及び経済的実施可能性が見込まれるという確実な研究成果を出し始めている。

（2）自立発展性強化を促進した要因

組織維持及び学生への研究奨学金及び論文指導に対する予算確保が適切に確保されている。またプロジェクト目標に関連した研究（ＩＮＰＡが実施している林間の再植生研究に関するCT Petro Amazônia projectなど）に対する支援が継続的に確保されている。

また、供与機材が適正に管理・使用されていること（使用用可能期限の短い機材については、すでに交換されている）、更にはプロジェクト終了後、継続的に展開されている活動の中に、アマゾン森林の２０％を所有する先住民（Amerindians）に対するローカル知識に基づいた地図利用及びリモートセンシング分野のトレーニングがあることが、種子やギアナクラブウッドの伝統的樹液抽出方法等についての説明パンフレット作成等と並べて挙げられる。

３-３　プロジェクトの阻害要因

（１）インパクト発現を阻害した要因

上述の試みを除き、アマゾン地域の森林破壊の７０％を占める牧草地での再植の試みに対し、ＩＮＰＡから直接的な支援がなされなかった。再生林地はアマゾン地域のごく僅かな割合を占めるのみで、リモートセンシングにより視覚的に確認することは不可能である。更に、広範囲に配置されたＩＮＰＡ研究者によると、旧牧草地に造成された二次林では炭素吸収溝としての機能が不十分であることが分かってきた。

また、アマゾン森林の存在価値は、焼畑農牧や大豆生産と比較して深刻なほど過小評価されており、それがブラジルの厳しい現状であり、大きな原因となっている。

少なくとも 2012 年までのＣＤＭ取り組みの中に熱帯林を加えることができなかったことと、経済的により良い選択がほとんどできなかったために、森林破壊が継続され森林再生の取り組みはあまりなされなかった。

（２）自立発展性強化を阻害した要因

プロジェクトの継続性上で重要な問題の１つは、試験区画を維持するための補助員（助手・実験補助員など）を確保する予算が組織として不足していることである。種子及び樹液に関する説明パンフレットの印刷・配布が各 1,000 部と限られていた。（ＩＮＰＡスタッフがＪＩＣＡはパンフレット販売を禁止していると理解したためであったが、実際には非営利目的の販売であれば問題ない）

３-４　結論

本プロジェクトは技術開発及び関連知識の広報活動の面では自立発展性はあると確認された。しかし、普及活動及びアマゾン森林の大規模な回復及び保全は初期段階であり達成は非常に困難である。元プロジェクト研究者及び他のＩＮＰＡ学者による州・連邦レベル及び世界規模の公共政策に影響を与えようとした試みは、まだ成果を得られてはいないが非常に重要である。

荒廃地の回復は環境保護の主要素となりえ一次林への圧力を減少するという未実証の仮説と同様に、非現実的な想定（ブラジル政府がアマゾンの土地利用に関し統一的かつ効果的な政策を施行することなど）や実施計画の経済的視点による考察などの点で明解さに欠けており、プロジェクトの妥当性及びインパクトは理論的に制限があった。

３-５　提言（当該プロジェクトに関する具体的な措置、提案、助言）

熱帯林に関する地球規模や国家レベル政策への適切な適用と強制に関しては今後も注視していくべきである。ブラジル及び日本政府は、国際フォーラムにおいて森林修復及び保全のためのカーボンクレジットの適用がすぐになされるよう支援すべきである。国内及び国際協力においては、アマゾン及び他の熱帯林地域における荒廃地回復を積極的に支援・公開すべきである（国内及び国際的な民間企業にアマゾン地域及び他の熱帯林地域における荒廃地の回復に係る投入を積極的に促進すべきである。）

リモートセンシング技術により作成された INPA／Siglab 地図及び情報（現在ではポルトガル語版 Google にて利用可能）の翻訳及び普及にかかる支援がなされるべきである。ブラジル政府はＣＰＳＴ及びＩＮＰＡの研究及びサイト維持に必要な基本的なサポート継続の確約と、普及にかかるネットワーク形成支援に必要な調整実施を検討すべきである。

３-６　教訓

荒廃した熱帯林の回復は、総合的な政策イニシアチブにより実施された時に初めて地球温暖化および関連する事象に対し本質的なインパクトを与えることが可能である。その点において、本プロジェクトの実施中から実施後にかけて発表されている研究は、非常に高い妥当性を持つであろう。いずれにしても、国際社会はブラジル・アマゾン地域のような熱帯林の破壊を緊急に中止する必要がある。経済的な考察もまず初めに着手されるべきである。リモートセンシングは、プロジェクトの 5 つ分野のうち本プロジェクトのフェーズで最も弱かった分野であったが、ローカルコミュニティ、国家、地球規模の要望に非常にタイムリーに情報を提供するようになった。

３－７　フォローアップ状況

現時点では実施予定なし。今後、何らかのフォローアップが計画される場合には、特に普及に際し使用する資料について、これまでのプロジェクト関係者と事前に十分な協議を持つべきである。

Brazilian Amazon Forest Research Project – Phase II

1. INTRODUCTION

1.1 Project Background

The Brazilian government, with the aim of consolidating a model of management of preservation and sustainable use of the tropical rainforest in the Amazon region, requested a technical cooperation project of the Japanese government. Responding affirmatively to this request, the Japanese government initiated a three year technical cooperation project aiming to promote the institutional strengthening of the National Institute of Amazon Research (INPA) and the conducting of experiments. The Amazon Forest Research Project, Phase I, was executed between 1 June 1995 and 31 May 1998 and, subsequently, for a four month follow-up period, from 1 June to 30 September 1998. Phase II of the project, of five years duration, began immediately afterwards. In September 1999, it was included as an associate project of the Pilot Program to Conserve the Brazilian Rainforest, the PPG-7. The support organization in Japan was the Forest and Forest Products Research Institute (FFPRI), in Tsukuba.

1.2 Project Synopsis

Phase II of the project involved the formation of demonstration forest plantations in old areas degraded by cattle ranching and agriculture. Such reforestation is done with the aim of demonstrating to private initiative the advantages of this activity. Such areas were also to be used for applied research designed for evaluating the adaptability and growth of such plantations and the stages of recuperation of these areas. Phase II of the project had five components: distribution patterns of forest types (remote sensing), natural forest dynamics, site characteristics, seed ecophysiology and site adaptability.

The June 2003 project design matrix, version *e* (PDMe) presents the following:

1.2.1 **Super Goal:** The Amazonian forest resources are used on a sustainable basis.

1.2.2 **Overall Goal of the Project:** Effective technologies for forest conservation and rehabilitation of degraded areas in the Amazon are in use by the people and organizations concerned.

1.2.3 **Project Purpose:** Biological and ecological knowledge is increased and technologies are improved at INPA for forest conservation and the rehabilitation of degraded areas in the Amazon.

1.2.4 Outputs:

1. Updated information on land cover and land cover change is available.
2. The understanding of the natural forest dynamics is increased.
3. Characterization of different sites in the natural forest and in plantations on degraded areas is improved.
4. The main seed characteristics necessary for seed management are known, regarding important species for forest conservation and reforestation of degraded areas.
5. Planting techniques, including seedling production, are improved for rehabilitation of degraded areas in the Amazon.

1.2.5 Inputs:

The Japanese side sent ten long-term and nineteen short-term experts and received eleven counterparts for training in Japan. The Brazilian side assigned thirty counterparts, from professional researchers to students, as well as land for the experimental plots and sites and the project office and related facilities, for a total local cost of R$ 635,000.00 (US$212,000.00).

1.3 Objective of the Evaluation

The aim of this post-project evaluation is to improve the planning and management of the continuing activities aimed at accomplishing the project objectives, as well as to increase the effectiveness of any similar projects in the future. The results are to be shared with the counterpart institution and related public and private organizations.

1.4 Scope of Work

The scope of the project and the evaluation encompasses all the three "worlds" proposed by philosopher of science Karl Popper (1972): world 1 (the physical world), world 2 (the world of our conscious experience) and world 3 (the world of the logical content of books, libraries, computer memories, etc.). In the case in point, world 1 encompasses the ecosystem; world 2 includes, among other things, the development of capacity at the National Institute of Amazon Research (INPA) and its network of influence (INPA+); and world 3 refers to the production of relevant knowledge by INPA researchers – mainly at the Department of Research in Tropical Silviculture (CPST) and the Remote Sensing Laboratory (SIGLAB, or GISLAB, as it was called at the time), which hosted the project.

The report takes into account the five criteria of the Development Assistance Committee (DAC), shown in italics below. However, in accordance with the terms of reference for ex post evaluations, it focuses on the criteria of *impact* and *sustainability*. Here, "impact" refers mainly to world 1, while "sustainability" refers to the continuation and broadening of the results of the project.

The evaluation proposes to test three hypotheses:

1. The inputs made it possible to strengthen INPA+ (*effectiveness*) and to promote the continuation of its efforts (*sustainability*).
2. INPA researchers produced *relevant* knowledge, with *efficiency.*
3. This knowledge was disseminated and has had *impacts* for environmental preservation and, mainly, recuperation.

Results include outputs and impacts (both mainly in world 1), as well as outcomes (mainly in worlds 2 and 3). Exemplifying outcomes, the logical contents of a scientific study exist in the researcher's head (world 2) and may find expression in the form of an article, book or chapter, conference proceedings, etc. (world 3). Obviously, the medium of reproduction (paper, CD ROM, cyberspace, etc.) exists in world 1; a journal's circulation or the number of copies of a reprint, book or CD ROM, or the number of hits to an internet homepage, quantify the output.

Ex post evaluations generally focus on sustainability and impact. However, the other criteria should also be taken into account. If the project was not *effective* (i.e. did not meet its institutional strengthening objective), it is less likely that the institution will be sustainable. Furthermore, the funding organization presumably would like it to be sustainable *in pursuit of valid project objectives*. If it does well financially and academically but its researchers no longer investigate questions related to the project objectives, its sustainability would probably not be considered *relevant* to the concerns of the project's funding organization. It may be that some relevant research is still conducted, but publications are few in number, or the existing facilities are no longer adequate to this purpose; this might reflect *inefficiency*.

1.5 Evaluator

JICA Brazil Office. The report was drafted by Robert K. Walker, as commissioned consultant.

1.6 Period of Study

The study was conducted between 14 July 2006 and 31 January 2007.

2. EVALUATION APPROACH

2.1 Procedures

The evaluation was conducted through interviews with INPA researchers and document review, including review of remote sensing data furnished by SIGLAB. Researchers' curricula vitae were accessed on the homepage of the Curriculum Lattes, of the National Council on Scientific and Technological Development. The draft of the summary sheet and a PowerPoint presentation were presented to JICA-Brazil on 27 December 2006, for discussion. A draft of the evaluation report in Portuguese was forwarded to the Brazilian government and to an expert in the area for comments.

2.2 Program Design Matrix (PDM version e) – see Annex 1

3. PROJECT RELEVANCE

What was the relevance of the Amazon Forest Research Project for the Brazilian government? In her presentation of the book, *Projeto Jacaranda Fase II: pesquisas florestais na Amazônia Central* (Jacaranda Project Phase II: forestry research in the Central Amazon), the General Coordinator of Programs in the Brazilian Amazon at the Secretariat of Science and Technology Policies and Programs (SEPCT/MCT) stated that "Particularly with regard to the Brazilian Amazon Forest Research Project, Projeto Jacaranda, the great mission of the Brazilian researchers, in partnership with Japanese specialists, has been the development of new techniques to permit the recuperation of degraded areas (Canto, 2003, p. vii)." In fact, the Brazil-Japan Seminar, culmination of phase II, was entitled "Silvicultural and ecological studies for recuperation of degraded areas in the Brazilian Amazon." Thus it is clear that of the three questions prioritized by the then Coordinator for Technical Cooperation of Japan in Brazil (Matsutani, 2003, p. ix) – environmental protection, sustainable forest management and recuperation of degraded areas, it is the latter that received the greatest attention in practice. Furthermore, the title of the book mentioned above reveals the project focus on the *Central Amazon*.

The project super goal, in its phase II, was "The Amazonian forest resources are used on a sustainable basis." The respective verifiable indicators reflect the priority attributed to the conservation and preservation of the forest; there is no mention of recuperation of degraded areas. It is only in the overall goal of the project (the second level of the PDM) that recuperation of degraded areas is mentioned, together with conservation of the forest. Nevertheless, already in their introduction to the concluding volume of the first phase of the project (Ferraz and Suzuki, 1998, p. 17-25), the national project coordinator and his Japanese counterpart had affirmed that "The super goal of Project Jacaranda is to rehabilitate areas abandoned to different uses of the land of the Amazon, employing forestry practices appropriate to the region." On page 21, this same language is used to summarize the overall goal.

Apparently, the theory in use was that through recuperation of degraded areas of the Amazon forest, it would be possible to see to it that the resources of the forest are used in a sustainable manner. It is estimated (Houghton, 1994) that deforestation accounts for 25% of global carbon emissions (two out of eight pentagrams per year). Thus, if three quarters of the emissions due to deforestation were eliminated through reforestation, total carbon emissions would be reduced by 20%, even without reduced emissions from burning fossil fuels. Possibly, at that point, the forests would resume their traditional role as a carbon sink, thus acting as a factor in global cooling instead of global warming.

4. RESULTS

In general, it may be said that the project purpose, "Biological and ecological knowledge is increased and technologies are improved at INPA for forest conservation and the rehabilitation of degraded areas in the Amazon," was accomplished (*effectiveness*), principally at the Department of Research on Tropical Silviculture (CPST), which hosted the project, and the Remote Sensing Laboratory (SIGLAB). However, the super goal and the overall goal proved too ambitious for a research institute like INPA, which lacks the institutional mission and the capability to guarantee that "education of and the transfer of skills to local residents for sustainable development of forest resources are carried out in a broad area of the Brazilian Amazon" or "Tree planting activities are undertaken systematically in a considerable space of the Brazilian Amazon" (two of the verifiable indicators of the overall goal). Thus, the super goal, "The Amazonian forest resources are used on a sustainable basis," continues far from accomplishment, not only by INPA but by all mankind.

The hypotheses to be tested may be divided into the third one, related to the intended impact (mainly in world 1) and the other two (the means to accomplish the intended impact). Let us first consider hypotheses 1 and 2, which are broadly related to the sustainability of project initiatives.

4.1 Sustainability of the Project

Here the first two hypotheses apply:

1. The inputs made it possible to strengthen INPA+ (*effectiveness*) and to promote the continuation of its efforts (*sustainability*).
2. INPA researchers produced *relevant* knowledge, with *efficiency.*

Version *e* of the PDM specifies, as the only verifiable indicator of the project purpose, "By September 2003, all submitted research outputs are compiled into an integrated form, as the final report." The Minutes of the Joint Evaluation, signed 17 June 2003, specifies that "In accordance with the plan shared by the members of the project team the series of CD's (compact disks) will be created as the final product of the project, including items such as the final report, the outputs, the internal reports, memoranda, database, etc."

The anticipated final report was never prepared in the form specified. In July 2003, one thousand copies of the concluding volume, *Projeto Jacaranda Fase II: pesquisas florestais na Amazônia Central*, were published, with 17 chapters (papers), which "present part of the knowledge… generated during phase II, including details of the different methodologies adopted by the research components (p. xii)." There is very little overlapping of these papers with the output matrix included in the Minutes of the Joint Evaluation (Yamaguchi and Gomes, 2003), an extensive list in the categories of scientific papers, doctoral or masters theses, books, oral poster presentations, and others (including databases, manuals, etc.). In addition to the book, the evaluator was given copies of seven articles by project researchers published between 1998 and 2003 (of which six are in English), as well as six published between 2004 and 2006 (of which three are in English).

The numbers of scientific works published in the post-project period by counterparts are presented below, in Table 1. Obs.: double counting is not excluded, because more than one of the researchers may have signed the same work.

Table 1
Scientific Production by Counterparts in the Post-Project Period, 2004-2006

Compo-nent	Researcher	Journal Articles	Books	Book Chapters	Journal or Magazine Articles	Proceedings (Complete Papers)
1	A. D. Nobre	11	0	0	1	0
	A. Carneiro Filho	2	0	3	0	2
2	N. Higuchi	20	1	11	1	1
	J. dos Santos	5	0	4	0	5
	G. Vieira	5	0	0	0	1
3	J. B. S. Ferraz	2	0	2	0	1
4	I. Ferraz	6	3	1	0	2
	P. Sampaio	5	0	0	0	0
	J. F. C. Gonçalves	9	1	1	3	2
	M. Ramos	10	0	0	0	2
5	A. P. Barbosa	3	0	1	0	7
	R. Marenco	5	1	0	0	0
	M. Campos	1	0	0	0	0
	A. Mocambite	2	0	0	0	0
	T. Neves	1	0	0	0	0
Total		**87**	**6**	**23**	**5**	**23**

Source: Compiled from National Council on Scientific and Technological Development (CNPq), website www.lattes.cnpq.br .

Six articles from the post-project period considered particularly relevant and, therefore, handed to the evaluator, were examined. They represent the research areas of project components 2, 3 and 4. Of these papers, five involve research along the same lines as the respective component of the project; one, an article by Niro Higuchi (2006), presents research results of general interest in the popular science magazine of the Brazilian Society for the Progress of Science (SBPC). As for component 5 (Site Adaptability), a list of publications was given to the evaluator, including four articles published in journals after project conclusion.

During the project, component 1 (patterns of distribution of forest types – remote sensing) presented only three products at the intermediate project workshop, as well as one pamphlet and two papers for the Brazil-Japan Seminar held 15-17 July 2003 (see abstracts in Jacaranda Project-Phase II, 2003). In contrast, component 5 (site adaptability) published 102 products, as well as six presentations at the seminar. Components 2, 3 and 4 had 34, 14 and 58 products, respectively, and two, three and two seminar presentations. In addition to the presentations by project counterparts at the seminar, there were two invited researchers.

There are currently twelve researchers at the CPST. It cannot be said that the number of CPST researchers working in the areas of the Amazon Forest Research Project has increased, in spite of the moderate growth of INPA and of related areas in the universities of the region – to which the graduate internships at INPA have greatly contributed. There are currently twelve researchers at CPST, according to department head Paulo Sampaio. There is still a shortage of forestry engineers in the Amazon – much greater numbers of which will be required if, in the future, there is a serious effort to manage and recover forests. In the past three years, INPA has trained 23 students per year in forestry engineering, in collaboration with other institutions of

higher education. The research conducted during and after the project is broadening the scientific base for courses of study in forestry engineering and related areas.
Recently three high school students won the 47th "Scientists of Tomorrow" competition promoted by the SBPC and UNESCO. The prize was a trip to Paris to present the paper. For eight months, the young scientists were advised by Niro Higuchi, Joaquim dos Santos and others, as a part of the INPA program, "A Look to the Future." The topic of the paper is "The role of mahogany in the process exchange of gases between the biosphere and the atmosphere." The LICOR equipment for gas analysis, donated by Japan and evaluated at US$50,000, was used in the study.

As for the relevance of the research and other intellectual products from the project and the researchers' activities in the three subsequent years, our analysis is grounded in the breakdown of project participants into three areas of activity presented by Ferraz and Suzuki (1998, p. 25). We may divide the papers aiming at intervention into two major areas: a) forest management and conservation, and b) rehabilitation of degraded areas. As for the third area, remote sensing, it may be seen as a tool for gathering data of utility to forest management and conservation and, potentially, for rehabilitation of degraded areas. Therefore, we shall focus on the first two areas, citing, whenever relevant, information derived from remote sensing. These areas refer to Popper's world 1 and, therefore, to the issue of impact, and our third hypothesis.

4.2 Impact of the Project

Here, the following hypothesis applies:

3. This knowledge was disseminated and has had *impacts* for environmental preservation and, mainly, recuperation.

a) Dissemination of knowledge and its impacts for forest management and conservation

The relevance of forest conservation and management, especially of the Amazon forest, to the preservation of biodiversity has long been recognized. Recently, their importance for the question of emission of greenhouse gases (principally carbon and CO_2) and, consequently, for the regional, national and global climate, is also being increasingly recognized, due, in part, to the activities of INPA researchers. This recognition coincides with humanity's growing awareness of the dangers of global warming.

Philip Fear side, of the ecology department at INPA, is the second most cited researcher worldwide in the area of global warming: 530 times. Although his involvement in the project itself was rather minor, it is clear that a substantial part of the information he synthesizes is derived from the work of former project participants, as well as SIGLAB. Recently, he recalled (in an interview conducted 25 November 2006) that "not to preserve the Amazon will provoke acceleration of the greenhouse effect. The fact that there is still a lot of forest in the Amazon… also means that there is a great deal of carbon running the risk of being released into the atmosphere."

Until recently, global warming was considered to be a problem that concerned the first world countries more than the countries of the region (IADB/UNDP, 1990, pp. 39-41). Furthermore, it was argued that researchers in the Latin America and Caribbean region shouldn't waste their time on subjects of planetary interest such as global warming (Gligo, 2001).

On the other hand, the document drawn up for the Latin America and Caribbean Regional Conference preparatory to the World Summit on Sustainable Development (ECLAC/UNEP, 2001, p. 120) states that "Latin America and the Caribbean are responsible… for 48.3% of the

emissions [of greenhouse gases] due to changing land use – which shows the importance of the loss of vegetal cover, also in terms of its effect on the global atmosphere."

This belated recognition reflects the conclusions of a paper by Fearnside published in *Forest Ecology and Management* in 1996, entitled "Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest," which presents biomass values that "are more than double those forming the basis of deforestation emission estimates currently used by the Intergovernmental Panel of Climate Change." Ten years later, Fearnside, in a September 2006 interview, stated that "The IPCC still uses estimates of greenhouse-gas emissions based on improbably optimistic assumptions of the rate at which Amazonian secondary forests grow and reabsorb carbon dioxide from the atmosphere." The implication of this conclusion is that it is much more important to conserve the primary forest; because the secondary forest, whether replanted or natural, is much less effective in combating the greenhouse effect.

This line of argumentation is potentially of very great impact, because it affects the destiny of the region, the nation and the planet, and translates into clear proposals for conservation of the forest, justifiable, in terms of cost-benefit, to the international community and the producers themselves. Furthermore, such proposals do not depend on the dubious surveillance capacity of the State in such a vast region, nor do they require diffusion of innovations.

There are different versions of these proposals. At the Conference on Climate Change in Nairobi, 6-17 November 2006, held jointly with the Conference of Parties (COP 12) of the twelfth UNFCCO (United Nations Framework Convention for Climate Change), the Brazilian proposal for voluntary forest-related carbon credits (a global fund) was not adopted. In turn, the Papua New Guinea proposal for mandatory credits, within the Clean Development Mechanism, was discussed in New York in January 2007, at an encounter organized by The Rainforest Coalition; Niro Higuchi, project researcher, was one of the invited speakers. Obs.: Higuchi advocates credits for *effort*, not for *natural endowments*. In his opinion (communicated verbally to this evaluator), it would be immoral for Brazil, for example, to permit authorization of burning of fossil fuels in other countries, in exchange for the mere existence of the Amazon forest.

Will such proposals prove persuasive? At the June 2001Conference on Climate Change in Bonn, the possibility of credits for forest preservation was put off until after the year 2012. Official international discussions initiated at COP 11, in December 2005, focused on issues related to the reduction of greenhouse gas emissions by deforestation in the developing countries. The resolution arising out of COP 11 established a procedure for submission of recommendations regarding implementation of policies aiming at the reduction of such emissions and for consideration of related matters of a scientific, technical and methodological nature. On 23 October 2006, a World Bank study concluded that the carbon saved by avoiding deforestation is the great "unexploited opportunity" for the planet to reduce poverty, at the same time that it conserves biodiversity and helps resolve the climate crisis.

The research studies related to component 2 (natural forest dynamics), like the products of SIGLAB (fruit of component 1 – patterns of distribution of forest types), serve mainly as a foundation for initiatives aiming at forest preservation and management. For example, a study done in Manaus, Rio Branco and Santarém (respectively in central, western and eastern Amazon) and published in *Oecologia* (S. Vieira, et al., 2004), with four project co-authors (da Silva, Chambers, Higuchi and dos Santos), points out that "Living trees constitute one of the major stocks of carbon in tropical forests," together with "the amount and decomposition rate of dead wood, the production and decay of litter and fine roots, and changes in the stocks of soil

organic carbon." With regard to the dynamics of carbon stocks, it shows that "live wood is approximately in steady state in the Manaus forest, but accumulating approximately 1.5 Mg C ha^{-1} $year^{-1}$ in the Rio Branco and Santarém sites." The authors observe that "carbon accumulation in tree trunks does not mean that the whole forest is acting as a carbon sink." In fact, "the entire wood (live + dead) C pool is losing C to the atmosphere at the Santarém site."

In another study published in *Oecologia* (Chambers, et al., 2004), some of these same authors observe that "a rapid increase in tree growth following disturbance… could be misinterpreted as carbon sequestration if changes in coarse litter stocks were not considered… predictions of changes in forest carbon balance during the twenty-first century are highly dependent on assumptions of tree response to various perturbations…."

Are Brazilian efforts to conserve the Amazon forest already bearing fruit? If so, could such results be considered, in part, an impact of the Amazon Forest Research Project, or of the Plan of Prevention and Control of Deforestation of the Amazon? It is claimed that there was a reduction in the rate of deforestation in 2004-05 and 2005-06. Reduction in the former period was allegedly 31%. Preliminary data, based on a small sample, seem to indicate a 30% reduction in 2005-2006 (although the DETER – Real Time Detection of Deforestation – projection is for just 11%).

Higuchi (2006) presents the following time series on gross annual deforestation of the Brazilian Amazon (Figure 1). We see that deforestation increased between 1996 and 2003, falling in 2004-05 to a level a little higher than that prevailing between 1999 and 2001. After critical data analysis, Higuchi concludes that "The stabilization of deforestation, whether within the confidence interval or below the lowest probable estimate, is not welcome and should not be commemorated. The goal must be a yearly reduction, until it is possible to completely stop cutting down the forest."

According to Higuchi (2006), the problem is that "The public authorities have shown little effectiveness in enforcement and control of access to the forestry resources of the Amazon." Deforestation authorized by IBAMA corresponded, between 1997 and 2004, to just 17.4% of total deforestation of the Amazon. Likewise, "Of all the timber put on the market in the years 1997, 1998, 2000 and 2001, an average of 17% was extracted under Sustainable Forest Management Plans (PMFS), 20% were from authorized deforestation and 63% had no defined origin." The researcher concludes that "In such a situation, we can hardly say that sustainable forest management exists in the Amazon."

A recent PowerPoint presentation by SIGLAB cites a recent World Bank study to the effect that the main cause of deforestation is expansion of cattle ranching. It occupies 75% of the deforested areas; medium-scale and big ranchers are mostly responsible. From an economic viewpoint, the process is basically due to the high private profitability in the region, in comparison to other non-livestock activities or to animal husbandry in other areas of the country. Today, Brazil is the biggest beef exporter in the world, in spite of the prevailing unfavorable exchange rates. With a more realistic exchange rate (a more devalued real), certainly exports would be even greater.

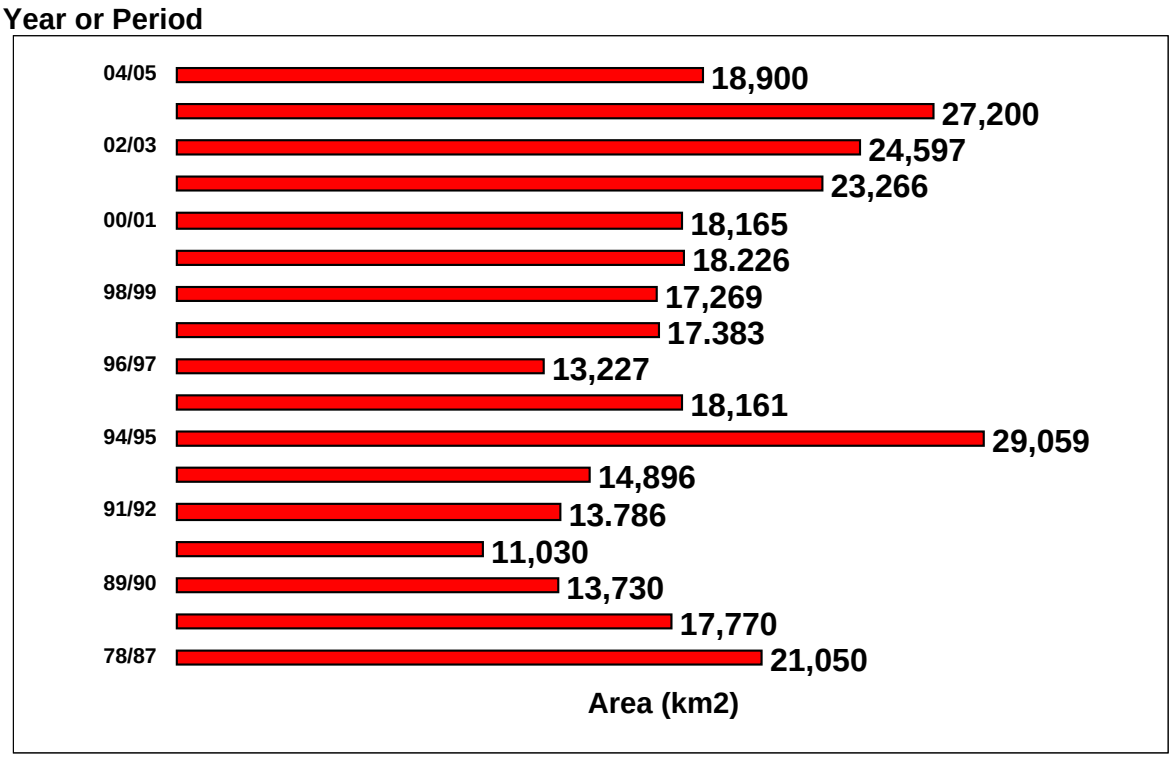
PDMe postulates, as an important assumption related to the super goal, that the "Brazilian government's policies to harmonize development and environment are maintained." With regard to cattle ranching, all indications are that in practice, the need for hard currency prevails over the determination to enforce the rules on deforestation. In addition to interest and exchange rates, today the federal and state governments' main policy for preserving the Amazon forest is the creation of conservation units (UC). Figure 2, below, shows the location of these units, by

year of creation. More recently, in late 2006, a large new unit was created, located mainly in the northeast of the state of Amazonas. To be sure, the rarity of UC in the south and east of the region, especially of any created in the past four years, is a cause of concern, in view of the observations below regarding the "Arc of Deforestation."

In view of the fact that Indian reservations currently account for approximately 20% of the territory of the Amazon, the training of indigenous leaders by SIGLAB, in agreement with the Confederation of Indigenous Organizations of the Brazilian Amazon (COIAB) and the Geo-Processing Center, is of considerable relevance. Participants learn not just to interpret the maps done by remote sensing, but also to confront these data with information known to the respective tribe.

Figure 1

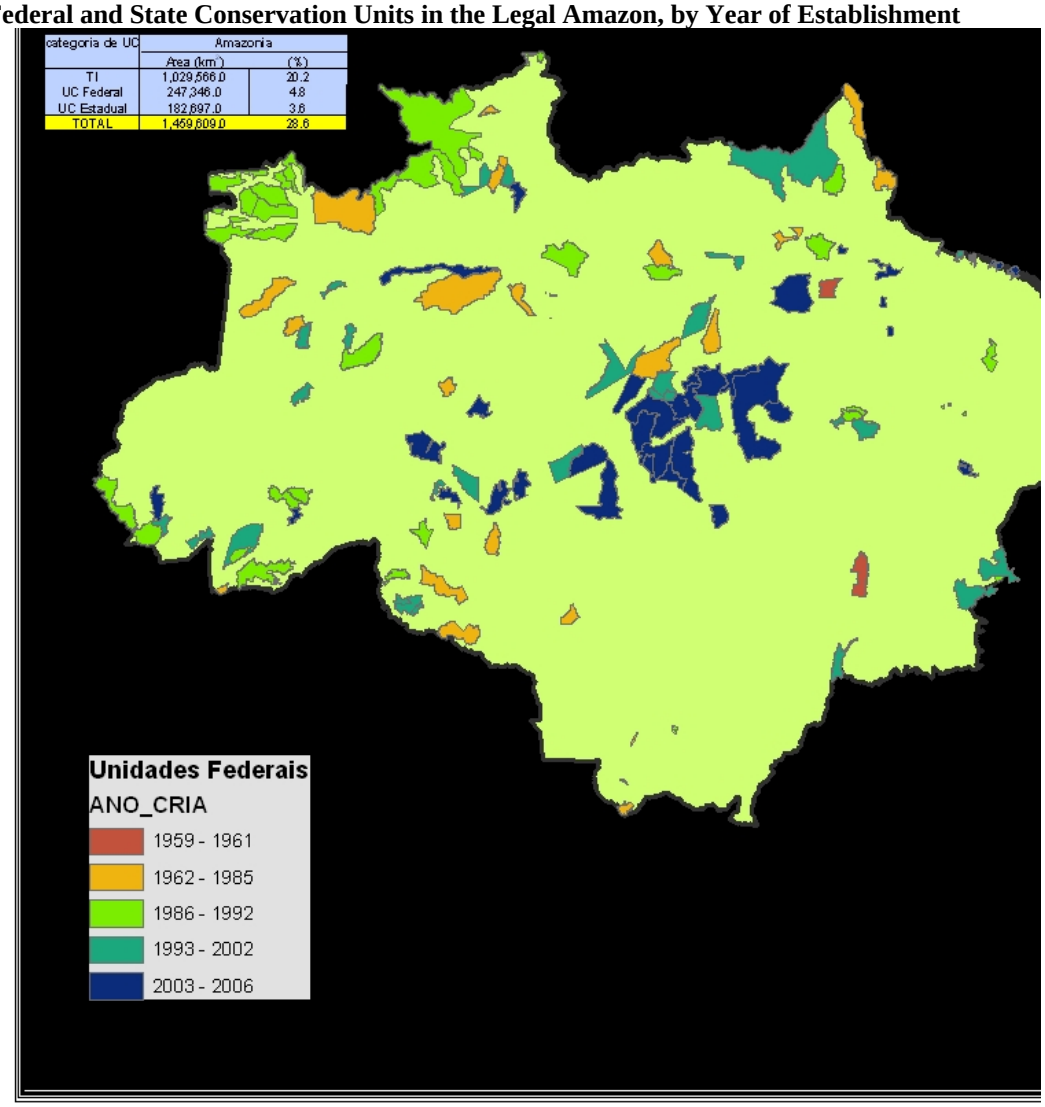
Gross Annual Deforestation (in km^2) in the Brazilian Amazon, between 1978 and 2005



Source: Higuchi, 2006.

Figure 2

Federal and State Conservation Units in the Legal Amazon, by Year of Establishment



fonte: IMAZON, 2005

b) Dissemination of Knowledge and its Impacts for the Rehabilitation of Degraded Areas

If enforcement is inefficient and the rate of deforestation depends mainly on the profitability of cattle ranching, would the solution be to try to cover our mistakes, promoting the reforestation of degraded areas? The optimism of Houghton, op cit., still remains a hope with very little to show for it, especially in Brazil, where reforested areas continue to be practically insignificant, in terms of percentage of the 680,000 square kilometers of degraded areas in the region detected by the National Institute for Space Research (INPE).

Deforestation in the Amazon region is concentrated in the "Arc of Deforestation," in the south and southeast of the "Legal Amazon." The states of Mato Grosso, Pará and Rondonia account, respectively, for 41.80%, 33.52% and 16.14% of all deforestation in the region. Of course, it is precisely in those states that cattle ranching is concentrated. The Amazon Forest Research Project, conducted in the central Amazon, dealt very little with the issue of deforestation in those states.

It is clear that the idea that a research institute could take responsibility for "tree planting activities in a considerable part of the Brazilian Amazon" represents a theory failure. Even contracting hired hands to maintain INPA's five experimental stations has been a problem, for bureaucratic reasons; the plantation at station 45 has long been abandoned (source: Paulo Sampaio, personal communication).

On the other hand, according to Barbosa (comments, 2007, regarding the reforestation of a smaller area in the central Amazon), "The experiments with recuperation of areas used by extensive cattle ranching (the area of Santa Cláudia, in Presidente Figueiredo) installed through the Jacaranda Project have had important results, both in silvicultural planting techniques and in selection of species with greater potential to establish themselves in degraded environments. The experiments are being maintained and evaluated, and a doctoral candidate is interested in basing her dissertation on these results. Maintenance of the experiments in 2006 was not ideal, because of temporary problems such as the breakdown of a tractor. However, this does not invalidate the experiments." According to Barbosa, "the viability of recuperation of degraded areas through reforestation cannot be evaluated in a few years of study. These experiments have been going on for only five years; even so, the effects of reforestation (via the experiments) are already evident, for they are making possible greater enrichment of other species through natural regeneration.... The experiments at the Santa Cláudia farm are still underway, supporting practical classes for students of the agrotechnical school and the Forestry Engineering programs at the Federal University of Amazonas and the State University of Amazonas, as well as the masters and doctoral programs in Tropical Forestry Sciences at INPA."

In this regard, Fearnside (2006) points out that cattle pasture,

> by the time it has degraded to the point where it is abandoned to secondary vegetation, has left the soil compacted, biologically impoverished, and depleted of basic nutrients. The result is that secondary forests in these vast areas grow much more slowly than do secondary forests in fallows left after slash-and-burn agriculture, as was shown by my second-most-cited study, "Carbon uptake by secondary forests in Brazilian Amazonia," coauthored by Walba Guimarães.

The paper by Barbosa, et al. (2003), "Tropical silviculture and recuperation of areas degraded by itinerant agriculture in the central Amazon," refers to the recuperation of an area previously

used for banana and manioc cultivation. The authors state that "it is an initial experiment with recuperation of degraded areas in the Amazon." Five years before, Ferraz and Suzuki (1998) had referred to "The rapid development that has occurred in this area [of recuperation]." As it happens, there had been little work with recuperation of *cultivated areas*, and still less of *pasture lands*. The pioneering work of Barbosa, et al. is today being followed up on in a tangentially related area: recovery of clearings opened up for oil prospecting, with the support of the new CT-Petro project (Usechi and Barbosa, 2005). In the Amazon Forest Research Project, the research by J. Ferraz, et al. (2003) and Ferreira, et al. (2003) also focused on the central Amazon. There, even deforestation for tillage has been less than in the eastern Amazon, because of the low soil fertility.

During the project, there was implementation failure in the execution of one attempt to reforest a small area north of Manaus that had been degraded by pasture. Furthermore, it is clear that the idea that a research institute could take responsibility for "tree planting activities in a considerable part of the Brazilian Amazon" represents a theory failure. Even contracting hired hands to maintain INPA's five experimental stations has been a problem, for bureaucratic reasons; the plantation at station 45 has long been abandoned (source: Paulo Sampaio, personal communication). The question is, is the attempt to reforest degraded areas, especially pasture lands, impracticable *per se*?

The former project coordinator, João Ferraz, has been working with reforestation of bauxite mining areas in Pará state (in the eastern Amazon) since the late eighties. Three thousand hectares (thirty square kilometers) have been reforested to date. According to J. Ferraz, mining has the greatest impact, so success in a mining area proves the feasibility of reforestation of any degraded land. Obs.: in his experience, a layer of 350 centimeters of fertile soil, established through fertilization, is required. J. Ferraz has also been working with reforestation of a small pasture in Itacoatiara, Amazonas. In another example, along the 225 kilometers between Itacoatiara and Manaus, a sawmill is paying to reforest the area of felled trees.

An INPA fellow, Pereira de Souza, an advisee of J. Ferraz, has documented good results with tree planting in areas degraded by pastures in Mato Grosso (the Peugeuot-Citroën project, Reforestation for Carbon Sequester). According the project's balance sheet on six years of activity (Grupo PSA Peugeot Citroën, July 2006), from 1999 to 2003 almost 2000 hectares were fully reforested with approximately two million seedlings of native species, with a view to forming a new forest.

This Peugeot-Citroën project may, perhaps, be considered a good example of the type of initiative recommended by the weekly magazine *Exame* in its edition of 26 December 2006 (Teixeira, 2006), in a cover story entitled "[Global warming] Will companies save the planet?" The author winds up recommending actions "out of pure capitalist pragmatism": "Saving the planet is too big a goal for each company individually. However, saving its own image is a possible objective." This present evaluation has no intention of judging the idealism or pragmatism of the PSA Peugeot-Citroën Group initiative. The project's press release affirms that "Right from the beginning, Peugeot decided not to get into the Clean Development Mechanisms (CDM), even though it is in favor of them, in principle. Therefore, it will not request carbon credits for this project. If they are officially commercialized, Peugeot and ONF promise to fully reinvest them within the social objectives of the project." In fact, with regard to carbon credits, the *Exame* article observes that "the depression in this very new market is having a real impact in an area of nascent entrepreneurialism in Brazil."

The research done in components 3, 4 and 5 of the Amazon Forest Research Project (site characteristics, seed ecophysiology and site adaptability), and in the three years since then, have mainly, but not exclusively, served to provide a foundation for initiatives of reforestation of degraded areas.

One study (Hirai, J. Ferraz, Ferreira and Kobayashi, 2005), conducted by former project counterparts (component 3) – two from the Department of Forest Site Environment, Forestry and Forest Products Research Institute, in Ibaraki, and one from the CPST-INPA (with the collaboration of one researcher from the Department of Climate and Water Resources, also at INPA), concerns the changes in the physical properties of soils of the Ferralsol type with tree planting in the central Amazon.

The two basic requirements for all planting are seed and soil. Component 5, which deals with planting itself, received a certain priority during and after the project. For example, it is the seeds left over from planting that are typically made available for research in component 4. This has been the case despite the fact that tested seeds, together with user friendly explicative material, have a potential for replication characteristic of nature itself.

One chapter of a book of the series, Scientific Library of the Amazon (I. Ferraz, Leal Filho and Imakawa, 2004, pp. 37-45) explains that "Information regarding dispersion, size and dormancy of seeds is relevant, both for understanding forest dynamics and for management and conservation," in addition, of course, to reforestation.

In this regard, the authors cite Garwood (1989), who wrote that "After perturbation, one of the resources of forest regeneration is the seed bank in the soil." However, in the case of the seeds studied, "The predominance of zoocoria, the large size of the seeds and the rapid germination indicate that a majority of the species selected are adapted to non-perturbed areas of primary forest."

The Seed Manual of the Amazon, initiated in the last year of the project with the publication of three installments (related to Guiana crabwood (Carapa procera D.C. and Carapa guianensis Aubl.), the Guiana cannonball tree (Cariniana micrantha Ducke Lecythidaceae) and Ceará rosewood (Aniba rosaeodora Ducke Lauraceae), continued with publication of fascicle 4, on *Acariquara-roxa* (Minquartia guianensis Aubl. Olacaceae), and fascicle 5, on the spiny peachpalm (Bactris gasipaes Kunth Arecaceae), in 2004 and 2005, respectively. Each is a five to twelve page color illustrated publication of excellent quality, purportedly in user friendly language. In addition, attractive explanatory brochures about seeds and on traditional extraction of the Guiana crabwood have been published. These materials are printed in limited editions (one thousand each), and there is a backlog of demand. Due to a misunderstanding, INPA has not offered the publications for sale, which would make it possible to print more copies. (Obs.: the JICA-Brazil office explains that there is no prohibition of non-profit sale of such publications.)

Two chapters of the concluding volume of phase II (chapters 6 and 13) deal with Ceará rosewood. Spironello, Sampaio, G. Vieira and Barbosa (2003) explain that "terra firme" forests in the Amazon show great diversity of plant species, a considerable number of which have commercial value. The species of greatest economic value, like rosewood, are the first to suffer the consequences of commercial exploitation. IBAMA requires linalol extractors to plant four rosewood seedlings for each cubic meter of wood utilized. However, it is very difficult to obtain seeds of this plant, and of many other forest species.

The research studies mentioned seek to remedy some of these difficulties; while the fascicle, and also the technical information sheet of the Seed Network of the Amazon (no. 4, of 2004), of which INPA is a partner, disseminate more useful information in this regard. Another species described in a technical information sheet (no. 5, of 2005) is the kopie, a hardwood that is widely used to make posts.

One species of great commercial potential, currently the object of the attention of the researchers (although as yet without any specific publications in this regard), is balsa wood – a light wood traditionally used to make canoes and boats. In the above mentioned study by Hirai, J. Ferraz, Ferreira and Kobayashi (2005), balsa wood was planted in two of three experimental plots. It grew more in the tilled lot; this was not the case with the five indigenous species, due to the insufficient luminosity provoked by the balsa wood canopy.

4.3 Analysis of Factors of Impact and Sustainability

4.3.1 Factors Promoting Impact and Sustainability

Our first hypothesis was confirmed: the inputs made possible institutional learning and the strengthening of the National Institute of Amazon Research, principally the Department of Research in Tropical Silviculture (CPST) and the Remote Sensing Laboratory (SIGLAB). Some of the donated equipment, mainly information technology in the SIGLAB, is now obsolete and has been replaced. The remainder is still put to good use, at either CPST, SIGLAB or other areas of INPA, furthering the sustainability of the efforts. Training of interns, elementary and high school students and indigenous leaders is an important factor in the sustainability of the ideals of the Amazon Forest Research Project.

With regard to the second hypothesis, it is evident that the researchers produced, and continue producing, a great deal of knowledge. The relevance of this research for conservation of the Amazon forest, carbon balance and global warming is becoming clearer day by day. The principal positive factor in sustainability is the competence and dedication of the INPA researchers, particularly at the CPST and SIGLAB, as evidenced by the many publications listed in the annex, as well as the new website, Atlas Amazonas. This has made possible the continuation of high quality relevant research, often employing equipment donated by the Japanese government during the Amazon Forest Research Project. Several researchers have also been involved in advisory and extension work in related areas. Funding for continued research in the state of Amazonas has been provided by the Foundation for Support of Research of the State of Amazonas (FAPEAM). Although recuperation of degraded areas has so far been limited in quantity, and certainly is less important that conservation and management of the natural forest, there is no reason to deny the relevance of recuperation *per se*. Thus, the research conducted during or after the Jacaranda project, which may come to be applied in such undertakings, may be considered relevant in and of itself.

Concerning the third hypothesis, dissemination of research findings among stakeholders able to apply them directly in environmental preservation and the recuperation of degraded forests has been good but modest. The INPA director asserts[2] that the institute has been very concerned with the popularization of science, but that further work in this area is required. SIGLAB's work with Amazon Indians to interpret maps in the light of tribal knowledge is one good example of such efforts; distribution of the fascicles of the Seed Manual for the Amazon is another. Recently three high school students advised by a counterpart researcher won an important science competition.

It must be acknowledged that the impact of the initiatives promoted during and after the project on the forest itself has been minimal to date, although not insignificant. In the terminology of philosopher of science Karl Popper, there were effects in world 2 (conscious experience) and world 3 (production and dissemination of knowledge), but limited impact so far on world 1 (the physical world).

According to information provided by SIGLAB, the main factors promoting impact, in the sense of consequences for the forest itself, are not directly related to the project. On the one hand, high domestic interest rates and the overvalued national currency to some degree restrain investment in cattle ranching, including massive deforestation, mainly in the southern Amazon. Largely in other areas of the Amazon, conservation units and Indian reservations help conserve large tracts of forest lands. What reforestation does exist is largely due to private initiative, as well as certain legal requirements; some project researchers and their advisees have studied or indirectly supported such initiatives.

In a broader sense, "impact" may be taken to include knowledge production (i.e., Popper's world 3), as reflected in the publication of scientific papers in refereed journals, books, etc., and citations of these works by the scientific community, as well as dissemination of such knowledge among the general public. It is noteworthy that former project researchers at INPA published 87 papers in scientific journals, 6 books, 23 chapters of books, 5 articles in newspapers and magazines and 23 full papers in conference proceedings in 2004-2006. One INPA researcher, tangentially related to the project, is among the most cited authors in the world on global climate change; others, who were directly involved in the project, are frequently called upon for advising and policy formulation regionally, nationally and internationally.

Important project-related policy initiatives are currently being taken at the state level. As noted above, INPA's efforts are concentrated in the state of Amazonas, where its headquarters are located. Amazonas is the largest state in the Amazon region, and has preserved 98% of its tropical forest. Therefore, its main challenge is preservation, not recuperation. The state government envisions transforming the tropical rainforest into financial assets; the return on investment would initially be found in the capacity of the native forest to sequester carbon.

The state's biggest advantage is also its biggest drawback for carbon credits based on opportunity cost. Amazonas has 9.5 million hectares of state protected areas where, theoretically, there should be no productive activity at all. How, then, can its "owners" be compensated for not producing? On the other hand, how can powerful interest groups in the state be dissuaded from transforming Amazonas into a new frontier for agriculture and ranching? The governor and his secretary of sustainable development are currently negotiating the creation of an investment fund with North American and European governments, multilateral organizations and banks, and international NGO's. This idea is said to be quite different from the Brazilian proposal presented in late 2006 to make the rich countries pay up front for conservation of Brazil's forests.

In June 2007, the Climate Change, Environmental Conservation and Sustainable Development of Amazonas law was passed and the State System of Conservation Units established. Following the example of the famous "Bolsa Escola" program, which paid poor families for keeping their children in school, the "Bolsa Floresta" program will pay people for recuperating and preserving the forest.

By 2008 or 2009, INPA will have received about R$ 15 million (approximately 7½ million dollars) in research funding from the state, through its Secretariat for Science and Technology

or the Foundation for Support of Research of the State of Amazonas (FAPEAM).[1] In fact, INPA has entered bids for participation in 27 of the state's 28 research programs. When the Large Scale Biosphere-Atmosphere Program in the Amazon (LBA) was transferred from São Paulo to INPA, the state of Amazonas organized a commission of universities, the Ministry of Agriculture and SIVAM (Amazon Surveillance System), together with INPA, to establish undergraduate and master's degree programs in meteorology at the State University of Amazonas, as well as a northern region meteorological program, with a view to including Amazonas in the carbon sequester market.

In June 2007, members of the Joint Special Commission on Climate Change of the Brazilian Congress visited INPA. Its president observed that "The information on climate change produced by institute scientists can serve to orient the entire country and South America – and this is what we are going to tell Congress." The commission's rapporteur pointed out that while there are isolated activities at the ministries of the environment and of science and technology, there are as yet no broad inter-ministerial measures in this regard. Another commission member discussed the need for better salaries at the institute with the minister of science and technology, who reportedly responded positively to her concern.

INPA is encouraging its 216 scientists to seek patents and copyrights and to become scientific "entrepreneurs." In its first fifty years of existence, only three of the institute's products were patented; seventeen others are currently awaiting patents. Scientific and technological entrepreneurialism has been one key to the sustainability of leading universities and research centers in Brazil and abroad.

4.3.2 Factors Inhibiting Impact and Sustainability

As INPA director Adalberto Luis Val states, "investment in science and technology depends on the presence of professors in the institution." According to Val, in the past twenty years, INPA has lost half its faculty (a net loss of 542 people), at the same time that there has been an increasing demand for information about the region. Its low salaries are considered insufficient to attract PhD's from the more developed southeast and south of the country. Furthermore, certain major federal research institutions in the southeast currently pay 70% more than INPA. Currently, of the institute's 700 employees, only 170 are PhD's. Considering scheduled retirements, the number of employees in 2015 will be just 40% of today's figure if no new personnel are hired.

Research funding, now almost always by project ("soft money"), tends to point research in certain directions, especially since the federal government began insisting on research groups and networks instead of providing umbrella funding; even so, there has generally been a certain continuity in lines of research in the post-project period.

A lack of regular funding for maintenance of INPA experimental stations in Amazonas state has inhibited project sustainability. A misunderstanding regarding a supposed JICA prohibition on selling publications placed a constraint on some extension work, particularly in the area of seeds.

Theory failure is largely responsible for the fact that expected positive environmental impacts have largely not been forthcoming. In the first place, it was not reasonable to expect a research

[1] Interview, "Diretor do INPA diz que Instituto precisa de mais recursos para ampliar pesquisas sobre região", 6 February 2007. In MCT/INPA, *INPA Orgulho da Amazônia*, http://www.inpa.gov.br/noticia_sgno.php?codigo=362

institute to conduct large scale extension work. INPA, as a research institute, is currently not equipped for large scale installation and maintenance of plantations. In the second place, economic factors were neglected in project planning. In terms of area, reforestation in the region has been extremely limited.

Furthermore, the project did not focus on the main cause of deforestation, which is ranching in the southern Amazon. One case of implementation failure in this regard during the project (near INPA headquarters in Manaus, in the central Amazon) seems to have somewhat discouraged further attempts. There was little real progress in the area of forest management. As for possible impacts on forest conservation, the current situation is very volatile, both globally and in Brazil, with rising awareness of global warming and of the consequences of deforestation for the carbon balance. Efforts by INPA researchers just may have important consequences in this area.

4.4 Conclusions

The evaluation proposed to test three hypotheses with reference to phase II of the Amazon Forest Research Project and the subsequent period (2004-2006):

1. The inputs made it possible to strengthen INPA+ (effectiveness) and to promote the continuation of its efforts (sustainability).
2. INPA researchers produced relevant knowledge, with efficiency.
3. This knowledge was disseminated and has had impacts for environmental preservation and, mainly, recuperation.

The first hypothesis was confirmed, although recent budgetary cuts have put a squeeze on the institution. With regard to the second hypothesis, it is evident that the researchers produced, and continue producing, a great deal of knowledge. The relevance of this research for conservation of the Amazon forest, carbon balance and global warming is becoming clearer day by day. As for the research on recuperation of land degraded by tillage in the central Amazon, its direct relevance remains in doubt. Concerning the third hypothesis, dissemination of research findings among stakeholders able to apply them directly in environmental preservation and the recuperation of degraded forests has been good but modest. It must be acknowledged that the impact of the initiatives promoted during and after the project on the forest itself has been minimal to date, although not insignificant. In the terminology of philosopher of science Karl Popper, there were effects in world 2 (conscious experience) and world 3 (production and dissemination of knowledge), but limited impact so far on world 1 (the physical world).

In terms of the evaluation checkpoints, the following conclusions apply, with regard to project impact.

- The overall goal of the project, "Effective technologies for forest conservation and rehabilitation of degraded areas in the Amazon are in use by the people and organizations concerned," has only begun to be achieved.
- Commitment to the goal of forest conservation is beginning to be expressed in state government development plans, particularly in the state of Amazonas – where conservation is of much greater concern than rehabilitation.
- Rehabilitation of degraded areas, mainly in the states of Mato Grosso, Pará and Rondonia, will have to depend on a partnership between the state and federal governments, on the one hand, and the international community and major corporations, on the other. While federal law requires preservation of a portion of the territory of

farms, ranches and other productive enterprises, reforestation efforts have so far been very limited in the Brazilian Amazon.

- Whatever limitation has been placed on the deforestation of the Amazon has resulted more from the overvaluation of the real (or the undervaluation of the dollar) than from effective research-based policy.
- Several important assumptions stated in the Project Design Matrix remain largely unmet: with minor exceptions at the state level, a forest extension system has not been implemented; since the extinction, in 1991, of the Brazilian Enterprise for Technical Assistance and Rural Extension (EMATER), rural extension work has suffered throughout Brazil, and particularly in the Amazon region; personnel and budget necessary for conducting research have not been maintained continuously at INPA; the Brazilian government has not implemented a unified and effective policy on Amazon land use; and whatever policy the Brazilian government may have had to harmonize development and environment has tilted strongly toward the development end of the continuum.

5. RECOMMENDATIONS AND LESSONS LEARNED

5.1 Lessons Learned

First lesson learned: To have impacts on the physical world, economic factors must be taken into account. Knowledge is a necessary but not sufficient condition for sustainable development. It is argued that the impact of interest and exchange rates on the preservation of the Amazon forest is much greater than that of other government policy; obviously, initiatives like the Amazon Forest Research Project hardly influence the policies of Brazil's central bank, although INPA researchers just may influence decisions taken at international forums.

Second lesson learned: Preservation of tropical rainforests should be top priority. Comprehensive global, national and regional policies to this end should be put into place and maintained. Reforestation is also important, but no unrealistic expectations that it will be able to undo the damage caused by continuing deforestation should be allowed to distract the global community from its top priority in this area.

Third lesson learned: Recuperation of degraded tropical forests can only have a substantial impact on global warming and related matters if it is implemented through comprehensive policy initiatives. At that point, the kind of research published during and after the Amazon Forest Research Project will be of great relevance. Whether or not this happens, the world urgently needs to put a stop to the destruction of tropical forests, among which the Brazilian Amazon is the prime example.

Fourth lesson learned: The governments of Brazil and Japan may wish to work together to ground their positions at international forums in the research and practical experience accumulated through the JICA projects and related programs and projects.

5.2 Recommendations

1. Recommendation to the Brazilian government: To have greater impact through reforestation in the Amazon, it will be necessary to focus on pasture lands in the Arc of Deforestation, which are currently responsible for most of the deforestation in the region. The concentration of the efforts of some of the Amazon Forest Research Project researchers on reforestation in areas of tillage, mining and oil prospecting, principally in the central and eastern Amazon, while praiseworthy and certainly understandable given INPA's location in Manaus and the opportunities that have presented themselves, seems a little out of focus with regard to this specific purpose.

2. Recommendation to the Brazilian government: Promote comprehensive extension programs for conservation, management and recuperation of the Amazon forest. The Brazilian government should guarantee continual basic support for research and site maintenance at INPA and its Department of Research on Tropical Silviculture (CPST), and consider adoption of networking arrangements in support of extension work. The Amazon Forest Research Project may be considered a prelude to future projects or programs of extension aiming at the sustainable development of the Amazon. If such initiatives are indeed forthcoming, extension should be re-conceptualized to encompass the different stakeholders involved, locally, regionally, nationally and even globally – all of whom should be considered partners in a mission of vital interest to all humanity, and all of whom require accurate and relevant information.

3. Recommendation to the Brazilian government: Strongly support remote sensing for monitoring of the Amazon forest. Although the weakest of the five components during project execution, remote sensing (component 1), which got underway during phase I of the Amazon Forest Research Project, now provides very timely information, of relevance to local communities (as shown by the work with the Amerindians) as well as to the nation and the planet itself. Support for translation and widespread dissemination of INPA/SIGLAB maps and information from remote sensing, which are now available in Portuguese via Google,[2] should be provided. The proposed Amazon Monitoring Project, using Japanese satellite imagery, may help avoid any discontinuity due to the anticipated retirement of certain NASA satellites in the next few years.

4. Recommendation to the Japanese government: Support immediate adoption of some form of carbon credits for forest recuperation and preservation, whether the Brazilian or Amazonas state proposal or some other.[3] Consider supporting projects related to the Clean Development Mechanism.

5. Recommendation to the Japanese government: Negotiate possible support for state governments in the Amazon region.

[2] http://siglab.inpa.gov.br/atlasamazonas/index.php?mapw=659&maph=480
[3] This may, inter alia, help to relieve the financial crunch affecting INPA.

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ANNEXES

- **Annex I - Project Design Matrix, Version e (PDMe)**
- **Annex II - Evaluation Grid**

Name of the Project: The Brazilian Amazon Forest Research Project Phase II

1. Period of Cooperation: 5 years (Oct. 1998 – Sep. 2003
2. Method: PDMe was formulated by the evaluation team who consulted with JICA and the project implementation team
3. Japan´s Implementing Agency: JICA
4. The Recipient Country´s Implementing Agency: the National Institute of Amazonia Research (hereinafter referred to as "INPA")
5. Project Area: same as 4

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumptions
Super Goal The Amazonian forest resources are used on sustainable basis	1. Conservation units (area) are maintained or increased in the Amazon. 2. Degrade area decreases drastically, evidenced by the number of projects and investment on recuperation of degraded area. 3. Deforestation rates are reduced.	1. IBAMA´s statistics showing the conservation units. 2. IBAMA´s and INPE´s statistics 3. Governmental (e.g., INPE´s) and NGO´s statistics on the deforestation rates on Brazilian Amazon.	Brazilian government´s policies to harmonized development and environment are maintained.
Overall Goal of the Project Effective technologies for conservation and rehabilitation of degraded area in the Amazon are in use by the people/organizations concerned.	1. Comprehensive guidelines in terms of forest management, forest conservation and restoration of degrade area are formulated in good cooperation of governmental agencies such as IBAMA, INCRA, MMA and INPA. 2. The number of projects using the above guidelines increases. 3. Activities of the education of and the transfer of skills to local residents for sustainable development of forest resources are carried out in a broad area of Brasil-Amazon. 4. Tree planting activities are undertaken systematically in a considerable space of Brazil Amazon	1. Guidelines 2. Proposals of reforestation projects submitted to IBAMA 3. The number of primary and secondary schools including in their curriculum the education on sustainable development and the number of local residents receiving skills based on the results acquired at INPA (Survery is necessary to acquire these data). 4. INPE´s data on land cover change over years.	1. The Brazilian government implements a unified and effective policy on the Amazon land use. 2. Economic and political conditions of Brazil are fairly stable. 3. International agreements (ITTO 2000, TARAPOTO) and conventions on climate, biodiversity and AGENDA 21 are implemented.
Project Purpose Biological and ecological knowledge is increased and techonologies are improved at INPA for forest conservation and the rehabilitation of degrade areas in the Amazon.	By September 2003, all submitted research outputs are compiled into an integrated form such as the final report.	The final report (collection of reports)	1. Personnel and budget necessary for conducting researches are maintained continuously in INPA. 2. INCRA´s policies are adjusted to what emphasizes environmental protection and becomes closer to those of IBAMA´s. 3. Forest extension system is implemented. 4. Research achievement of INPA is well delivered to governmental agencies and educational organizations.

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumptions
Outputs 1. Updated information on land cover and land cover change are available. 2. The understanding of the natural forest dynamics is increased. 3. Characterization of different sites in natural forest and in plantations on degraded areas is improved. 4. Main seed characteristics necessary for seed management are known of important species for forest conservation and reforestation of degrade areas. 5. Planting techniques including seedling production is improved for rehabilitation of degrade areas in Amazon.	The following results are achieved in the Outputs stated on the left. a. The result of technology development is summarized in the form of manual b. Data is kept in file or database is formulated. c. The result of research development is summarized in the form of thesis, scientific paper or presented in a seminar. d. Experimental forest is established.	a. Technical manuals b. File or database c. Thesis, scientific paper, and presentation documents d. Experimental fields	
Activities I. Updated information on land cover and land cover change are available. [field 1.Distribution Patterns of Forest Types] 1.1. To classify forest types by using remote sensing ("RS") technology 1.2. To classisfy degraded area by using RS technology. 1.3. To detect land cover change by using RS methodology. 1.4. To develop methodology to improve classification accuracy and to detect land cover. 1.5. To improve methodology of evaluating distribution and seasonal changes of trees by using proximal RS. 2. The understading of the natural forest dynamics is increased. [Field 2: Natural Forest Dynamics]. 2.1. To clarify distribution pasterns of main tree species growing under different environmental and topographical conditions. 2.2. To clarify natural regeneration process of main tree species growing under different environmental and topographical conditions. 2.3. To clarify relationships between growth rates of some selected trees and environmental conditions. 3. Characterization of different sites in natural forest and in plantations on degraded areas is improved. [Field 3: Site Characteristics]. 3.1. To compare soil chemical properties in the sites of primary forest, degraded areas and plantation over degraded areas. 3.2. To compare soil physical properties and temperatures of sites in primary forest, degraded arcas and plantation over degrade areas.	**INPUT** Japanese side 1. Dispatch of researchs (experts): Long-term researchers: several pesons/year (Chief Adviser, Project Coordinator. Experts in the fields of Distribution Patterns of Forest Types, Natural Forest Dynamics. Site Characteristics and Site Adaptability) Short-term researchers in the fields of a. Distribution Patterns of Forest Types, b. Natural Forest Dynamics, C. Site Characteristics, d. Seed Ecophysiology, e. Site Adaptability, f. Other Related fields necessary for the project upon which both sides agree. 2. Receiving of researchers. 3. Provision of equipment machinery, equipment, and their spare parts in the fields of a. Distribution Patterns of Forest Types, b. Natural Forest Dynamics, c. Site Characteristics, d. Seed Ecophysiology, c. Site Adaptability. 4. Supplementary cost support for afforestation promotion programme.	**INPUT** Brazilian side 1. Assignment of counterpart researchers and administrative personnel. 2. Provision of equipment machinery, equipment, and their spare parts in the fields of a. distribution Patterns of Forest Types, b. Natural Forest Dynamics, c. Site Characteristics, d. Seed Ecophysiology, e. Site Adaptability. 3. Running costs including supply or replacement of machinery, equipment, instruments, vehicles, tools and spare parts.	1. Procedure of customs clearance of equipment is undertaken smoothly. 2. Brazilian researchers can allocate enough time for project activities. **Pre conditions** 1. There are research sites of sufficient space. 2. Basic infrastructure necessary for conducting researches such as water and electricity and are well functional.

3.3. To undertake nutritional characterization of selected tree species. 3.4. To establish relationships between tree distribution patterns and soil site characteristics in primary forest. 3.5. To establish relationships between the growth of selected tree species and main soil site characteristics in plantation over degraded areas. 4. Main seed characteristics necessary of seed management are known of important species for forest conservation and reforestation of degraded areas. [Field 4: Seed Ecophysiology]. 4.1. To describe biometry and morphology of fruits and seeds and seed extraction methods. 4.2. To determine requirements for seed germination. 4.3. To classify seeds in relation to storage behavior. 4.4. To determine tolerance to desiccation and low temperature stress of non-orthodox seeds. 4.5. To gather information about longevity of seeds after dispersal in natural and disturbed environments. 5. Seedling growth response to different environmental environmental conditions is clarified for rehabilitation of degraded areas in Amazon. [Field 5: Site Adaptability]. 5.1. To clarify seeding responses to environmental factors. 5.2. To clarify growth characteristics of seedlings planted in degraded areas. 6. [Activities other than researches]. 6.1. To establish management organization of the project and to formulate the detailed plan of the project. 6.2. to undertake financial management and general administration including the arrangement of dispatch of Brazilian researchers to Japan and receipt of researchers from Japan. 6.3. To procure necessary equipment for he project. 6.4. To conduct monitoring of the project activities and results regularly.			

Annex II
Evaluation Grid

Criteria	Evaluation Questions		Achievement Criteria/	Data	Data	Data Col-
	Main Questions	Sub-Questions	Measures	Needed	Sources	Lection Methods
IMPACT	To what extent has the project overall goal been achieved since the final evaluation?	- To what extent is efficient and effective technology being applied by persons and institutions in the area, for conservation of the Amazon rainforest and recovery of degraded areas? - What are the trends in such technology utilization?	• Areas deforested and recovered • Coverage of appropriate technology	• Nº of ha. in the Legal Amazon, annually • Spec's on available technologies • Correlation of technology use with conservation and recovery • Which technologies were researched under the project?	• Satellite imagery • Manufacturers' brochures • Project records	• Interviews • Literature/ document search
	After termination of the technical cooperation project, has any unforeseen positive or negative impact been verified?	- Has the research undertaken by INPA during the project, or related research, continued after project termination, or is it being pursued by other institutions? - Has there been increased demand for INPA research in the area after project termination? - Has there been an increase in the number of researchers, in and outside INPA, interested in doing research related to the project studies, or actually doing such research? - Has the research by INPA in the area been of interest to the Brazilian or international scientific community? - Has there been a demand for the research by INPA and the other institutions, for practical application? - Has the research initiated by INPA during project execution been applied and disseminated by other research and educational institutions, etc.?	• No. of publications and citations, by journal circulation and rating • Frequency of requests for copies and for new research or inclusion in ongoing research • Have any requests not been met?	• Time line of publications, citations and requests	• Library • Google.scholar • Qualis database of journals	• Interviews • Literature/ document search • Publications and citations • Level and circulation (domestic or international) of journals
	What factors were behind these impacts?					• Interviews • Literature/ document search

Criteria	Evaluation Questions		Achievement Criteria/ Measures	Data Needed	Data Sources	Data Col-lection Methods
	Main Questions	**Sub-Questions**				
SUSTAINABILITY	How are the activities consolidated during project execution being maintained?	- Has the federal government guaranteed funding for INPA for maintenance and research? - Is the equipment donated still in use, or has new equipment been acquired by INPA? - Have additional planting experiments for site-species matching and planting methods been implemented?	• Time line of federal transfers and other funding sources • % fulfillment of commitments and allocations • Equipment needs vs. availability, expected and actual lifetime, planned and actual purchases • Expected and actual results of experiments	• INPA financial requirements • Federal transfers • INPA inventories • Equipment maintenance, replacement, upgrading • No. and rigor of experiments	• Planning Ministry, Civil Society Organizations that monitor federal expenditures, INPA books • Progress and final reports on experiments	• Interviews • Literature/ document search • Examination of federal outlays and INPA receipts • Observation
	Are the results achieved by project termination being maintained and/or expanded?	- Are the students who participated in the research pursuing careers in the area? - Are the remote sensing techniques employed still in use, with the necessary documentation and capacity building? - Has the experimental plot been maintained and properly utilized? - Have data collection on soil characteristics and comparison with primary forest been completed, informing soil management technologies for degraded areas? - Has all the seed ecophysical data been collected for indigenous species? - Have growth response and characteristics of tree species been identified, with applications for site adaptability?	• % of former students active in the area • Professional productivity of former students • Results of remote sensing techniques • Maintenance of experimental plot • Results of soil management research • Status of seed ecophysical data collection • Results of research on trees and site applicability	• Names and addresses of former students, employment history • Efficiency of research management • Relevance of ongoing and terminated research	• INPA records on former students • Research logs and reports	• Follow-up questionnaire • Interviews • Literature/ document search
	What have been the hindering or facilitating factors in project sustainability?	- Have the communication problems and lack of coordinated policy within INPA been resolved since project termination? - Has the problem of adequate technical	• Is there free flow of communication among all who need to know or contribute?	• Typical communication routes • Policies adopted and disseminated, with dates	• Records of communications, policy statements, purchase and maintenance records,	• Interviews • Literature/ document search • Observation

		transfer to the Brazilian side been resolved? - Has equipment been made available in a timely fashion and properly maintained? - Has project management been technically adequate? - Is integration within the project team and among the 5 research fields adequate? - Is the number of workers sufficient to conduct field trials on all species? - Have highly qualified specialists provided training? - Has exchange of scientific information with external organizations been institutionalized? - Have links been strengthened with PPG7 and other related programs?	• Are there conflicting policies? • Does the technology offered match the needs and absorption capacity? • Have deadlines been missed due to late delivery or poor maintenance of equipment? • Does manpower availability meet requirements? • What are the channels for exchange of scientific information? How are they used? • Does INPA receive adequate support and provide needed services and information to partners in the PPG7? What other relevant programs exist, and how strong are the links to them? • What has been the role of JICA?	• Planned and implemented schedule of maintenance, purchases, delivery and installation • Manpower needs and personnel information • Websites, records of communication via different media • Information regarding related programs	plans, personnel records, websites, studies and publicity materials	