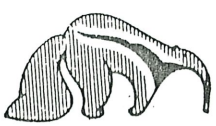
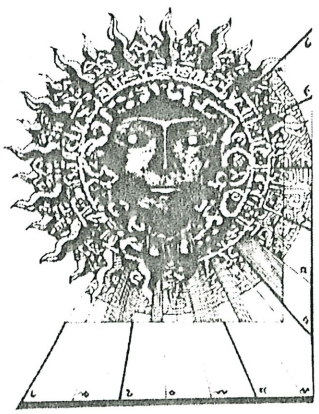
PROYECTO DE IMPLEMENTACION CONJUNTA SIERRA DE LAS MINAS GUATEMALA

FIJACION Y DESPLAZAMIENTO DE GEI

PROYECTO PILOTO



FUNDACION
DEFENSORES DE LA NATURALEZA



FUNDACION SOLAR

FUNDACION

DEFENSORES DE LA NATURALEZA

Guatemala, October 17th, 1997

Ingeniero
Carmelo Torrebiarte
Presidente OGIC
FUNDESA
Diagonal 6 10-67, zona 10
Ciudad

Dear Mr. Torrebiarte:

We are glad to present the endorsement of the Joint Implementation Project, Guatemalan office, which is entitled: ***"Sierra de las Minas Biosphere Reserve Joint Implementation Project"***.

The organization responsibles to prepare this project are Fundación Solar and Fundación Defensores de la Naturaleza; two private development organizations concerned with climate change mitigation action, and the sustainable human development. With this project, we plan to avoid and fix more than 3 million tonnes of carbon, by a contribution to green house mitigation.

If you have any doubts about our project or our organizations, please do not hesitate to contact us. Looking forward for your prompt news, with best regards.

"FOR LOVE AND RESPECT FOR LIFE"

Ing. Oscar Manuel Núñez
Executive Director

Fundación
Defensores de la Naturaleza
Ing. Oscar Núñez
DIRECTOR EJECUTIVO

OMN/jv
Encls. As indicated
cc. file

Av. Las Américas 20-21, zona 14, C.P. 01014, Guatemala, C. A.
Teléfonos: (502) 337 0319 - 337 3897 Fax: (502) 368 2648 EMAIL: defensores@pronet.net.gt

FUNDACION SOLAR

18 AVENIDA 18-72 ZONA 15, OTOT
GUATEMALA, GUATEMALA, C. A.
TEL.(502) 360-1172, TEL/FAX (502) 332-2548
e-mail: funsolar@guate.net

Papel Reciclado

Guatemala,
14 de octubre de 1997

Ingeniero
Carmelo Torrebiarte
Presidente OGIC
FUNDESA
Diagonal 6 10-67, Zona 10
Ciudad

Dear Mr. Torrebiarte:

I am pleased to present for the endorsement of the Guatemalan office on Joint Implementation the project entitled "Sierra de las Minas Biosphere Reserve Joint Implementation Project".

The project was prepared jointly by Fundación Defensores de la Naturaleza and Fundación Solar, private development organizations that are concerned with climate change mitigation actions as well as sustainable human development.

The project will avoid and/or fix more than 3 million tonnes of carbon, thus making a sustantial contribution to green house gases mitigation. Our carbon offsets calculations are conservative and methodologically sound.

We believe that this project will break ground for other national and international proponents of Joint Implementation initiatives.

Thank you very much for your attention to this matter. Please do not hesitate to contact us if further information is needed.

Sincerely yours,

Hugo E. Beteta
President

Maritza A. Canek
Secretaria Ejecutiva

Iván Azurdia Bravo
Director

cc.: S. Barrios, FUNDESA/OGIC
O. Nuñez, Defensores de la Naturaleza

THE SIERRA DE LAS MINAS BIOSPHERE RESERVE CARBON SEQUESTRATION PILOT PROJECT

PROPOSAL

SUBMITTED
FOR CONSIDERATION UNDER
THE GUATEMALAN INITIATIVE ON JOINT IMPLEMENTATION

by:

Fundacion Defensores de la Naturaleza
and
Fundacion Solar

September 1997

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ACKNOWLEDGEMENTS

The proponents of the Sierra de las Minas Joint Implementation Project, Fundacion Defensores de la Naturaleza and Fundacion Solar wish to thank the following persons and institutions for their support to prepare the first Guatemalan Joint Implmentation Project: USAID/G and ANACAFE for their financial support for project preparation; Winrock International, CSDA, CCAD, TNC, and the Universidad del Valle de Guatemala; and particularily Keneth MacDicken, Ellen Kennedy, Tia Nelson, Chrsitina Figueres, Carmen Torrebiarte, Edin Barrientos and Tobey Pierce.

PROPOSAL DEVELOPMENT TEAM

This proposal was developed under the direction of Ing. Oscar Nunez, Msc, Executive Director of Defensores de la Naturaleza. The proposal development team is comprised of the following individuals: Oscar Rojas, Igor de la Roca, and Anne M. Dix, PhD from Fundacion Defensores de la Naturaleza and Ivan Azurdia-Bravo and Hugo Beteta from Fundacion Solar.

THE SIERRA DE LAS MINAS BIOSPHERE RESERVE JOINT IMPLEMENTATION PROJECT

EXECUTIVE SUMMARY

Project Name: The Sierra de las Minas Biosphere Reserve Joint Implementation Project

Category: Land Conservation, Sustainable Forestry, and Renewable Energy

Greenhouse Benefits: Carbon Sequestration and Carbon Release Avoidance

US Participants: TBD

Guatemala Participants: Fundacion Defensores de la Naturaleza
Fundacion Solar

US Domestic Requirements/Motivations:

In the United States about 60% of the energy produced comes from burning fossil fuels. Fossil fuel combustion is the largest source of atmospheric pollution involving sulphur and nitrogen oxides, heavy metals, unburned hydrocarbons, particulate matter, carbon monoxide, and other health damaging pollutants. This pollution arises, not only as a result of fossil fuel combustion in power plants and industry, but also as a consequence of energy use by motor vehicles and households.

The United States is also committed to mitigating the impact of this excessive production of pollutants for future generations. Thus, it sees joint implementation as a cost-effective way to reduce global emissions of greenhouse gases while also helping less developed countries foster a sustainable development path and promoting environmentally friendly economic growth.

Project Description:

The Sierra de las Minas Biosphere Reserve (SMBR) covers 2,400 square kilometers and represents 2.22% of Guatemala's National Territory. It contains the largest remaining tract of cloud forest in Central America and is currently threatened by human activities such as agriculture, cattle ranching, fire, and lumber extraction. This situation is made worse by the lack of steady landholdings for the inhabitants around the reserve and shifting patterns of human colonization after years of civil unrest. The Sierra de las Minas encompasses 6 major life zones (Holdridge) and is an important watershed resource for the inhabitants of the Polochic River which drains into Lake Izabal and the Motagua River, both of which drain into the Caribbean. Countless farmers depend on these rivers to grow crops such as corn, beans, cotton, melons, sugarcane, rice, coffee, cardamom, bananas, shrimp, tomatoes, potatoes, broccoli, and raise cattle which constitute an important souce of subsistence and revenue for Guatemala. The rivers also provide a resource for industry such as sawmills, soft drink transnational manufacturers , and paper recycling plants that provide employment for local people and products consumed on the internal market. Unfortunately, shifting patterns of colonization indicate that the Sierra is one of the last frontiers to be settled within the country, and the lack of adequate financial resources and opportunities for part of the population is contributing towards the continual degradation of this important resource.

Based on an initial pilot study, which involved an inventory of standing biomass and leaflitter, as well as a survey of land use changes in the Sierra de las Minas between 1987 and 1995, we estimate that today, we are releasing 536,917 tons of carbon/year into the atmosphere as a consequence of deforestation in the Sierra. Currently this gas is responsible for 57% of the global warming trend. The Sierra de las Minas Biosphere Joint Implementation Program has two main components directed towards mitigating the effects of current land use patterns and therefore reducing CO_2 emissions due to deforestation, and providing alternative sources of energy in order to reduce the use of firewood and fossil fuels as a source of energy in the region. The land use component is geared towards the protection and enhancement of the Sierra de las Minas Biosphere Reserve's capacity as a carbon sink. This will be done through reforestation, managing natural regeneration and agroforestry systems. We believe that with adequate

management we can limit the total loss of carbon from the Sierra de las Minas to 164,000 tons of carbon/year. The energy component is geared towards using renewable energy technologies (photovoltaics and hydropower) in order to offset fossil energy production and use; and emission reduction using improved fuelwood stoves.

Minimum Greenhouse Gas Reduction Estimates (20 years):

Component A	Land Use	3,246,227 tC
Component B	Energy	246,672 tC
TOTAL		3,492,899 tC

This estimate is based on conservative assumptions for Component A . It does not include carbon sequestered as a result of farming practices such as those that grow corn, beans and others. Component B does not include 10,000 tC avoided due to the introduction of fuelwood saving stoves.

Project Duration:

Maximum carbon benefits will be realized over the period of 20 years. Private financial contributions are required for an initial ten year implementation phase, with an option for renewal. This project is expected to become self-supporting over the period of 20 years.

Total Cost per Unit of Greenhouse Gas Reduced:

Component A	US$ 4.23/tC
Component B	US$ 18.29/tC
Total Cost	US$ 5.27/tC

Based on a conservative estimate of carbon sequestered.

Budget:

Component A	Protection	$ 13,889,786
Component B	Energy	$ 4,511,596
Total Cost		$ 18,401,382

Monitoring and Verification:

Defensores de la Naturaleza and Fundacion Solar are currently developing a monitoring and verification protocol, which will be finalized in the preparatory phase of the project. It will be submitted to the USIJI committee for review and acceptance prior to its implementation. The main objective of the protocol will be to determine the actual amount of carbon being sequestered and avoided as a result of the Joint Implementation Program. An independent advisory panel will provide anual internal verification.

Other Environmental Impacts:

There will be direct positive impacts on ecosystem integrity and biodiversity. There will also be a direct positive effect on deterring the advance of the agricultural frontier. Secondary impacts are more difficult to measure, but equally important, among them insurance of the continuation of an adequate water supply for the communities located in the Polochic and Motagua drainage basins, whose livelihood is directly linked to the resource provided by the Sierra de las Minas. We expect the Sierra de las Minas Biosphere Reserve Joint Implementation Program will serve as a model for similar initiatives throughout Guatemala and the world.

Acronyms and Abbreviations:

AID	United States Agency for International Development
ASD	Alliance for Sustainable Development
C	Carbon
CO_2	Carbon Dioxide
CONCAUSA	Convenio Centroamericano-Estadounidense
Defensores	Fundacion Defensores de la Naturaleza
DOE	Department of Energy
EPA	Environmental Protection Agency
FCCC	Framework Convention on Climate Change
GHG	Greenhouse Gas
GIC	Guatemalan Office on Joint Implementation
GIS	Geographic Information Systems
IRC	Internal Revenue Code
JI	Joint Implementation
kWh	Kilowatt Hour
MEM	Ministry of Energy and Mines, Guatemala
MDB	Multilateral Development Bank
MOA	Memorandum of Agreement
NGO	Non-Government Organization
ODA	Overseas Development Organization
PUE	Productive Uses of Elcctricity
PV	Photovoltaics
SD	Steam Density
SMBR	Sierra de las Minas Biosphere Reserve
RET	Renewable Energy Technology
TAGB	Total Aboveground Biomass
tC	Tons of Carbon
TNC	The Nature Conservancy
USIJI	United States Initiative for Joint Implementaion
VOC	Volatile Organic Compound
Winrock	Winrock International

THE SIERRA DE LAS MINAS BIOSPHERE RESERVE JOINT IMPLEMENTATION PROGRAM

CARBON SEQUESTRATION PILOT PROJECT PROPOSAL

SUBMITTED FOR CONSIDERATION UNDER THE GUATEMALAN INITIATIVE ON JOINT IMPLEMENTATION

PART I. Project Proponents

A. Foreign Participants

To be determined

B. Domestic Participants

Fundacion Defensores de la Naturaleza

1. Corporate Officer Responsible for the Project

Ing. Oscar Nunez, Msc
Executive Director
Fundacion Defensores de la Naturaleza

2. Principal Contact Person for the Project

Ing. Oscar Rojas
Park Manager, Sierra de las Minas Biosphere Reeserve
Fundacion Defensores de la Naturaleza

Technical Advisors:

Anne M. Dix, PhD
Project Development Coordinator
Defensores de la Naturaleza

Igor de la Roca
GIS Systems Analyst
Defensores de la Naturaleza

3. Address

Fundacion Defensores de la Naturaleza
20-21 Avenida Las Americas, Z. 14
Guatemala City, Guatemala

(502)337-3897 (telephone)
(502)368-2648 (fax)
Defensores@pronet.net.gt (email)

4. **Category of Eligibility**: Fundacion Defensores de la Naturaleza is a Guatemalan non-profit organization, established in 1983 under government decree. It has legal administration of the Sierra de las Minas Biosphere Reserve through Decreto de Ley 49-90.

5. **Legal Proof of Eligibility: Fundacion Defensores de la Naturaleza is legally** registered in Guatemala with Tributary Tax Number: 559877-K.

Fundacion Solar

1. **Corporate officer responsible for the project**

Ing. Ivan Azurdia-Bravo, MSc.
Director, Project Development
Fundacion Solar

2. **Principal contact person for the project**

Ivan Azurdia-Bravo, ~~PhD~~ (MSc)
Director, Project Development
Fundacion Solar

Technical Advisor:

Hugo E. Beteta Mendez-Ruiz, PhD
President
Fundacion Solar

2. **Address**

Fundacion Solar
15 Avenida 18-78, Z. 13
Guatemala City, Guatemala
(502)360-1172 (telephone)
(502)332-2548 (fax)
funsolar@guate.net (email)

4. **Category of Eligibility:**

Fundacion Solar is a legally established private development organization under government decree number 302 published Monday, September 6, 1994.

5. **Legal Proof of Eligibility:**

Fundacion Solar is legally registered in Guatemala with Tributary Tax Identification Number 745003-6.

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C. Project Manager, Implementation Team, Advisory Panel and Changes in Participants

1. Organizational Structure

The Sierra de las Minas Joint Implementation Program will include the following organizational components, each to be established during the different phases of project approval by the USIJI Evaluation Panel.

a. Project Manager

A project manager will be appointed by the participants to direct project implementation in the SMBR, and facilitate coordination of the project participants and the the USIJI program.

b. Project Implementation Team

A project implementation team will be appointed by Fundacion Solar, Defensores de la Naturaleza and the US Partners with staffing adequate to carry out project objectives in both the land and energy components.

c. Internal Verification Advisory Panel

An advisory panel will be established, that will include representatives from Defensores, Fundacion Solar, OGIC, the Government of Guatemala, private financial participants, and local communities. The panel will also include technical experts in carbon sequestration, sustainable forestry management, renewable energy, socioeconomics, government, and FCCC (Framework Convention on Climate Change) policy and regulation. The project participants will keep the USIJI Secretariat and the Government of Guatemala promptly and fully informed in writing of all SMBR Pilot Project appointments.

2. Organizational Changes

The Project Manger and members of the Project Implementation Team, and members of the Internal Verification Advisory Panel may be changed from time to time by the participants. The participants will notify OGIC Secretariat and the Government of Guatemala in writing of any such changes in the annual report.

3. Changes in the List of Project Participants

In the event of a new participant in the Reserva de las Minas Joint Implementation Program, or should a participant of the project decide to no longer participate, the Project Manger will submit a revision of the list to the OGIC within 60 days following the conclusion of an agreement of participation with a new participant, or following a participants termination as appropiate.

D. About Defensores de la Naturaleza and Fundacion Solar

1. Why Defensores?

Defensores de la Naturaleza is a private, non-profit organization founded in 1983 and legally ratified in 1987 by Guatemalans committed to protecting the natural heritage left in the country. Defensores mission is to protect and conserve Guatemala's biodiversity for its intrinsic and human value. Its main activities are concentrated on: Protecting Natural Areas, Sustainable Development, Environmental Education, and Environmental Legislation and Policy. Defensores played a pivotal role in establishing the Sierra de las Minas Biosphere Reserve and was appointed coordinator and administrator of the area in 1990.

Defensores currently has two management programs within the Sierra de las Minas:

1. Protection of wildlife areas through patrols, wildlife monitoring, fire and pest control, land acquisition and the resolution of land disputes.
2. Sustainable development of the communities within and around the reserve through sustainable agriculture, the integration of women, forestry and environmental education.

Specific activities within these programs are being implemented based on a participatory process so that local populations take leadership in reserve protection. Defensores is currently funded by international organizations such as WWF, TNC, MacArthur, USAID and IUCN. Defensores personnel include a broad range of technical staff in areas such as ecology, forestry, biology, wildlife management, agriculture, anthropology, sociology, administration, and education.

Due to its success in the Sierra de las Minas, Defensores has recently acquired the administration of the Bocas de Polochic Wildlife Refuge, a wetland at the mouth of the Polochic River in Izabal; and the Parque Nacional Naciones Unidas, a recreational park protecting part of the watershed for Lake Amatitlan. Defensores is well respected within the conservation community in Guatemala and has a well deserved reputation for accomplishing what it proposes to do.

Defensores was the recipient of international recognition in 1991, when it was awareded the Clifford Messinger Award, given to the best conservation organization in Latin America. In 1994 Defensores de la Naturaleza was awarded the Guatemalan Presidential Medal for the Environment, given yearly to the most succesful environmental organization working in Guatemala.

2. Why Fundacion Solar?

Fundacion Solar is a private development organization registered in Guatemala since 1993 and founded with the vision to contribute to the construction of a society that respects nature and seeks the satisfaction of the needs of present and future members through the efficient use of energy and natural renewable resources. The vision of the organization is accomplished through the development of programs that are centered on: fostering participation, providing technical knowledge, participating in the policy dialogues and fostering the development of financial delivery mechanisms that are necessary to achieve a sustainable society.

Fundacion Solar promotes and develops programs in renewable energy and energy conservation with a special emphasis on rural communities. Fundacion Solar is a highly committed, creative and flexible organization that can respond to management of diverse types of projects. This fact is clearly reflectd by the programs that they have developed in the past for several donors, organizations such as Winrock International, USAID, Sandia National Labs, CECI, The World Bank, and ORNL.

One of Fundacion Solar's strengths is the flexibility of a diversified constituency and personnel, that ranges from energy specialists, economists, urban planners, and social scientists that have a record of hands on experience in rural energy projects and development programs.

II. Project Information

A. Description and Milestones

1. Project Summary

Unfortunately, shifting patterns of colonization indicate that the Sierra is one of the last frontiers to be settled within the country, and the lack of adequate financial resources and opportunities for part of the population is contributing towards the continual degradation of this important resource. Based on an initial pilot study , which involved an inventory of standing biomass and leaflitter, as well as a survey of land use changes in the Sierra de las Minas between 1987 and 1995, we estimate that today, we are releasing 536,917 tons of carbon/year into the atmosphere as a consequence of deforestation in the Sierra. This gas is responsible for 57% of the global warming trend.

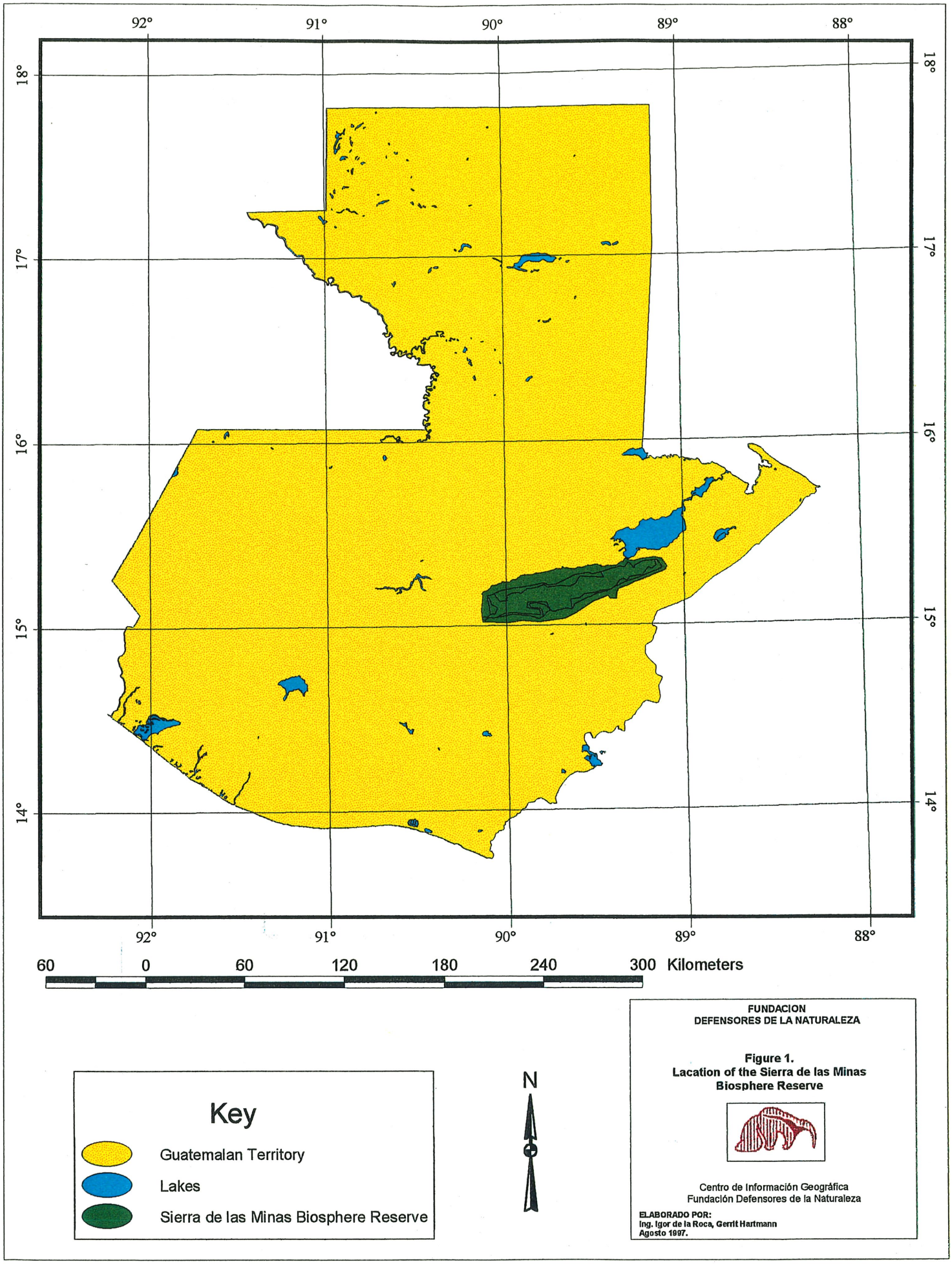
The Sierra de las Minas Biosphere Joint Implementation Program has two main components directed towards mitigating the effects of current land use patterns and therefore reducing CO_2 emissions due to deforestation, and providing alternative energy sources in order to reduce the use of firewood and avoid fossil fuel use in the region. The land use component is geared towards the protection and enhancement of the Sierra de las Minas Biosphere Reserve's capacity as a carbon sink. This will be done through reforestation, managing natural regeneration and agroforestry systems. We believe that with adequate management we can limit the total loss of carbon from the Sierra de las Minas to 164,000 tons of carbon/year, constituting a 70% reduccion in current emissions. The energy component is geared towards using renewable energy technologies (photovoltaics and hydropower) in order to offset fossil energy production and use; and emission reduction using improved fuelwood stoves.

2. Precise Location of the Project

The Sierra de las Minas Joint Implementation Project will be located in the Sierra de las Minas Biosphere Reserve (Figure 1), located in Eastern Guatemala, between the Motagua and Polochic Valleys. It covers an area of approximately 236,300 ha., measuring 130 km. in length and 10 to 30 km. in width. The reserve is the most important protected area in Guatemala for biodiversity conservation, because of the great diversity of ecosystems that it encompasses. Ranging from 150 to 3015 m. in elevation, it covers diverse climatic regimes, in a mountain chain that crosses five Guatemalan Departments (Alta Verapaz, Baja Verapaz, El Progreso, Zacapa, and Izabal). It is estimated that the reserve includes 70% of the vertebrate species found in Guatemala and Belice.

3. Other Relevant Information

The Sierra de las Minas Biosphere Reserve covers 2,400 square kilometers and represents 2.22% of Guatemala's National Territory. Located in Central Guatemala, it contains the largest remaining tract of cloud forest in Central America and is currently threatened by human activities such as agriculture, cattle ranching, fire, and lumber extraction. This situation is made worse by the lack of steady landholdings for the inhabitants around the reserve and shifting patterns of human colonization after years of civil unrest. The Sierra de las Minas encompasses 6 major life zones (Holdridge) and is an important watershed resource for the inhabitants of the Polochic River which drains into Lake Izabal and the Motagua River, both of which drain into the Caribbean. Countless farmers depend on these rivers to grow crops such as corn, beans, cotton, melons, sugarcane, rice, coffee, cardamom, bananas, shrimp, tomatoes, potatoes, broccoli, and raise cattle which constitute an important souce of subsistence and revenue for Guatemala. The rivers also provide a resource for industry such as sawmills, soft drink transnational manufacturers , and paper recycling plants that provide employment for local people and products consumed on the internal market.


92°
91°
90°
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18°
17°
16°
15°
14°
60 0 60 120 180 240 300 Kilometers
Key
Guatemalan Territory
Lakes
Sierra de las Minas Biosphere Reserve
N
FUNDACION
DEFENSORES DE LA NATURALEZA
Figure 1.
Lacation of the Sierra de las Minas
Biosphere Reserve
Centro de Información Geográfica
Fundación Defensores de la Naturaleza
ELABORADO POR:
Ing. Igor de la Roca, Gerrit Hartmann
Agosto 1997.

4. Description of Components

a. Summary of Component A: LANDUSE

Component A is geared towards the protection and enhancement of the Sierra de las Minas Biosphere Reserve as a carbon sink. Based on the principal problems that determine loss of forest cover, six subcomponents have been established, which represent actions that will be taken to avoid carbon emissions due to loss of carbon sinks from the Sierra de las Minas. The components are: Protection, Land Tenure, Forestry, Sustainable Rural Development, Monitoring and Evaluation and a Patrimonial Fund for the Long Term Protection of the Sierra.

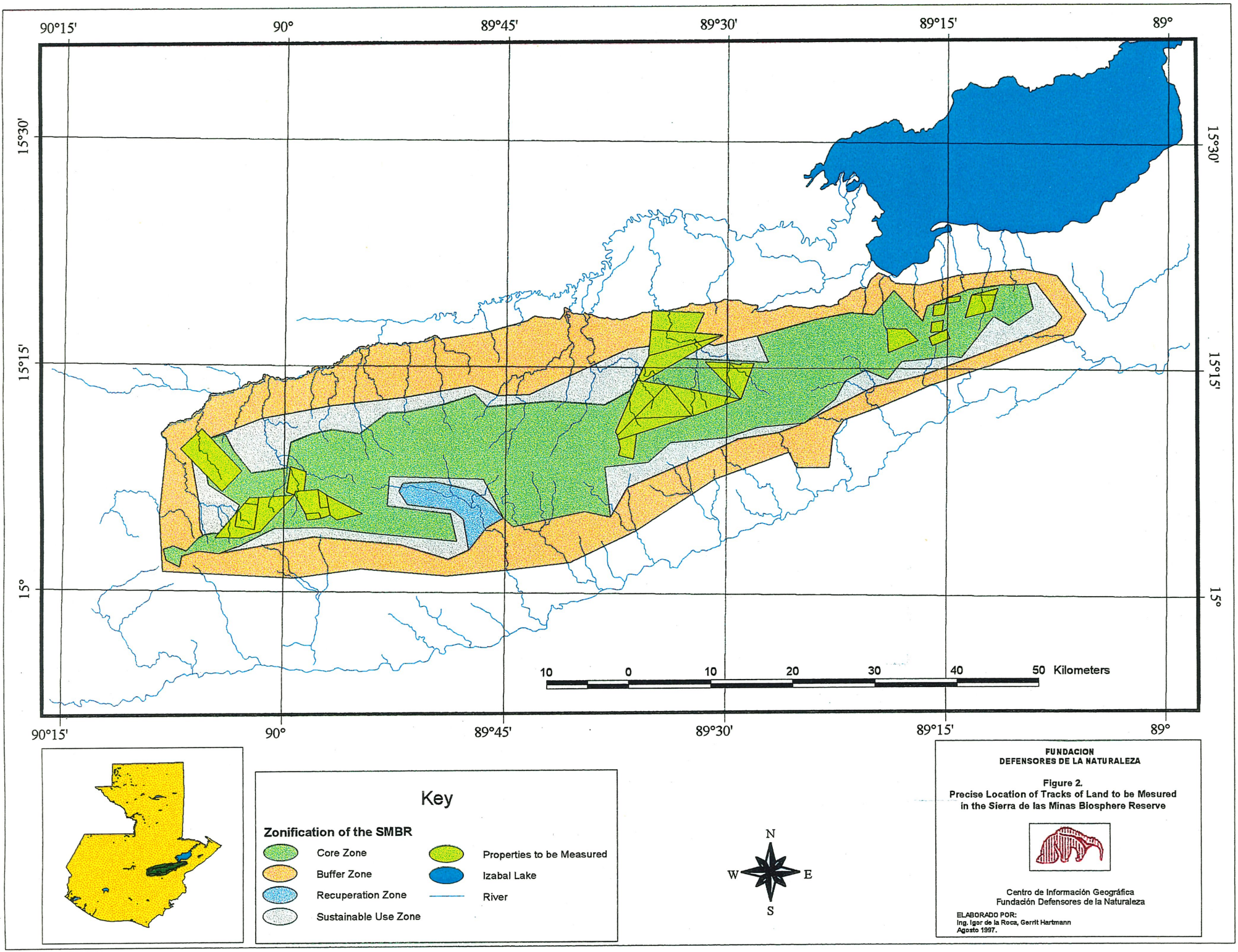
1. ***Protection.*** **Its main objective is to ensure natural resource protection, which includes the current forest cover and therefore existence of a carbon sink.** In this area the focus will be on land measurement (property of Defensores de la Naturaleza and the National Comission for Protected Areas), hiring personnel to monitor illegal activities, physically delimit the nuclear zone, construct basic infrastructure for forest protection, compensation of private landowners in the nuclear zone, and the implementation of legal action against abusers. Table 1 details specific tracts of land to be measured in the core zone of the reserve and basic expenses expected for this component. Figure 2 shows the precise location of these tracts of land.

2. ***Land Tenure.*** **The main objective is to regulate land tenure in order to reduce the advance of the agricultural frontier in places where there is still land tenure insecurity.** The main activities included under this subcomponent would be updating markers for priority areas, work on state lands and purchase of private lands for communities established on them. Table 1 details estimated expenses for updating legal land titles in the Polochic Drainage Basin, Lake Izabal and Los Amates, as well as estimates of how much it will cost to negotiate state lands in the communities of Pueblo Viejo, Semilha, Panjacoco, Sibija, Mululha, Tohila, Ribaco and Los Espinos. See Figure 3 for the precise location of state and Defensores owned tracts of land in the Sierra de las Minas.

3. ***Forestry.*** **The main objectives of this subcomponent are to recover forest cover, provide economic alternatives based on sustained use of the forest, and recuperate forest cover through the use of permanent crops, protection and rehabilitation of soil fertility, and intensification of integrated management of the forest resource.** This subcomponent will be developed along the following lines of action: reforestation, natural regeneration and community forest management. Figure 4 details areas to be reforested. An estimated cost of this component can be found in Table 1.

4. ***Sustainable Rural Development.*** **The main objective of this component is increase productivity per unit area in order to reduce the pressure on the soils of forest vocation within the reserve.** Furthermore, we want to contribute to food availability and improve the quality of life of local populations. In order to carry out these objectives we will promote food security based on sustainable agriculture and localized cattle production (not based on widespread grazing). Activities to be implemented will include and not be limited to shade coffee and cardamom, fruit trees, alley cropping, organic agriculture, soil conservation, pasture improvement, fodder storage and taungya. Table 1 contains estimated costs for this component.

5. ***Monitoring and Evaluation.*** **Through this component we propose to develop baseline information that could be used for making management decisions and monitor the development of the joint implementation project.** This component will support monitoring through remote sensing and will track changes in climate, fire regimes, succession, and wildlife populations around the reserve (mainly large mammals and birds). Figure 5 details the precise location of Defensores permanent monitoring plots established for the Joint Implementation Project. Table 1 summarizes estimated costs for this component.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90°
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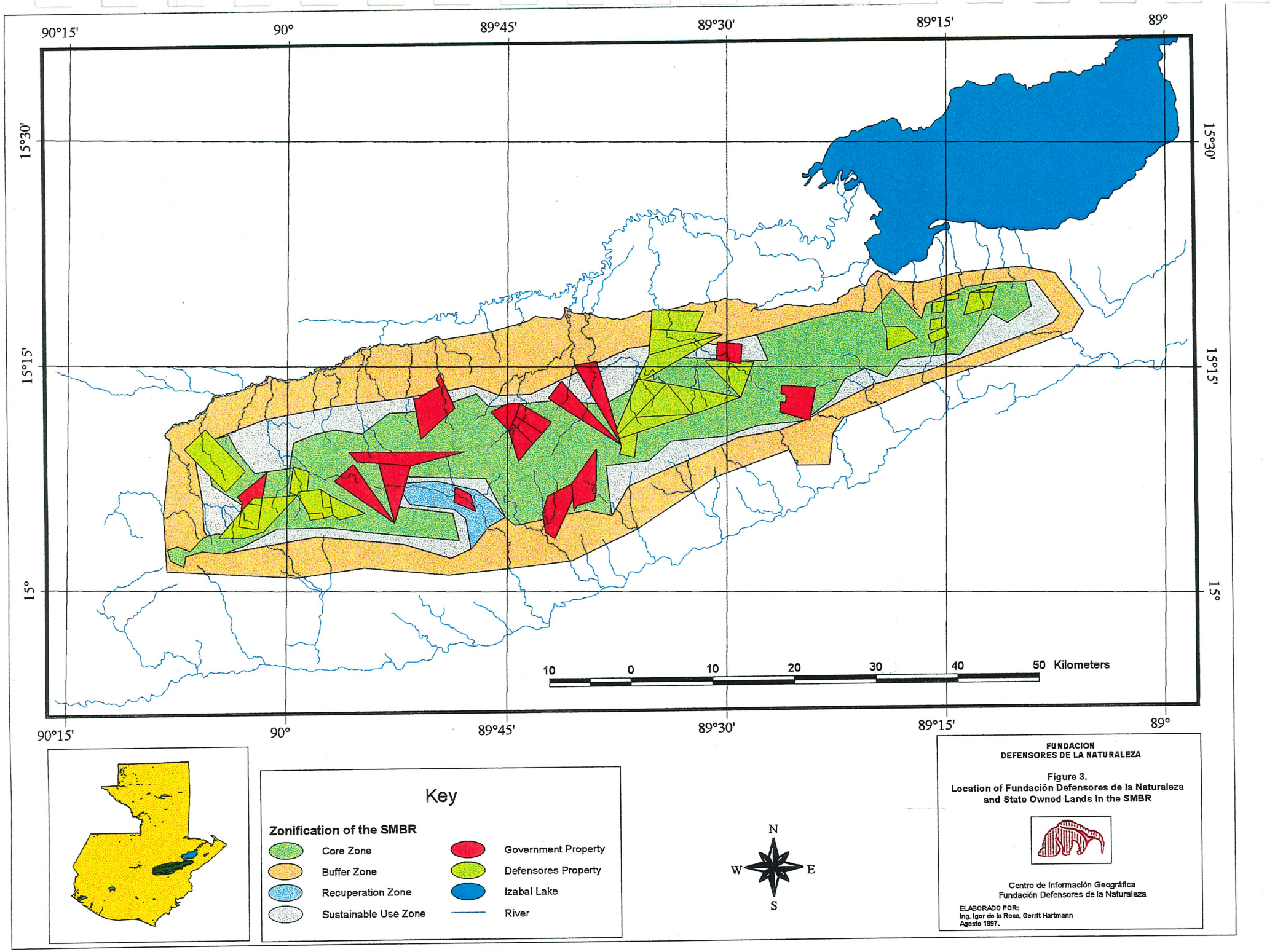
15°30'
15°15'
15°
10 0 10 20 30 40 50 Kilometers
Key
Zonification of the SMBR
Core Zone
Buffer Zone
Recuperation Zone
Sustainable Use Zone
Properties to be Measured
Izabal Lake
River
N
W
E
S
FUNDACION
DEFENSORES DE LA NATURALEZA
Figure 2.
Precise Location of Tracks of Land to be Mesured
in the Sierra de las Minas Biosphere Reserve
Centro de Información Geográfica
Fundación Defensores de la Naturaleza
ELABORADO POR:
Ing. Igor de la Roca, Gerrit Hartmann
Agosto 1997.


90°15'
90°
89°45'
89°30'
89°15'
89°
15°30'
15°15'
15°
10 0 10 20 30 40 50 Kilometers
Key
Zonification of the SMBR
Core Zone
Buffer Zone
Recuperation Zone
Sustainable Use Zone
Government Property
Defensores Property
Izabal Lake
River
N
W
E
S
FUNDACION
DEFENSORES DE LA NATURALEZA
Figure 3.
Location of Fundación Defensores de la Naturaleza
and State Owned Lands in the SMBR
Centro de Información Geográfica
Fundación Defensores de la Naturaleza
ELABORADO POR:
Ing. Igor de la Roca, Gerrit Hartmann
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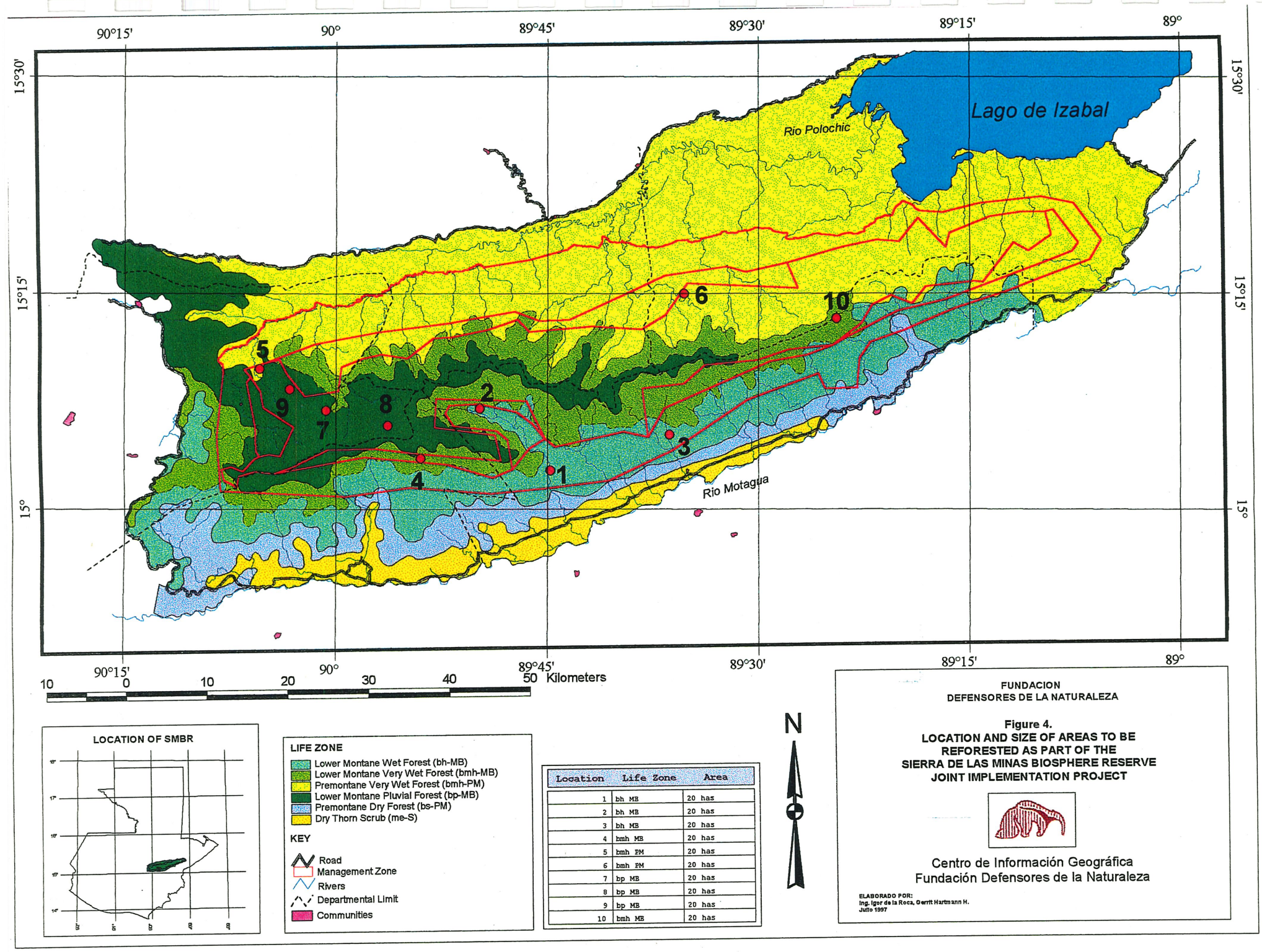

LOCATION OF SMBR

LIFE ZONE

- Lower Montane Wet Forest (bh-MB)
- Lower Montane Very Wet Forest (bmh-MB)
- Premontane Very Wet Forest (bmh-PM)
- Lower Montane Pluvial Forest (bp-MB)
- Premontane Dry Forest (bs-PM)
- Dry Thorn Scrub (me-S)

KEY

- Road
- Management Zone
- Rivers
- Departmental Limit
- Communities

Location	Life Zone	Area
1	bh MB	20 has
2	bh MB	20 has
3	bh MB	20 has
4	bmh MB	20 has
5	bmh PM	20 has
6	bmh PM	20 has
7	bp MB	20 has
8	bp MB	20 has
9	bp MB	20 has
10	bmh MB	20 has

FUNDACION
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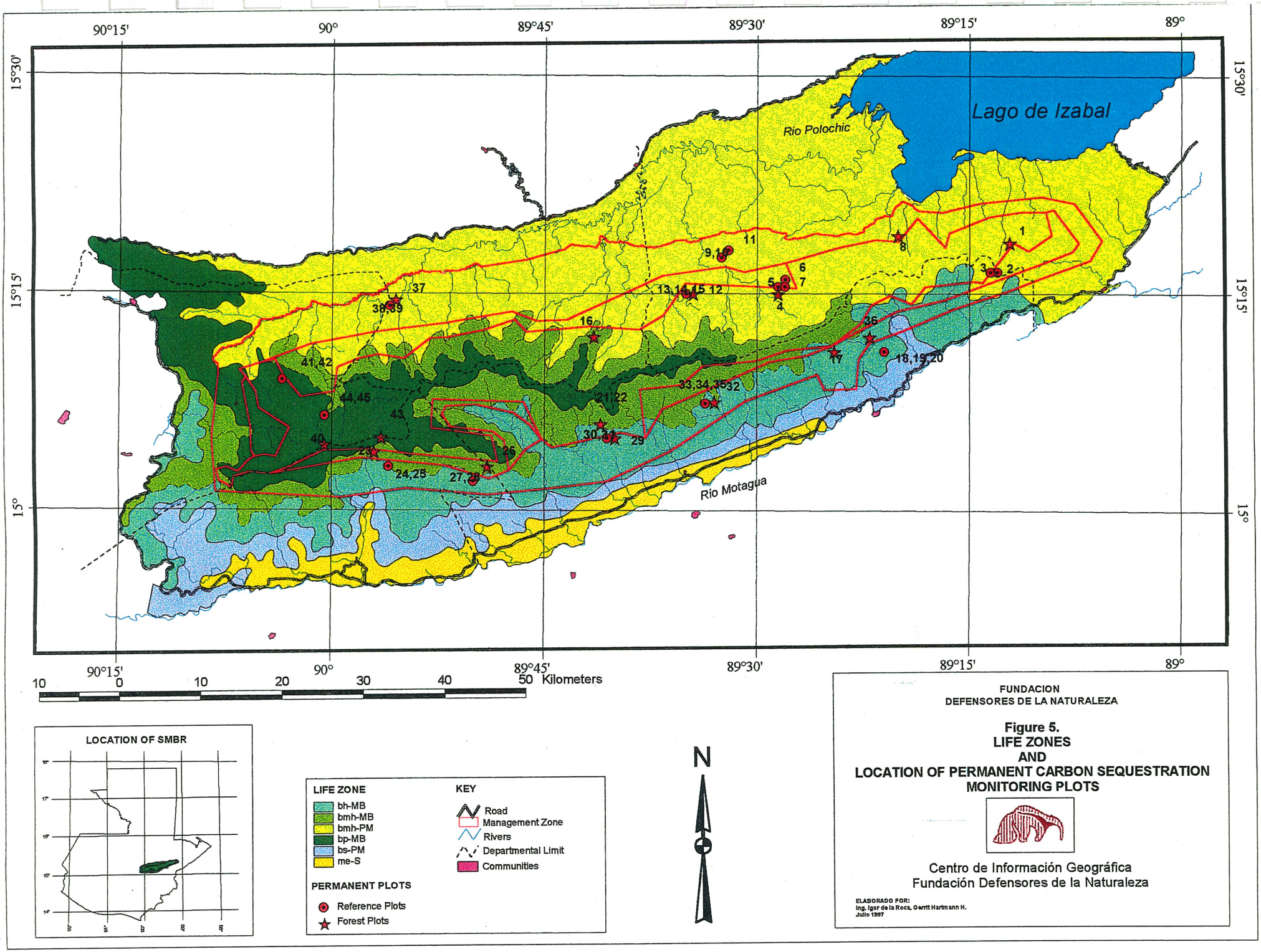
Figure 4.
LOCATION AND SIZE OF AREAS TO BE REFORESTED AS PART OF THE SIERRA DE LAS MINAS BIOSPHERE RESERVE JOINT IMPLEMENTATION PROJECT

Centro de Información Geográfica
Fundación Defensores de la Naturaleza

ELABORADO POR:
Ing. Igor de la Roca, Gerrit Hartmann H.
Julio 1997


90°15'
90°
89°45'
89°30'
89°15'
89°
15°30'
15°15'
15°
Lago de Izabal
Rio Polochic
Rio Motagua
1
2
3
4
5
6
7
8
9,10
11
12
13,14,15
16
17
18,19,20
21,22
24,25
26
27,28
29
30,31
32
33,34,35
36
37
38,39
40
41,42
43
44,45
10 0 10 20 30 40 50 Kilometers
LOCATION OF SMBR
LIFE ZONE
bh-MB
bmh-MB
bmh-PM
bp-MB
bs-PM
me-S
KEY
Road
Management Zone
Rivers
Departmental Limit
Communities
PERMANENT PLOTS
Reference Plots
Forest Plots
N
FUNDACION
DEFENSORES DE LA NATURALEZA
Figure 5.
LIFE ZONES
AND
LOCATION OF PERMANENT CARBON SEQUESTRATION
MONITORING PLOTS
Centro de Información Geográfica
Fundación Defensores de la Naturaleza
ELABORADO POR:
Ing. Igor de la Roca, Gerrit Hartmann H.
Julio 1997

6. ***Patrimonial Fund for the RBSDM.*** **The patrimonial fund established during the first 5 years of the project will be used in order to generate funds for long-term (20 years) protection of the reserve.** By financing the project in this way, inflationary costs are avoided and the total project investment will decrease by almost 40%. Table 1 details our financing plan for the project.

b. Summary of Component B. ENERGY.

In order to remedy the lack of alternative energy sources a dual energy strategy will ration consumption and increase biomass fuel efficiency:

1. Managed production of biofuels to diminish firewood combustion.
2. Extending modern energy supplies to those lacking it, through renewable energy sources.

The challenge is to introduce technologies that are both locally relevant, while reducing local demand for biomass fuels and promoting a shift to environmentally benign technologies. A multifaceted approach involving the following components will be used:

1. *Improved Stoves.* Kitchen performance tests comparing open fire and improved stoves show that the latter yield firewood savings ranging from 19 to 44% depending on cooking practices, diets, and income levels (Vita 1982). The first subcomponent would support efficient use of biomass fuels for cooking and space heating, reducing cash expenditures, time and effort collecting firewood, reduce pollution, improve health, lower pressure on the forest, and reduce soil erosion. In addition the project will promote better architecture, better ventilation, more and larger openings and the use of more porous wall materials and roof types, and kitchen location as ways of maximizing the benefits of these stoves. Figure 6 describes an improved stove.

FINANCING PLAN

ACTIVITY	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14
Protection														
Land Measurement				$ 34,160	$ 34,160	$ 34,160	$ 34,160	$ 34,160						
Core Zone Delimitation				$ 30,493	$ 30,493									
Refuge Construction				$ 3,159		$ 3,159					$ 3,159			
Computers		$ 5,000	$ 5,000		$ 5,000	$ 5,000					$ 10,000			
GPS	$ 6,000	$ 2,500	$ 2,500			$ 11,000					$ 11,000			
Field Equipment	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493
Vehicles	$ 30,000		$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000		$ 30,000	$ 30,000	$ 30,000	$ 30,000
Contract Lawyer	$ 29,001	$ 29,001	$ 29,001	$ 29,001	$ 29,001	$ 9,667	$ 9,667	$ 9,667	$ 9,661	$ 9,667				
Contract Protection Personnel	$ 177,100													
Field Expenses and Maint	$ 64,000													
Land Tenure in Communities														
Personnel Acquisition			$ 33,880	$ 33,880										
Field Expenses			$ 6,776	$ 6,776										
Vehicles			$ 10,000											
Equipment and Maintenance			$ 3,333	$ 3,334										
Land Legalization-Lawyer			$ 4,000	$ 4,000										
Field Expenses-Lawyer			$ 4,000	$ 4,000										
Land Purchase for Communities				$ 240,000	$ 240,000	$ 240,000	$ 240,000	$ 240,000						
Measure and Title Land				$ 140,400	$ 140,400	$ 140,400	$ 140,400	$ 140,400						
Forestry Subcomponent														
Reforestation FDN/CONAP				$ 14,600	$ 14,600	$ 14,600	$ 14,600	$ 14,600	$ 14,600	$ 14,600	$ 14,600	$ 14,600	$ 14,600	
Reforestation Incentives				$ 7,000	$ 7,000	$ 7,000	$ 7,000	$ 7,000	$ 7,000	$ 7,000	$ 7,000	$ 7,000	$ 7,000	
Sustainable Rural Development														
Contract Personnel			$ 160,396	$ 160,396	$ 160,396	$ 160,396	$ 160,396							
Field Expenses			$ 32,079	$ 32,079	$ 32,079	$ 32,079	$ 32,079							
Educational Materials			$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000							
Workshops and Field Trips			$ 39,057	$ 39,057	$ 39,057	$ 39,057	$ 39,057							
Vehicles			$ 30,000											
Vehicle Maintenance			$ 6,510	$ 6,510	$ 6,510	$ 6,510	$ 6,510							
Personnel Training			$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000							
Monitoring and Evaluation														
Satellite Imagery	$ 4,500			$ 4,500			$ 4,500			$ 4,500			$ 4,500	
Produce Materials		$ 5,000		$ 5,000		$ 5,000		$ 5,000		$ 5,000		$ 5,000		$ 5,000
Computers	$ 25,000			$ 25,000			$ 25,000			$ 25,000			$ 25,000	
GIS Software	$ 2,000		$ 2,000		$ 2,000		$ 2,000		$ 2,000		$ 2,000		$ 2,000	
Plotters/Printers	$ 17,500			$ 17,500			$ 17,500			$ 17,500			$ 17,500	
Personnel Training	$ 7,500		$ 7,500		$ 7,500		$ 7,500		$ 7,500		$ 7,500		$ 7,500	
Forest and Agricultural Monit	$ 10,000		$ 20,000	$ 20,000	$ 10,000									
Climate Monitoring			$ 10,000											
Wildlife Monitoring			$ 10,000	$ 10,000										
Fire Monitoring				$ 10,000										
Succession Monitoring			$ 10,000	$ 10,000	$ 10,000	$ 10,000								
Monitoring and External Evaluation			$ 135,260			$ 135,260			$ 135,260			$ 135,260		
Trust Funds														
Personnel	$ 3,059,347													
Field Expenses and Equipment Maint		$ 740,000												
Boundary Revival			$ 124,785											
Land Compensation		$ 3,670,179												
Yearly Total	$ 3,434,441	$ 4,454,173	$ 735,570	$ 960,344	$ 837,695	$ 902,780	$ 789,862	$ 483,320	$ 208,514	$ 85,760	$ 87,752	$ 194,353	$ 110,593	$ 37,493
	$ 3,511,590	$ 7,965,763	$ 8,701,333	$ 9,661,676	$ 10,499,371	$ 11,402,151	$ 12,192,013	$ 12,675,333	$ 12,883,847	$ 12,969,607	$ 13,057,359	$ 13,251,711	$ 13,362,305	$ 13,399,798

YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20
	$ 3,159				
	$ 10,000				
	$ 11,000				
$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493	$ 2,493
	$ 30,000	$ 30,000	$ 30,000	$ 30,000	
	$ 4,500			$ 4,500	
	$ 5,000		$ 5,000		$ 5,000
	$ 25,000			$ 25,000	
$ 2,000		$ 2,000		$ 2,000	
	$ 17,500			$ 17,500	
$ 7,500		$ 7,500		$ 7,500	
$ 135,260			$ 135,260		
$ 147,253	$ 108,652	$ 41,993	$ 172,753	$ 88,993	$ 7,493
$ 13,547,051	$ 13,655,702	$ 13,697,695	$ 13,870,448	$ 13,959,441	$ 13,966,935

Table 1. Budget and Financing Plan for the Sierra de las Minas Joint Implementation Project Landuse Component

Figure 6. Description of an Improved Stove

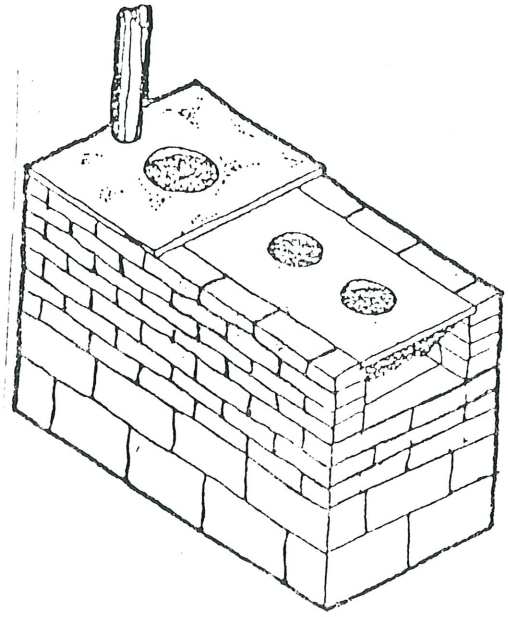
Components: Firebox, flue or chimney, air inlet, one damp, baffles, and heat exchangers.

Materials:

- Metal sheet 3/16" x 1.5" x 3": 3 potholes
- 78 bricks
- 3 pieces for chimney pipe
- Accessories (sheetmetal, cement, sand, etc.)

Total Cost: including labor US$ 150.00 each.

Figure of stove



2. *Photovoltaics for Rural Lighting.* The project proposes to install 2,000 stand alone photovoltaic systems (50 watts or less) for home, health clinics and school lighting. The proposed systems will be independent (not part of a network) and consist of a photovoltaic panel that generates electricity using sunlight, a battery to store the energy produced, an electronic charge controller to protect the main system from excessive charge or downloads, three 20 watt fluorescent lamps to convert electric power to light, an outlet to supply 12 V. power to small appliances (radios, black and white televisions, or kitchen appliances, cables and accesories (switches, contacts, and mounting base) needed to mount the system (Figure 7). These systems have no moving parts and can provide power for over 20 years if used adequately, and are designed to withstand local environmental conditions and use. The photovoltaic systems can provide 113 ampere/hours and may last up to 4 days with no sunshine. The P.V. systems will avoid almost 700 tC in the project lifetime.

3. *Small Hydroelectric Systems.* The project proposes to install forty 50 kW units in order to foster productive uses of electricity such as water pumping for irrigation, sawmills, carpentry shops, refrigeration, food processing and other non agricultural productive activities. The hydro facilities will be strategically located and users will pay a base fee in order to cover maintenance and the eventual replacement of the unit. See Figure 8 for description of hydroelectric systems. The hydroelectric systems will avoid 245,980.8 tC in the life of the project.

Table 2 contains estimated budget for component B.

5. Dates of Significant Milestones

a. Date and Circumstances When Substantive Discussions Regarding the Project were Initiated

The Sierra de las Minas Joint Implementation Project has been developing over 2 years, as a result of promotion by CCAD and an initial contact made through The Nature Conservancy in Six months later, Defensores and Fundacion Solar began collecting information on Carbon Sequestration based on methodologies developed by Winrock International. At the same time Defensores de la Naturaleza initiated discussions with Fundacion Solar about potential renewable energy technologies that could be used in the area. Fundacion Solar negotiated support from USAID and ANACAFE in order to develop the current proposal.

b. Dates for applying for and receiving necessary permits, licenses, written approvals, letters of intent, agreements with host country governments and financing for this project.

i.	Permits and Licenses	TBD
ii.	Host Country Ratification	March 1995
iii.	Letter of Intent	
iv.	Host Country Approval	October 1997
v.	OGIC Approval	October 1997
vi.	Project Financing	TBD

Table 2. Estimated Budget for Sierra de las Minas Biosphere Reserve Joint Implementation ENERGY COMPONENT.

TABLE 2: ESTIMATED BUDGET FOR COMPONENT B: ENERGY
INSTITUTION IN CHARGE: FUNDACION SOLAR
YEAR 1 BUDGET

ITEM	RATE US$	DAYS/UNITS	TOTAL
I PERSONNEL			
Project coordinator	150.00	260	39,000.00
Hydro specialist	120.00	160	19,200.00
PV specialist	80.00	160	12,800.00
Stoves specialist	100.00	160	16,000.00
Gender specialist	120.00	200	24,000.00
RET technitian	80.00	260	20,800.00
Training staff	80.00	260	20,800.00
Support staff	60.00	260	15,600.00
Sub-total			168,200.00
Finge Benefits (14%)			23,548.00
II MATERIALS & EQUIPMENT			
□ stan alone PV system	750.00	1,000	750,000.00
□ mini-hydro systems	57,000.00	20	1,140,000.00
□ improved fuelwood stoves	100.00	800	80,000.00
□ computer equipment	2,000.00	3	6,000.00
□ office supplies	1,500.00	1	1,500.00
□ tools	1,500.00	1	1,500.00
□ walky talkies	1,000.00	1	1,000.00
□ Training material	2,000.00	1	2,000.00
□ miscelaneus expenses	1,500.00	1	1,500.00
Sub-total			1,983,500.00
III VEHICLES & TRAVEL			
□ vehicles 4X4	30,000.00	2	60,000.00
□ fuel	6,000.00	1	6,000.00
□ O/M vehicles	3,000.00	1	3,000.00
□ per-diem rural	20.00	400	8,000.00
□ trasportation mat.	600.00	40	24,000.00
□ insurance	2,000.00	2	4,000.00
□ international travel	900.00	2	1,800.00
□ per-diem international	250.00	8	2,000.00
Sub-total			108,800.00
IV OTHER DIRECT COSTS			
□ Training	2,500.00	1	2,500.00
□ communications (phone, e-mail, courier, fax)	4,000.00	1	4,000.00
□ office space	1,000.00	12	12,000.00
□ other ODC	300.00	12	3,600.00
Sub-total			22,100.00
V TOTAL YEAR 1			**2,306,148.00**

TABLE 2.1: ESTIMATED BUDGET FOR COMPONENT B: ENERGY
INSTITUTION IN CHARGE: FUNDACION SOLAR
YEAR 2 and 3 BUDGET

ITEM	RATE US$	DAYS/UNITS	TOTAL
I PERSONNEL			
Project coordinator	150.00	260	39,000.00
Hydro specialist	120.00	160	19,200.00
PV specialist	80.00	160	12,800.00
Stoves specialist	100.00	160	16,000.00
Gender specialist	120.00	200	24,000.00
RET technitian	80.00	260	20,800.00
Training staff	80.00	260	20,800.00
Support staff	60.00	260	15,600.00
Sub-total			168,200.00
Finge Benefits (14%)			23,548.00
II MATERIALS & EQUIPMENT			
□ mini-hydro systems	57,000.00	20	1,140,000.00
□ stan alone PV system	750.00	1,000	750,000.00
□ minor spare parts	2,000.00	1	2,000.00
□ improved fuelwood stoves	100.00	800	80,000.00
□ office supplies	1,500.00	1	1,500.00
□ Training material	1,000.00	1	1,000.00
□ miscelaneus expenses	1,000.00	1	1,000.00
Sub-total			1,975,500.00
III VEHICLES & TRAVEL			
□ O/M vehicles	4,000.00	1	4,000.00
□ fuel	5,000.00	1	5,000.00
□ per-diem rural	20.00	200	4,000.00
□ trasportation mat.	600.00	2	1,200.00
□ insurance	2,000.00	2	4,000.00
□ international travel	900.00	1	900.00
□ per-diem international	250.00	4	1,000.00
Sub-total			20,100.00
IV OTHER DIRECT COSTS			
□ Training	1,200.00	1	1,200.00
□ communications (phone, e-mail, courier, fax)	2,500.00	1	2,500.00
□ office space	1,000.00	12	12,000.00
□ other ODC	200.00	12	2,400.00
Sub-total			18,100.00
V TOTAL YEAR 2 & 3			2,205,448.00

Figure 7. Description of a Typical Photovoltaic Stand Alone System.

Components:

- 30-50 Wp panels (Solarex, Kyosera, Simmens).
- Deep cycle battery 105 Ah (Trojan, Titan, Reliable).
- LVD/HVD Controller (Trace, Sunamp, ASC-SCI).
- 3/20 W Lamps
- Accessories (Fuses, water, wire, plugs, etc.)

Total Cost: US$ 600 - 790/System

Photovoltaics (solar cells)

Photovoltaics -PV- or solar cells convert sunlight directly into electricity. Photovoltaics are self-contained and can be used in complete autonomy or in tandem with other electricity generating systems (i.e. wind or diesel) to offer greater diversity in generating capability. Photovoltaics require no fuel expenditures, have low operating and maintenance costs, and produce no noise pollution or electromagnetic emissions. The reliability factor of photovoltaics systems is extremely high because the systems have no moving parts. However, the initial cost is relatively high.

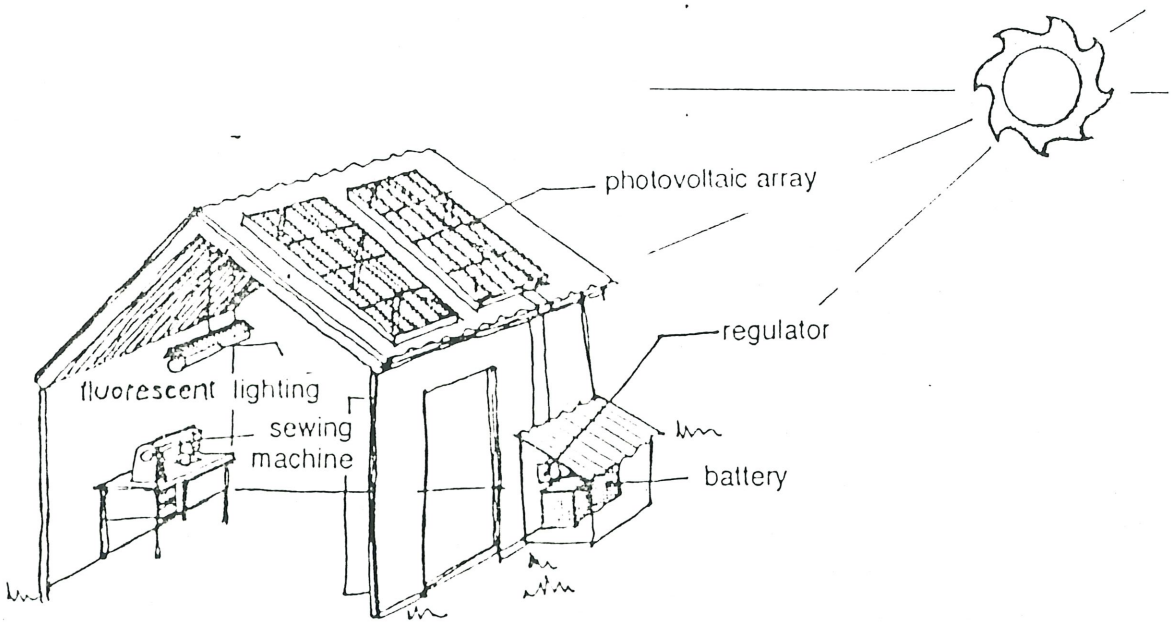


Table 3. Changes in land use between 1987 and 1995 and net carbon production in Tc/year in the Sierra de las Minas Biosphere Reserve (See Figure 1).

Life Zone	1987 Forest Cover (ha)	1995 Forest Cover (ha)	Total Loss (ha)	Net Gain (ha)	Net Loss (ha)	Deforestation ha/yr	%
Bp – MB	34002	33235	3430	2663	767	95.88	
Bmh –MB	44546	42641	6564	4659	1905	238.13	
Bh – MB	25810	18994	10158	3342	6816	852.00	
Bmh – PM	66161	60799	15749	10387	5362	670.25	
Bs – MB	302	271	161	130	31	3.88	
Overall	170821	155940	36062	21181	14881	1860.13	

Table 4. Estimated Lifetime of the Forest/Life Zone Without Measures

Life Zone (Holdridge)	Forest Cover 1995 (ha)	Annual Loss of Forest Cover (ha)	Number of Years Deforestation Rate
Bp-MB	33,235	95.88	346
Bmh-MB	42,641	238.13	179
Bh-MB	18,994	852	22
Bmh-PM	60,799	670.25	90

Figure 8. Description of a Small Hydroelectric System

Hydropower converts water's potential energy into electricty using a hydraulic turbine connected to a generator.

The picture below shows water being diversted by a small dam into a canal that carries the water to a pipe, called the penstock, which conveys the water downhill to the powerhouse. The key elements in the system are the quantity of water available and the drop in elevation from the forebay to the powerhouse. The cost of a hydro system is much lower if the change in elevation between the forebay and the powerhouse is large. Thus the best micro hydro sites are located where waterfalls and rapids exist. Many micro hydros do not have a power canal and the dam is usually locally made using stones or other local materials. The powerhouse can be very simple and is only needed to protect the electrical equipment from the elements.

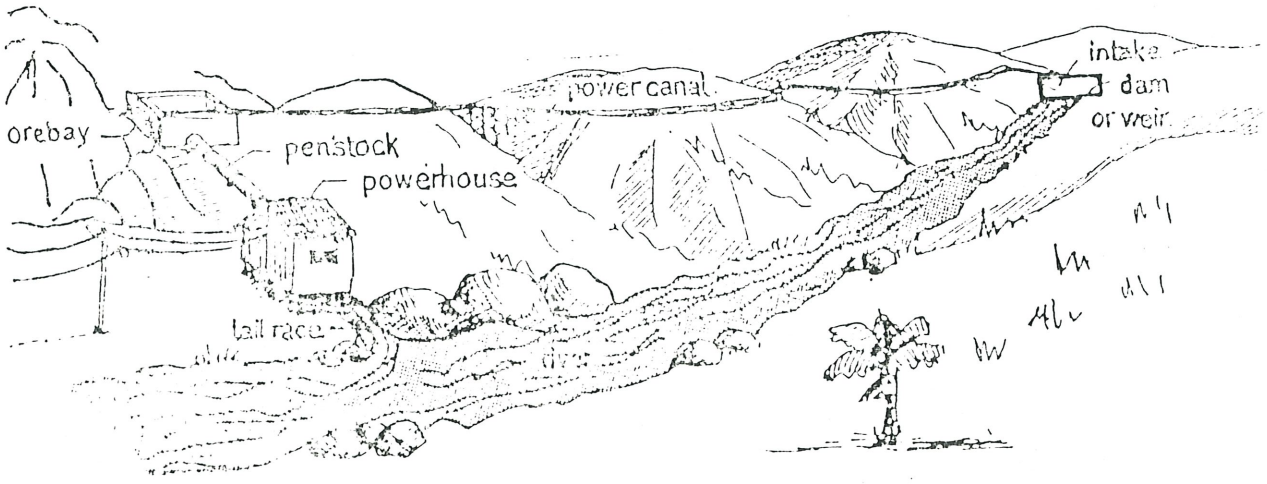


Table 5. Estimated Lifetime of the Forest/Life Zone With Measures

Life zone (Holdridge)	Forest Cover 1995 (ha)	% Deforestation to be Reduced by Joint Implementation Project	Number of Years Deforestation Rate
Bp-MB	33,235	42%	346
Bmh-MB	42,641	50%	179
Bh-MB	18,994	30%	22
Bmh-PM	60,799	60%	90

Appendix 4 shows how these figures were developed based on aerial photography, satellite imagery, and field sampling in order to determine current carbon stores in each life zone.

vii. Comprehensive Agreement August 5, 1995

c. Dates for Starting and Completing Signficant Phases of the Project

TBD

d. Dates for Initiating Greenhouse Gas Emissions

TBD

e. Anticipated Project Lifetime

Maximum carbon benefits will be realized over the 20 year period. Private financial contributions are required for an initial ten year implementation phase, with an option for renewal. This project is expected to become self-supporting in 20 years.

B. Sources of Funding for the Specific Measures to Reduce Greenhouse Gas Emissions

1. Sources and Expected Contributions

Feasibility Study: ANACAFE, USAID
Project Financing: TBD

2. Multilateral Financial Support

TBD

3. Federal Funds

TBD

C. Assignment of Emissions Credits

In general the GHG offset credits generated by this project will be apportioned between the projects financial participants, domestic and foreign, in proportion to their relative financial contribution to the project.

Component	Activity	Responsible Party	tC Sequestered or Avoided
Component A	Land Use	Defensores	3,246,227 tC
Component B	Energy	Fundacion Solar	246,672 tC

This estimate is based on conservative assumptions in the landuse component. The Energy component does not include the contribution of improved stoves (10,000 tC). It does not include carbon sequestered as a result of farming practices such as those that grow corn, beans and others.

An annual apportionment accounting of the offsets will be conducted each year by the parties. Defensores de la Naturaleza and Fundacion Solar will shared responsibility for supervising this aspect of the Sierra de las Minas Pilot Project's implementation. The results will be included in the Sierra de las Minas Pilot Project annual reports and will be submitted to the USIJI Evaluation Panel and the OGIC.

D. Additionality

a. General Demographic Trends and Land Use Patterns in Guatemala

Deforestation rates in Guatemala today are directly correlated with population growth in the last 50 years. In less than 30 years, Guatemala's population has doubled and aproximately 25,000 ha of forest have been lost. In 1960 Guatemala had 4 million inhabitants and 68% forest cover. By the end of 1981 the population had reached 8.6 million and total forest cover was only 39% (Leonard 1987). As of 1997, the population is close to 10 million and the country's forested area is only 29%. With a doubling time of 23 years, the Guatemalan population is expected to grow to 13 million people by the year 2000 (Mendez 1988).

The most commonly cited cause of deforestation in Guatemala is the increasing colonization of previously uninhabited regions. Shifting agriculture and the anual burning of large tracts of land for grazing cattle are having an irreversible effect on the forest cover of the Sierra de las Minas. In addition, many rural households firewood is the main source of fuel. With increasing population size, the need for firewood rises and pressure on local forest systems is intensified.

Between 1987 and 1995 the annual deforestation rate in the Sierra de las Minas amounted to 1.09%, which is equivalent to 1860 ha/year. Most of these losses are taking place in the lower montane wet forest (Holdridge) and the very wet premontane forest (Holdridge). The Sierra de las Minas is home to over 2000 species of plants, as well as 70% of the species of reptiles, birds and mammals known from Guatemala and Belice (Nations et al. 1989). These include endemic species of orchids, insects, and herpetofauna, and endangered bird and mammal species. It is also the largest source of tropical pine germplasm in the world.

Sixty three rivers are used to provide downslope for household consumption, irrigation, hydropower and industrial purposes come from the Sierra de las Minas. Because of its ecological importance, the Sierra de las Minas was declared a National Protected Area in 1990. This status has afforded some degree of protection to the area, particularly in the case of lumber extraction. However, conservation efforts have been hampered by insufficient resources. There have also been significant lapses in coordination between the different governmental and non-governmental bodies in charge of the area. The Sierra's forests, despite their protected status, are still threatened by illegal logging, firewood extraction, and clearing for agricultural and livestock use. Effective preservation will require more resources, better inter-agency coordination and active involvement of people living in the reserve's immediate surroundings.

Forty thousand inhabitants, living in 150 communities occupy the 38,700 ha buffer zone which surrounds the core protected area. Most of them depend on small scale farming and grazing for their subsistence and lack access to credit and technical assistance. For many, wood cutting is an important household income supplement. Only six communities in the Sierra de las Minas (including both buffer and multiple use zone) have access to electric power, and the remoteness of the other communties makes connection to the national electric grid costly and unlikely. Because the inhabitants of the reserve rely heavily on the Sierra for their subsistence and commercial activities, they are both the main threat to the forest, as well as the most dependent on the benefits it provides. By increasing their productivity and opportunities for employment, we hope to sustain the buffer zone resource base and avoid disturbing the core of the Sierra de las Minas Biosphere Reserve.

2. General Energy Consumption Patterns

At the moment, firewood provides 63% of all energy used in the country and 93% of the energy used by all households (CIEN, Carta Economica No. 134, Feb. 1994). Guatemala has Central Americas highest per-capita biomass consumption (2.7 beo/year), the highest growth of firewood consumption (4.8% between 1978 and 1983), and the highest share of firewood users (77%) as a percent of total population (Kline 1987). Modern fuels, including electricity, allow people to enjoy better living standards, more economic opportunities, and a cleaner and more sustainable environment. The availability of electricity has preceded local economic growth and has fostered the emergence of myriad enterprises. As a result, electricity has facilitated fuller employment, higher local wages, and acquisiton of new skills. Electricity has also made productivity increasing devices possible. Modern energy sources have reduced health threats for women and other users who embroider at night, cook with open fires or live with kerosene lamps. Electricity facilitates night studying and meetings, makes people feel safer, and brings about water pumping, communications and less expensive refrigeration.

Despite the importance of electricity, previous public efforts towards rural electrification in the Sierra de las Minas have not been sufficiently effective. In 1996, Guatemala's installed capacity was only 950 MW (INDE 1997). At current rural electrification rates it would take some 200 years to provide central grid electricity to every non-electrified community in the Sierra. In the meantime, effective demand would grow steadily at 7% yearly, representing some 66 MW a year or close to 300 MW to the year 2000. The investments needed to keep up with this demand represent more than US$ 450 million.

Given the supply gap, it is not surprising that access to electricity in the Sierra is among the lowest in Guatemala. Only 6 communities, of the 150 communities located around the Sierra have access to electricity. Besides low coverage, access to electricity is highly skewed: 73% of poor households in the metropolitan region of the capital city have electricity, but only 6 % of the poor households in the Sierra have similar access. To resolve this problem some 99% households in the Sierra depend primarily on biomass for cooking. This is a shame, considering the great hydropower potential in the Sierra. In Guatemala we are only using 9% of the hydropower sources we could use (Stein y Arias 1992).

* beo: Barrels of Equivalent Petroleum

3. History of the Sierra de las Minas Biosphere Reserve and Relation to Current Project

The Northern slopes the Sierra remained uninhabited until the end of the 19th century, when the Pocomchi indians were displaced by German immigrants. Initially, population density remained low, however in the 1970's the Q'eqchi rapidly occupied the central and eastern sections of the Sierra de las Minas. This was in part, a direct consequence of the political and social conflict in Guatemala at that time. Unfortunately, this rapid expansion, combined with increasing population density and scarce economic development opportunities has resulted in the disorderly invasion of the upper slopes.

On the other hand, on the Southern slopes of the Sierra de las Minas traditional cattle ranching and lumber extraction, combined with the increase of fire frequency and the inequivocable changes in natural forest composition are the major threats. This area is predominantly occupied by ladino populations, but despite all this, this is where the largest tracts of conifer forest remain.

Starting in the mid 1980's the Sierra de las Minas was identified along with other parts of Guatemala, as a hot spot for protection due to the high diversity of life zones it encompasses. It took 5 years of effort to legally declare the Sierra de las Minas as a Protected Area and Biosphere Reserve in 1990. Defensores has spent the past 7 years developing relationships with stakeholders (local communities, private landowners, authorities and resource users). Current demographic trends and land use patterns are one of the main contributors to the destruction of our remaining carbon sinks. This situation is closely linked to inadequate land titling and current energy consumption strategies. Implementing actions to mitigate both of these situations is costly and hard to fund over the long term. As a result, protection strategies often become temporary fixes until funding for another project, which is not necessarily complementary, comes through. Instead of a steady protection effort, we are often faced with stops and starts which lead to a lack of constancy in protection efforts.

Guatemala's National Budget is by no means capable of absorbing these costs and there are no legal internal mechanisms in place to support this kind of activity. Through this project we hope to raise enough funding to set up a trust fund, which after an initial investment would become self-sustaining over the 20 year period. This would help maintain protection efforts at an adequate level, secure land tenure and develop a renewable energy development program which would become self-sustaining after the initial investment.

E. Acceptance by the National or Federal Government of the Host Country

To be negotiated.

F. Technical Assistance

Negotiation with TNC and Winrock International is intended, since both are long term partners of Defensores de la Naturaleza and Fundacion Solar.

III. Component A: Greenhouse Gas Emissions and Sequestration

A. Baseline Estimate of Emissions and/or Sequestration of Greenhouse Gases Without Measures

The Sierra de las Minas Biosphere Reserve has a varied biomass, primarily consisting of broadleaf and conifer forests. These forests can be classified into five general life zones: lower montane wet forest, very wet lower montane forest, pluvial lower montane forest, very wet premontane forest, and lower montane dry forest (Figure 9). In terms of carbon sequestration we find the first four to be the most significant (Table 3). For the purposes of this proposal, limited to currently available data on these five vegetational associations, we have used the Winrock Methodology (based on point measurements of surface biomass, underground biomass, soil biomass, and leaf litter biomass) (Appendix I) for estimating biomass and established long term monitoring plots in order to begin generating in depth biomass stock information in order to develop more precise carbon calculations.

Biomass measurements were taken in 1996. At the same time 45 monitoring plots were established, of which 11 are permanent forest plots (50 m^2) (Figure 5). This totals 2,500 m^2 of broadleaf forest, 1000 m^2 of mixed forest (broadleaf and conifer) and 500 m^2 of conifer forest. Smaller transects were used to measure total biomass for different annual crops (corn, beans) (50m^2), permanent crops (4-5 plants), and cattle ranching (20 m^2).

There is virtually no information available on land use and biomass stock in the area. The calculations of land use change rely on aerial photography interpretation between 1987 and 1995, with a resolution of 1:50,000 (Figure 10). Figure 11 shows in red areas where forest cover was lost in the reserve between 1987 and 1995. It is noteworthy that the data obtained here is similar to the data obtained by Brown and Lugo 1984 in similar associations around the world. Table 4 provides estimates of the actual lifetime of the forest found in each life zone, based on current deforestation rates.

Characterization of Life Zones in the Sierra de las Minas and their Current Status as Carbon Sinks

a. Lower Montane Pluvial Forest (bp-MB).

This life zone is characterized by precipitation exceeding 4,000 mm/year.

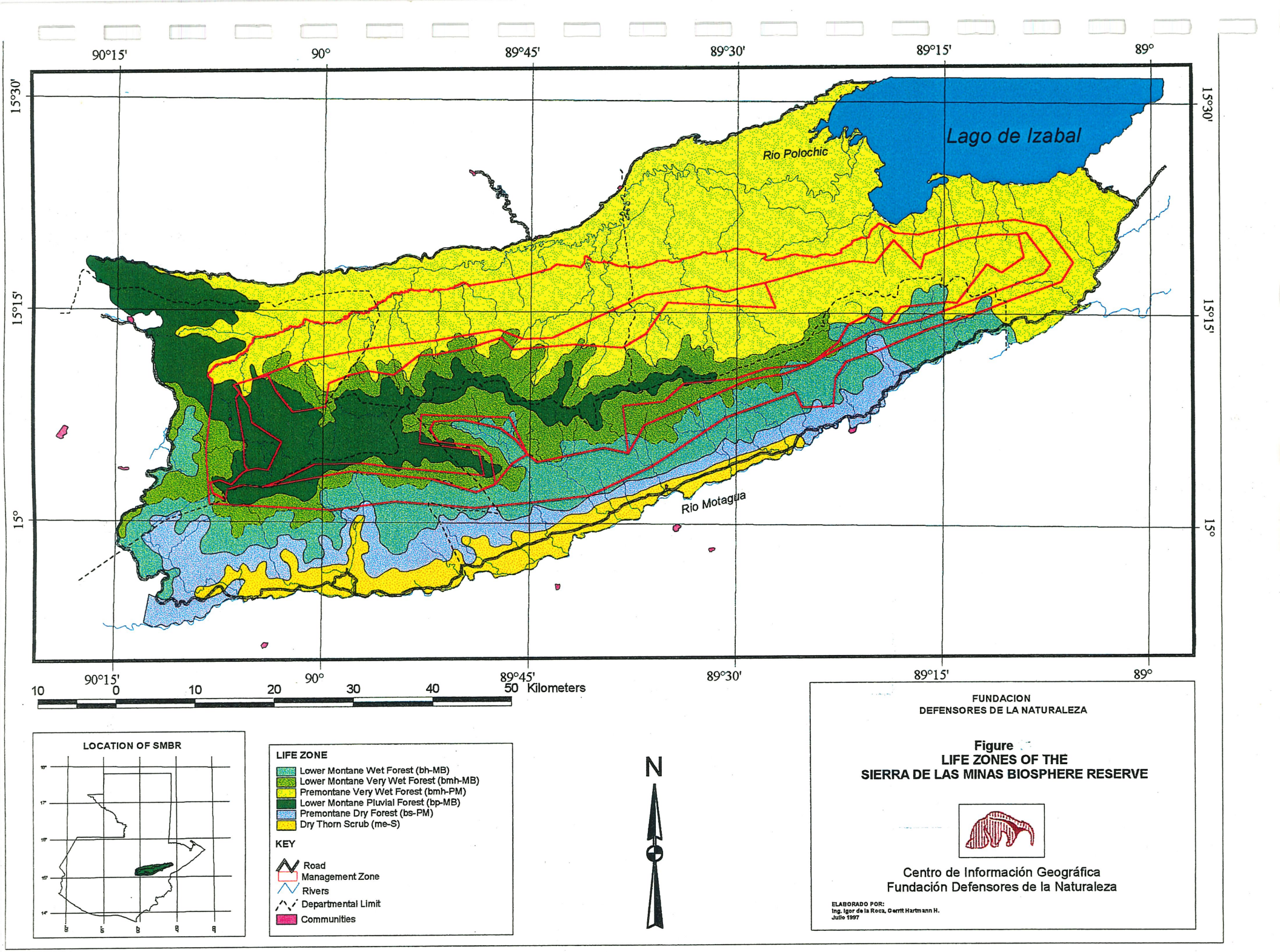
In this life zone 767 has of primary forest were lost between 1987 and 1995, which amounts to an annual loss of 75,000 tons of carbon/year during this time period. Most of this forest was transformed to anual agriculture and pastures (42%), and the remaining area became second growth shrubland (57%). This life zone is most heavily affected by losses due to subsistence agriculture, carried out by communities that have invaded the land and that do not have clearly delimited property lines. Most of the soils in this area

are classified as primarily for forest use. This is the most productive life zone in terms of carbon sequestration, producing 779.41 tC/ha/yr.

b. Very Wet Lower Montane Forest (bmh-MB)

This life zone is characterized by 1800-4000 mm of rainfall/year and is located between 1400 and 2700 m above sea level. Generally this land is full of faults. Characteristic vegetation includes encinos, Lauraceae, Magnoliaceae, Alnus, and Prunus. This is a cloud forest formation due to the constant high humidity levels. There are many arborescent tree ferns and Araceae.

The forest in this life zone is 68% broadleaf and 32% pine. Losses to this forest type amounted to 1905 ha between 1987 and 1995. This corresponds to releasing approximately 106,172 tons of carbon/year. Much of the deforestation in this area is due to ilegal lumber extraction and natural regeneration is limited by intensive use of these lands for pasture. The increased fire frequency due to this activity is drastically changing the composition of the forest and we don't expect to have any more by the year 2174 (less than 200 years away) (Table 5). This forest type is the second most productive in terms of carbon sequestration, producing 445 tC/yr. The Sierra de las Minas contains the largest continous extension of cloud forest in Central America.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Lago de Izabal
Rio Polochic
Rio Motagua
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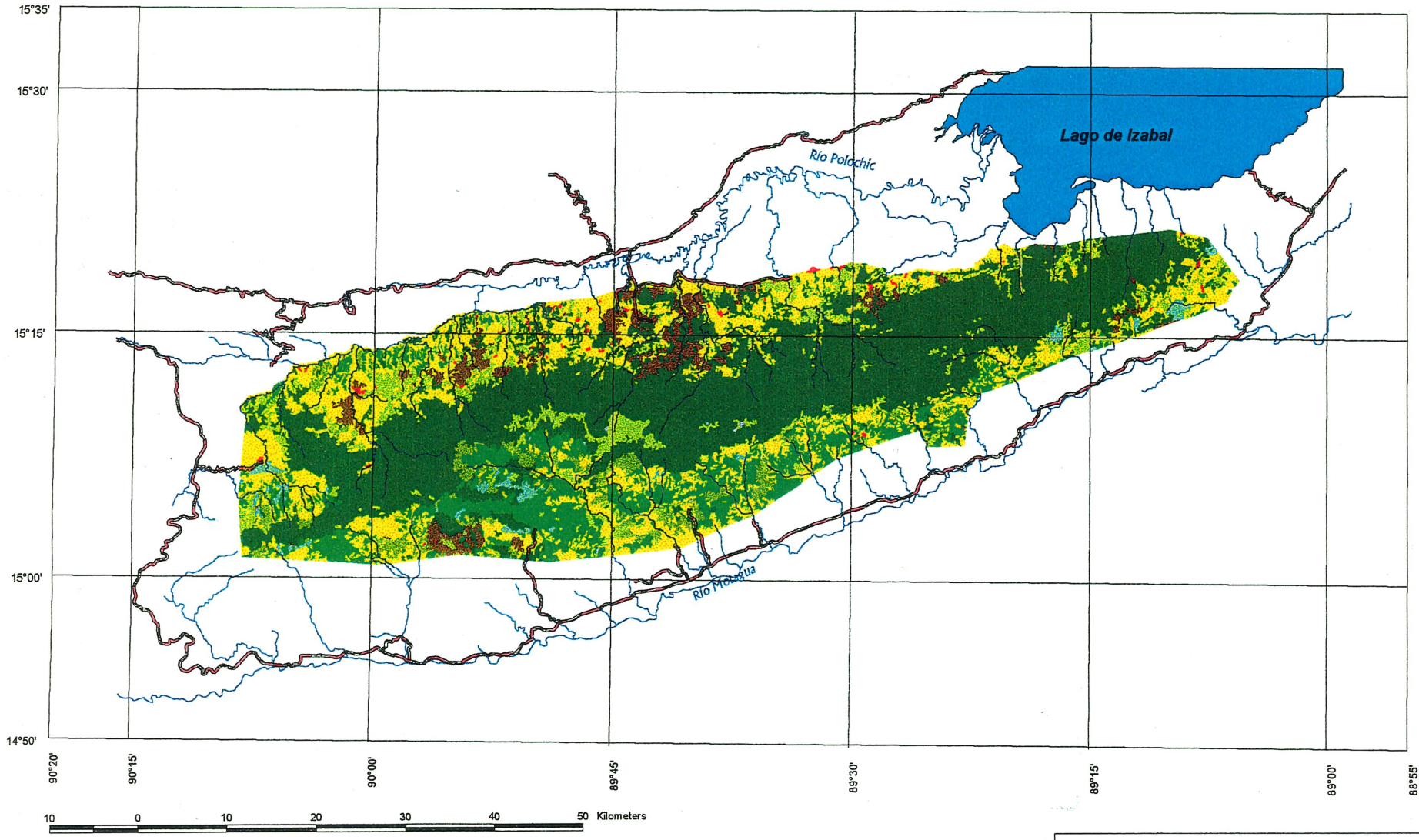
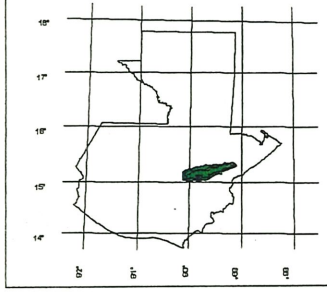
LOCATION OF SMBR
LIFE ZONE
Lower Montane Wet Forest (bh-MB)
Lower Montane Very Wet Forest (bmh-MB)
Premontane Very Wet Forest (bmh-PM)
Lower Montane Pluvial Forest (bp-MB)
Premontane Dry Forest (bs-PM)
Dry Thorn Scrub (me-S)
KEY
Road
Management Zone
Rivers
Departmental Limit
Communities
N
FUNDACION
DEFENSORES DE LA NATURALEZA
Figure
LIFE ZONES OF THE
SIERRA DE LAS MINAS BIOSPHERE RESERVE
Centro de Información Geográfica
Fundación Defensores de la Naturaleza
ELABORADO POR:
Ing. Igor de la Roca, Gerrit Hartmann H.
Julio 1997



LOCATION OF SMBR



SIGNS

- Rivers
- Roads

USE CATEGORY

- Anual Agriculture, Pastures
- Permanent Agriculture
- Shrubs
- Reforested Areas
- Broadleaf Forest
- Mixed Forest
- Conifer Forest
- Human Settlements
- Sterile Land, Open Mines

Cover	Surface Area (ha)
Mines	98
Human Settlements	589
Anual Agriculture, Pastures	62074
Permanent Agriculture	9682
Shrubs	13827
Reforested Areas	2081
Broadleaf Forest	117497
Mixed Forest	8281
Conifer Forest	28513

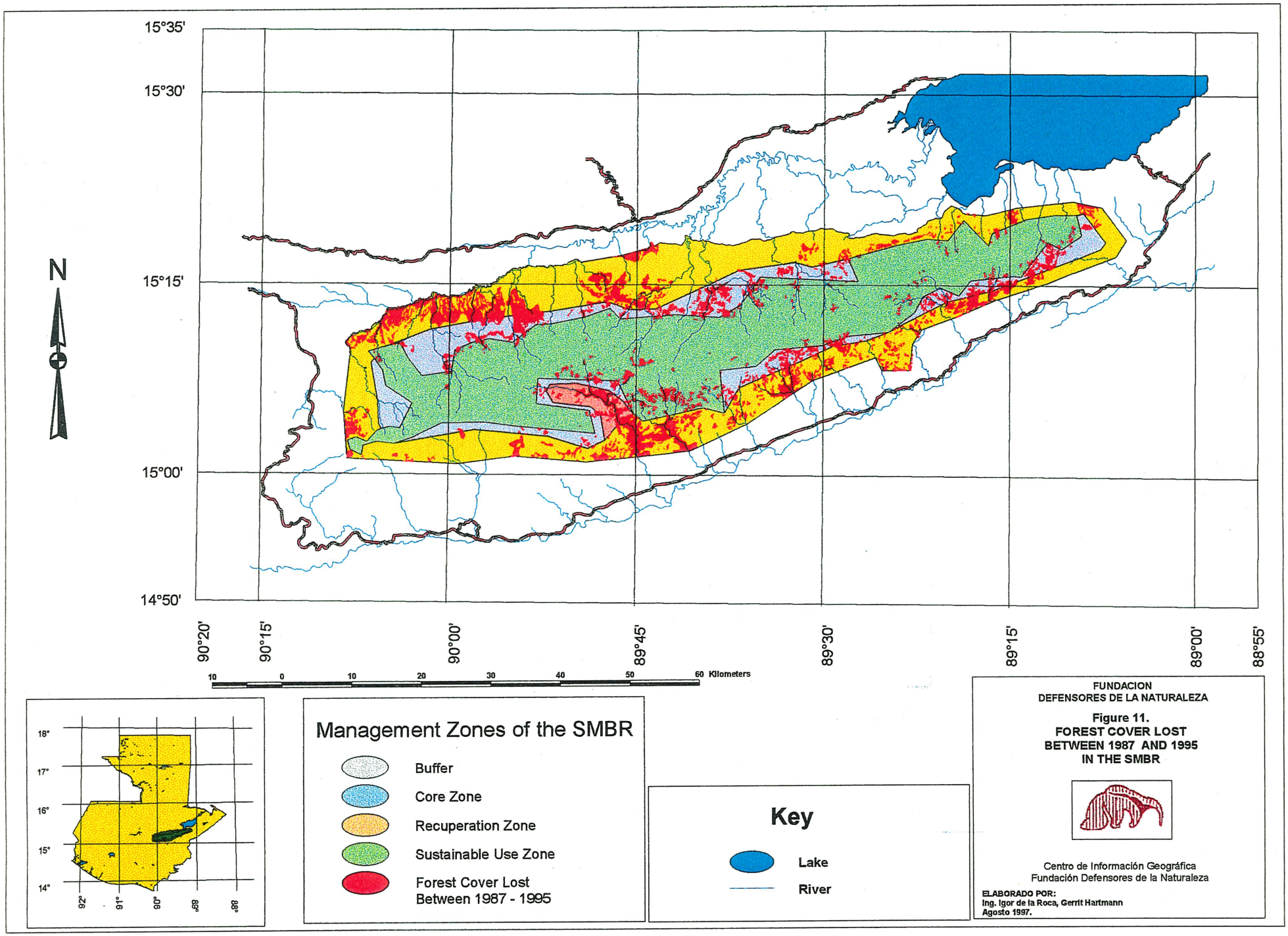
N

FUNDACION
DEFENSORES DE LA NATURALEZA

Figure
VEGETATION COVER AND LAND USE
1995

Centro de Información Geográfica
Fundación Defensores de la Naturaleza

ELABORADO POR:
Ing. Igor de la Roca, Gerrit Hartmann H.
Julio 1997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89°00'
88°55'
10 0 10 20 30 40 50 60 Kilometers
18°
17°
16°
15°
14°
92°
91°
90°
89°
88°
Management Zones of the SMBR
Buffer
Core Zone
Recuperation Zone
Sustainable Use Zone
Forest Cover Lost
Between 1987 - 1995
Key
Lake
River
FUNDACION
DEFENSORES DE LA NATURALEZA
Figure 11.
FOREST COVER LOST
BETWEEN 1987 AND 1995
IN THE SMBR
Centro de Información Geográfica
Fundación Defensores de la Naturaleza
ELABORADO POR:
Ing. Igor de la Roca, Gerrit Hartmann
Agosto 1997.

c. Wet Lower Montane Forest (bh-MB)

This life zone is characterized by 1000-2000 mm of rainfall/year and is located between 1400 and 2700 meters above sea level. This forest contains oak, pine, cypress, and pinabete. The pine is a natural successional stage of this forest. This is the part of the Sierra de las Minas that has been most affected by human activities and man. As rainfall increases, the pine forest grades into Liquidamber, and Tillandsia usneoides becomes more abundant in the trees. There are many epiphytes, mosses and arborescent tree ferns. This type of forest naturally occurss in 15% of Guatemala and is important both to agriculture and tourism.

Between 1987 and 1995 we lost 6815 has of forest in this part of this reserve. This corresponds to a loss of 160,942 tons of carbon/year. Subsistence agriculture and intensive pasturing again account for most of the deforestation in this area and it is the most threatened life zone in the Sierra. If deforestation continues at the current rate, we expect to have no more of this forest left in 22 years (Table 4).

d. Very Wet Premontane Forest (bmh-PM)

This life zone is characterized by 2040-4000 mm of annual precipitation. It generally is found between 700 and 1400 m above sea level. It is characterized by oaks, Lauracea, palms, and ferns. There is an abundance of epiphytes. These forests generally occur on steep slopes, highly susceptible to erosion. Seven percent of Guatemala is located within this life zone and it is here that most of Guatemalas Coffee and cardamom is grown..

5362 has were deforested in this life zone between 1987 and 1995, which accounts to a loss of 195,076 tons of carbon/year. The main causes of changes in land use in this area include migratory anual agriculture, extensive pasturing, land tenure insecurity, invasiones and problems in the delimitation of property lines. It is one of the most threatened life zones in Guatemala and if deforestation continues at the current rate, we expect this forest to completely disappear in the Sierra de las Minas in the next 90 years.

B. Estimates of Emissions and Sequestration of Greenhouse Gases with Measures

The proponents expect to reduce current deforestation levels by 42% in the lower montane pluvial forest, 50% in the lower montane very wet forest, 30% in the lower montane wet forest and 60% in the very wet premontane forest. Table 4 illustrates the expected lifetime of the forest with and without joint implementation. Through this project we expect to buy time for the forest and in most cases double the time we expect this kind of forest.

C. Monitoring Greenhouse Gas Emissions and Updating Emissions Estimates

1. Monitoring Program

We will periodically monitor the advance of the agriculture frontier, plant succession by life zone and carbon sequestration in permanent monitoring plots. As mentioned before we have 11 permanent forest plots, coupled with 34 reference plots in permanent agriculture (coffee, cardamom), annual crops (corn, beans), secondary growth, and cattle grazing areas. Monitoring will also include water quality variables (in order to monitor variables such as soil erosion), climatic stations (to track temperature and rainfall regimes on the long-term, and the impact of fire on the forest composition of the southern slopes.

Monitoring will be carried out using satellite images, which will be analyzed every 3 years. This will provide us with a measure of current land use patterns and changes, as well as an assessment on changes in temperature regimes in different parts of the Sierra through the use of thermal images. These images will be acquired through the collaborative agreement between NASA/Defensores and the Universidad del Valle.

The monitoring data will be used to publish current maps of the region which could later be used in order to manage the area under the principles of adaptive management.

2. Updates

D. External Verification

1.	Certification	TBD
2.	Data, Procedures, Methodologies	TBD

IV COMPONENT B: GREENHOUSE GAS AVOIDANCE.

A. BASELINE ESTIMATE OF EMISSIONS AND/OR AVOIDANCE OF GREENHOUSE GASES WITHOUT MEASURES:

In the Sierra de las Minas Biosphere Reserve there are forty thousand inhabitants, living in 158 communities within the 38,700 ha buffer zone. Only six communities in the Sierra have access to electricity power, and their remoteness makes connection to the national interconected grid costly and unlikely. Fuelwood, kerosene and dry cells batteries are the only source of energy for the people at the Sierra.

Furthermore, Guatemala's energy sector is agressively moving towards electricity generation by means of burning coal and petroleum. By October 1997, the national electrification index is 40%. For the SMBR the electrification index is less than 4%. If the communities ever get electrified, they will also become dependent on a system that is expected to be fueled 85% by fossil fuels by the year 2,000.

In any case, it is safe to say that the villages at the SMBR will rely only on biomass fuelwood as the primary source of energy, thus increasing the amount of GHG's though burning it in open fires at a very low efficiency (8%), releasing between 0.7 to 1 tC/year per open fire, releasing a total that ranges from 560 to 800 tC for a twenty year period in each open fire, this amounts a total of 10 tC that will be released to the environment.

Furthermore, if a very unlikely scenario of rural electrification takes place they will be consuming electricity generated by the burning of fossil fuels, and not necessarily replacing firewood. As a matter of fact of the 40% of rural households that do have access to electricity service only 7% cook with electricity or non-biomass stoves such as LPG.

B. ESTIMATES OF EMISSIONS AND AVOIDANCE OF GREENHOUSE GASES WITH MEASURES.

Electricity allows people to enjoy better standards of living, more economic opportunities, and a cleaner and more sustainable environment. The availability of electricity has preceded local economic growth and has fostered the emergence of myriad enterprises. As a result, electricity has facilitated fuller employment, higher local wages, and acquisition of new skills. Electricity has also made productivity-increasing devices possible. Modern fuels, moreover, have reduced health threats for women and other users who emboider at night, cook with open fires or live with kerosene lamps. Electricity facilitates night studying and meeetings, make people feel safer and have the ability to bring a myriad of productive uses of electricity such as water pumping, communications, refrigeration, and so on and so forth.

Despite the importance of electricity, previous public efforts towards rural electrification in la Sierra de las Minas have not been suffiently effective. In 1996, the region-s installed capacity was only 300 kW (EEGSA, 1994 cited in CIEN, 1994). At current rural electrification rates, it would take some 200 hundred years to provide central grid electricity to every non-electrified community in the Sierra.

Given the supply gap, it is not surprising that access to electricity in the Sierra is among the lowest in Guatemala. Forty thousand inhabitants (over 90% of the region's households) in over 150 villages and hamlets lack electricity. Besides low coverage, access to electricity is highly skewed: 73% of poor household in the metropolitan region of the capital city have electricity, but only 4% of poor household Sierra's region do. (INE. Aspectos Socio-demograficos de la Pobreza en Guatemala, Vol. VI, Marzo 1992).

To solve their energy needs, most households depend primarily on biomass for cooking in the Sierra (INE, 1992). Firewood provides 63% of all energy used in the country, and 93% of the energy used by all households in the country. (CIEN, Carta Economica No. 134, Feb., 1994).

Biomass resources are rapidly being depleted. Guatemala has Central America's highest per-capita consumption of biomass (2.7 BEP/year)[4], the highest growth of firewood users (77%) as percent of total population (Kline, 1987, p.4).

Better-off families, in contrast, spend only 7% of their non-food expenditures and 5% of their total annual expenditures in fuel. (INE, 1991, P.28). Though forth percent of all firewood is purchased following conventional market channels, 56% of those households consuming firewood haul it from two kilometers or more. (OLADE, 1989).

Biomass fuels alone cannot satisfy the energy needs of households. Guatemala produced 2 million barrels of crude oil but consumed almost 13 million barrels, accounting for about 11% of all country imports in 1992. (CIEN, Carta Economica, No. 152, 1995). The crude produced in Guatemala oil fields, moreover, is relatively heavy. Production in the operating fields is from fracture-type reservoirs that are rapidly depleted. Significant oil fields, however, have not been discovered. Environmental concerns regarding sulfur remoaval and pipeline construction are mounting.

Fortunately, the Sierra de las Minas is blessed with a climate, location and topography that results in a large renewable energy potential. A preliminary evaluation of the Sierra's hydroelectric potential indicates that some 60 MW are theoretically developable. (Defensores de la Naturaleza, 1996). Photovoltaic applications are feasible: there are some 2,000 systems in place, installed by Fundacion Solar along with partner organizations.

This context points to a integrated energy strategy: (i) to rationalize consumption and increase the efficiency in use of biomass fuels, (ii) managed production of biofuels to replace firewood gathering, and (iii) extending modern energy supplies to those lacking it, specially those based on renewable sources of energy. Single intervention alone cannot solve the energy and environmental problems faced by the rural poor. We need programs that catalize greater coordination among development agencies, that exploit the strengths of various organizations. We also need programs that are more consumer-oriented. The challenge is to introduce supplies that match people's preferences and income levels, while rationalizing consumption of biomass and promoting a shift to modern energy supply that are environmentally benign.

CHARACTERIZATION OF THE RENEWABLE ENERGY TECHNOLOGIES TO BE IMPLEMENTED IN THE SIERRA DE LAS MINAS

SUB-COMPONENT 1.1: INCREASED EFFICIENCY AND RATIONALIZED USE OF BIOMASS FUELS, THROUGH IMPROVED STOVES:

Kitchen performance tests comparing open fire and improved stoves show that the latter yield firewood savings ranging from 19% to 44% and averaging 28% depending on cooking practices, diets, and income levels. (VITA, 1982) the first sub-component of the energy component would support an increase in efficiency of use of biomass fuels for household end uses (cooking and space heating). Use can reduce cash expenditures, diminish time and effort collecting firewood, reduce pollution, lower pressure on nearby habitats and reduce soil erosion.

Reduced emissions and improved utilization of biofuel are the primary goals for promoting improved stoves in the Sierra de las Minas. End-users perceive the economics, the efficiency and to some extent, the safety of different appliances and sources of energy. However, the impacts of energy contaminants whose effects are delayed and difficult to link to exposure are harder to perceive. Burning of biomass fuels emits nitrogen dioxide, carbon monoxide particles and hydrocarbons. Many of these carbon-containing chemicals are potentially carcinogenic. Laboratories studies suggest that smoke emitted by fireswood may have about the same potential for producing tumors as smoke from burning tobacco. (Smith, 1987). In addition, carbon particles penetrate deep into the lungs and damage them. In sum, four major health-related hazards stem from exposure to biofuel emissions: (i) acute respiratory infections among very young children, (ii) chronic obstructive lung diseases among cooks, mostly women, (iii) low birth weight from smoke exposure of pregnant women, and to a lesser extent, (iv) cancer.

A study conducted in Guatemala took finger-prick blood samples from 208 non-smoking women and found that carboxihemoglobin levels fluctuated between 1.5% and 2.5%, levels that have been associated with increased incidence of cardiac disease in other countries. (Dary et al, 1981). The same study found

contamination levels of between 30-50 ppm at cooking times, whereas several countries have set maximum safe levels to CO contamination as being between 32 and 40 ppm for one-hour exposures. On the positive side, smoke may assist controlling mosquito repellence, analogous to the use of a mosquito coil. Smoke may also help preserve household thatched roofs and wooden beams.

One obvious way to reduce the negative impacts of biofuel emissions is to burn less firewood or to improve stove design to achieve higher efficiency. Most emissions from biofuel combustion steem from incomplete combustion, and high combustion efficiency means low emission factors per unit of fuel. Enclosing the combustion chamber and reducing airflow typically improve overall stove efficiency by increasing the heat transfer efficiency. Improved stoves may (i) ease shortage of biofuel, (ii) reduce time and drudgery spent gathering firewood, and (iii) reduce smoke and facilitate a cleaner environment, specially for infants, mothers and young girls.

Other less-obvious way to reduce the health hazards is through improved architecture: better ventilation, more and larger openings, use of more porous wall materials and roof types, and kitchen location.

Cooking Practices:

Women do all the food preparation, and cook three times a day. They cook in a separate building out of three stones planted vertically in the ground. The foods cooked are basically beans and corn tortillas. Meals are cooked in clay pots with aluminum lids. While cooking, women and girls often have to tend the fire constantly, feeding small twigs to the fire and breathing a thick smoke. Babies are often breastfed, or sleep in the kitchen, a practice that helps account for the high incidence of pulmonary infections among infants.

Firewood Consumption:

The following table reports firewood consumption for a sample of 61 stoves monitored during six weeks in Guatemala. The table shows daily consumption figures with the traditional open fires, and those reached after four weeks with improved stoves.

Consumption level	Traditional System (Pond/day)	Average w/improved Stoves (pound/day)	Savings (pound/day)	Savings (%)	Sample (%)
Low	15.6	12.7	2.9	18.6	16.4
Medium	31.6	23.2	8.4	26.6	34.4
Medium High	48.9	30.3	18.6	38.0	44.3
High	68.0	24.6	43.4	63.8	4.9
Average	38.4	24.7	13.7	35.7	100

Source: ICAITI "Estufas Mejoradas, Informe Técnico", 1989

Another study, (1989, ICAITI, Estufas Domésticas Mejorads: Lorena y similares) evaluated energy savings among a sample of 436 improved stoves in six Central American countries. The sample included five types of stoves: Lorena, Choola, Singer, Adobes and Blocks. The study concluded that:

(i) Firewood savings varied between 7.5 pounds/day (17%) and 11 pounds/day (25%).

(ii) 74% of sample households collected firewood, 21% bought it, and that five percent bought it and collected it.

(iii) Average consumption among sample households cooking exclusively with firewood was 44 pounds/day.

(iv) Average construction times for an improved stove were around four person-days.

The contribution to carbon displacement to be made by the introduction of metal sheet improved stoves is 10,000 tC over a 20 year period (see appendix 2).

SUB-COMPONENT 1.2: PHOTOVOLTAICS FOR RURAL LIGHTS.

The project proposes to install 2,000 small photovoltaic systems (less than 50 watts in power) for home, health clinics, and school lighting.

The proposed systems are independent (not interconnected by a network) and consist of (i) a photovoltaic panel that generates electricity by sunlight, (ii) a battery to store the energy produced, (iii) an electronic charge controller to protect the main system from excesive charge or downloads, (iv) three 20 watt fluorescent lamps to convert electric power to light, (v) an outlet to supply 12 V power to a small appliance (radio, black and white TV or kitchen appliance) and (vi) cables and accesories (switches, contacts, mounting base) needed to mount the system. The systems have no moving parts and have the capacity to provide over a period of 20 years the lighting for which they were designed.

The PV systems are designed to withstand local environmental conditions and use. Their installation is very safe, and reduce fire hazards at home. The systems are also compatible with the characteristics of solar resources at the Sierra de las Minas. They provide enough power to supply no less that 13 Ampere-hours and give for at least four consecutive days of zero sunshine.

The photovoltaic system will provide 288 MWh over a 20 year period for a total of 691.20 tC (see appendix 1). The amount of carbon only takes into account that electricity by the the national grid will be displaced. It does not inlcude GHG's displaced by replacing kerosene lamps for efficiency light bulbs.

SUB-COMPONENT 1.3: MINI-HYDROELECTRIC POWER PLANTS.

The project's proponents will displace electricity generated by the burning of fossil fuel via RET's utilization mainly in the buffer zone. The introduction of small hydro systems contributes to the development of new mechanisms for providing electrification to the rural dispersed market, under conditions that are commercially viable, and encourage local participation and capacity building. The component will foster Productive Uses of Electricity (PUE) for small applications, which will be closely integrated with Component A throughout adding value to forest products (carpentry, sawmills), and creating new non-agricultural jobs (refrigeration, corn grinding, sawing machines, irrigation, etc.) thus, reducing pressure on the core protected area.

Therefore, the RET's introduction to the area will accomplish somethig that would take at least a century if it is wanted to wait for the national grid to arrive. Worst of all, the electric generation capacity of Guatemala has added 200 MW of fossil fuel thermal plants, becoming reliant on non-renewable petroleum fuels, high emitters of GHG.

What is even more appealing is that RET's will allow a myriad of work opportunities, which in turn, will allow the very generating systems to be operated and maintained by the villagers' community organization, thus, reducing the chances of failure.

Finally, rural people need something in exchange from their traditrional forestry or agricultural subsistence practives. They need to know that there are other efficient economic activities based on PUE that will deter them from destroying their very own base of survival.

The contribution of small and micro-hydro facilities to GHG's mitigation is the biggest of all the technical options for the energy component. It amounts 245,980.8 tC over the life of the project (appendix 3).

PRE-INVESTMENT PHASE FOR THE ELECTRICITY TECHNOLOGIES:

1) Community Identification

Priority areas are defined among communities that (i) already have electrical power or Defensores de la Naturaleza, Fundación Solar and other agencies seeking support for rural electrification, and (ii) have formed a local electrification committee. The photovoltaic system or the micro-hydro facilities should support local development initiatives and capabilites. In communities lacking other basic services such as potable water and health clinics, we propose to conduct local planning excercises to to make sure that electricity is a priority, and that there are no other more important investments to make. These plannning excercises will also help define the community afforestation strategies financed under the other project component. Communities that are included in National utilities' rural electrification plan or that do not show a manifest commitment to rural electrification are excluded from the next stage, technical appraisal excersise.

2) Community Selection:

We will use the community appraisal forms included in annex "A". The appraisal focuses on (i) local organizational capabilities, (ii) determination of demand for lighting and power, (iii) assessing of the solar and hydro resource at the specific sites, (iv) understanding of use of firewood, sources, etc., and (v) other issues such as construction materials, density, access, etc. that may bear on project cost and design.

SUMMARY OF WITH AND WITHOUT MEASURES
COMPONENT B: ENERGY (20 year period)

TECHNOLOGY	tC AVOIDED	TC DISPLACED
Improoved fuelwood stoves	----------	10,000.00
Solar photovoltaics	691.20	----------
Micro-hydro systems	245,980.80	----------
TOTAL ≈ 256,672.00 tC		

Note: Only 246,672.00 tC will be reported during this phase of the project. Fundacion Solar would like to undertake on-site measures of the improved stoves Vs. Open fires.

V. Other Considerations

A. Non-greenhouse gas environmental impacts of the project

1. Effects on Biodiversity-Habitat Conservation

We expect that the promotion of agroforestry will have an effect on the integrity of biological communities by reducing boundary and edge effects. Furthermore, we expect that increased reliance on permanent crops such as coffee, cardamom, and rubber will reduce pressure on natural forests. Permanent Crops Reduce Pressure over natural forests. Through the forestry practices we expect to increase forest cover, and threrefore reduce processes such as erosion and the consequent degradation of water quality. Cover crops will be introduced throughout the Sierra in order to reduce these processes in areas that have already been deforested or are currently used for agriculture.

2. **Effects on Water**

The most important effect of protecting the Sierra de las Minas Biosphere Reserve will be the protection of 21 watersheds which provide water to countless guatemalans throughout the country. Erosion control practices will protect water quality by reducing the number of nutrients in the water, and should have a direct effect on the current rate of eutrofication of Lake Izabal, for which the Polochic Drainage Basin provides 80% of the water. By stabilizing forest cover we expect to also buffer the frequency of floods and dry spells in the region.

3. **Effects on Air**

The Sierra de las Minas Joint Implementation Project is expected to reduce CO_2 levels in the atmosphere through the reduction of greenhouse gas production (through processes such as fire and the us of firewood) and the protection of current carbon sinks. We also expect to protect the ozone and in the long term contribute to a reduction in the rate of global warming.

4. **Effects on Human Health**

Human health will be directly affected by this project through the reduction of firewood as a source of fuel. We expect that as a result, smoke will not continue to be a factor favoring respiratory illnesses in women and children throughout Guatemala. At the current time, the most common illnesses include flue, respiratory diseases, skin infections and parasites.

B. Development of Project Impacts

1. **Sustainable Agriculture**. Through the application of taungya, organic coffee and cardamom production, and other ecologically compatible and economically rewarding products

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2. **Effects on Timber Forest Harvesting**. We expect to introduce portable sawmills, increase the availability of wood through plantations and forest management and promote the use of local species such as medicinal plants

3. **Effects on Regional Employment**. Regional employment should be favored through the production of items with added value such as furniture, textiles, carpentry shops, coffee and cardamom processing plants, canning of jellies from local fruits, and processing of medicinal plants.

3. **Outreach/Education**. We intend to strenghten the ability of local people for self -organization, using clean and efficient technologies that will improve the quality of their lives and promote sustainable development. Vocational training programs will teach people how to best use introduced technologies and market their products.

5. **Effects on Land Productivity.** Through the sustainable rural development component and the forestry component we expect to increase the productivity of the land in the region, promoting more intensive use of smaller parcels of land. We expect to provide incentives for this activity by helping local people measure and title the land they currently occupy and thereby reduce incentives for migratory agricultural practices.

6. **Economic Impact.** This project is expect to have a direct economic impact on local communities by promoting more sustainable agricultural practices and alternative income generating activities that emphasize a final product with added value. It is also expected to increase productivity by extending the time people can work during the day into the night by providing rural electrification for a region that it is unlikely will become part of the national electrical grid in the next 200 years. Improved income and better access to education should have a singificant impact on patterns of population growth and natural resource use.

7. **Technology Transfer**. We expect technology transfer to take place through the energy component. We will provide and teach local communities how to use improved stoves, small hydropower plants and photovoltaic systems in order to generate clean, renewable energy and reduce firewood consumption. Vocational training programs will teach people how to run microenterprises, such as those for organic coffee production, textiles for the export market, and crafts such as the production of furniture.

C. Efforts to Reduce Domestic Greenhouse Gases by Guatemala Particpants

1. Current Emissions of Greenhouse Gases by Partners
2. Project US Greenhouse Gas Emissions by Partner de 1998-2018
3. Projected reductions and sequestration of US greenhouse gas emissions by Partner over the lifetime of the project
4. Steps being taken by Partner to reduce and sequester its emissions of greenhouse gases over the lifetime of the project.

D. Other Information

1. **Cultural heritage.** The Sierra de las Minas Biosphere Reserve encompasses 3 different cultural regions: the Pocomchi, Kekchi, and Ladino. Each of these groups has a distinct history and pattern of natural resource use. The challenge of the project and for Defensores de la Naturaleza and Fundacion Solar is to take into account all these different points of view and keep the doors of communication open between them as they become more involved in the management of the reserve.

2. **Environmental Education.** This project will be complemented by Defensores de la Naturaleza's ongoing enviornmental education program which works with schoolteachers in

all the communities around the reserve, as well through environmental awareness activities in individual communties throughout the Sierra de las Minas Biosphere Reserve.

3. **Community Outreach.** This project will complement Defensores current activities in community organization and ecotourism, through which we generate interest in the reserve and goodwill towards the protection of the area.

VI. General Provisions

A. Confidential Business Information

TBD

B. Monitoring and Verification

TBD

C. Withdrawal from GJI

TBD

D. Anual Reports

TBD

E. Promotional Cooperation

VII. Certification

We the undersigned have reviewed this proposal as submitted and to the best of our knowledge and belief certify that all information provided herien is accurate and complete. Further, the undersigned acknowledge that they have read and understand the General Provisions of the Guidelines for th OGIC Project Proposal and agree to comply therewith.

For Defensores de la Naturaleza

_____

For Fundacion Solar

_____

For Partners

_____

Appendix 1

Specific Measures Used to Measure Carbon Sequestration in the Sierra de las Minas Biosphere Reserve, Based on Methodology Developed by WINROCK, Intl.

Appendix **2**

Approximate Greenhouse Emissions of Firewood Stoves. Calculations

	C: 38%	(aproximation)
	H: 7%	HHV: 3500 cal/kg.
Firewood	O: 54%	LHV: 13000 cal/kg.
	Ash: 1%	

Where C= Carbon
H= Hydrogen
O= Oxygen
HHV= High Heat Value
LHV= Low Heat Value

Amin = 11.5 [C + 3 (H - O_2/8)] = 4.40 kg. Air, 1 kg. leña = 3.4 m^3 air / kg. Firewood (nominal)

Good Combustion => excess air between 50 - 100%
Poor Combustion => assume excess air of 200%

Combustion gas volume (Vg) is given by:

$$Vg = A + 22.4 (H/4 + O/32)$$

Where A = used air

The modification range of the minimum air ranges from 2-4 between a good and poor performance stoves.

$$Vg = 2 * A\ min + 22.4 (0.07 / 4 + 0.54 / 32) = 7.57\ m^3\ gas/kg\ of\ firewood$$

$$4 * A\ min + 22.4 (0.07 / 4 + 0.54 / 32) = 14.37\ m^3\ gas/kg\ firewood,$$

The volumetric composition of gases will be:

	Improved Stove (assume excess air of 100%)	Open Fire (assume excess air of 200%)
CO_2 Volume	0.75 m^3 CO_2 / kg comb.	3.59 m^3 CO_2 / kg comb.
	(0.97 kg CO_2 / kg firewood)	(4.66 kg CO_2 / kg firewood)

V

Los consumos velatinos de las estufas son:

Improved stove = 5 m^3 /yr = 1200 - 2000 kg firewood/yr
10% - 25%
Open fire = 7 m^3 /yr = 2100 - 2800 kg firewood/yr

Assumming firewood density of 300-500 kg / m^3

CO_2 emissions may range from

	Improved Stove				***Open Fire***
Carbon:	1164 - 1940 kg CO_2 / year	≤	Emission	≤	9000 - 13048 kg CO_2 /year
	97 - 160 kg C / year	≤	Emission	≤	700 - 1000 kg C /year

Transferring these results to tons of carbon (tC):

Emissions per stove per year are:

a) Improved Stove: 0.1 - 0.160 tC /yr

b) Open Fire: 0.7 - 1 tC /yr

Assuming we will promote improved stoves in 40 communities
At a rate of 20 stoves/community, the project will introduce 800 stoves.

Thus, total emissions in tons of carbon are estimated as:

Improved Stoves:	80 - 128 tC
Open Fire:	560 - 800 tC

Thus, we expect to prevent the emission of 480-672 tC/year. Estimating a mean of 600 tC/year for 20 years, we estimate to prevent the emission of 12000 tC over the lifetime of this project.

△ Over average life span of stoves = 10,000 tC

Cost of each stove= $ 83.00 => Cost of 600 units= $ 66,000.00

Total Cost of tC = Project Cost/tC = $ 68,000 / 10,000= $6.80/tC

CARBON AVOIDED BY PHOTOVOLTAIC SYSTEMS

Rnet = Emissions Equation of Net Savings

Rnet = (Er * Cr) - (Ep * Cp)

Where:

Er = Produced energy in the reference case (or base line).

Cr = Carbon intensity of produced energy in the reference case.

Ep = Produced energy in the project case.

Cp = Carbon intensity of the produced energy in the project case.

General Asumptions:

i) Guatemala's energy sector is agresively moving towards electricity generation by means of burning coal and petroleum.

ii) By July 1997, the National Electrificaton Index is 40%.

iii) There are 158 communities in the Sierra de las Minas, of which 6 have electricity through the National Grid.

Therefore, the calculus uses the following data:

a) National grid based on coal generation

b) Carbon contents 0.024 tC/GJ

c) Intensity of carbon of electricity 0.24 tC/MWh

d) Supply at a net efficiency of 36%

iv) The alternatives for electricity suplied by the National Grid are solar P.V. and micro-hydro facilities. Solar P.V.s are stand-alone systems for household lighting and entertainment (radio, B/W , T.V.). The micro-hydro systems are run of the river facilities to be used for productive activities such as sawmills, pumping water, refrigeration, carpentry, and so on). Therefore, the formula will be used for P.V. and micro-hydro only.

v) For woodfuel saving stoves, the general assumption will be based on the difference of efficiencies between an open fire system that is traditionally used in the Sierra ecoregion and the efficiency of an improved metal-sheet woodfuel stove equipped with chimney.

Using VITA's water boiling test (WBT), the open fire efficency is 8% and the improved stove is 23% both under field conditions.

Stand alone P.V. systems characteristics:

Components:

- 30-50 Wp. panels (Solarex, Kyosera, Simmens)
- Deep cycle battery 105 Ah (Trojan, Titan, Reliable)
- LVD-HVD controller (Trace, SUNAMP, ASC-SCI)

- 3/20W lamps
- Accesories (fuses, water, wire, plugs, etc.)

Example: 50 Households, 50 Wp panels

50 * 50 Wp = 2500Wp * 4 h/Day

=	10,000	Wh/Day * 30 Day/Month	
=	300,000	Wh/Month	
=	300	kWh/month * 12 months/yr	
=	3600	kWh/yr	
=	3.6	MWh/yr	

3.6	MWh/year * 40 communities= 144 MWh/yr	
144	MWh/year * 20 years =2880 MWh	
Total =	2880 MWh/(In a 20 year period)	

Carbon Intensity of electricity in Ton-C/MWh for coal 0.24, at 36% efficiency, then:

2880 MWh * 0.24 = 691.20 tC

50 systems * 40 communities * US$750/system installed turnkey.

US$1,500,000.^{00}/691.20 = $2,170.13/tC.

$2,170.13 = $108/tC/yr
20 yrs

Verification:

Rnet	=	(Er * Cr)-(Ep * Cp)
Rnet	=	(2880 MWh * 0.24)
Rnet	=	691.20 tC

Appendix 3.

MICRO-HYDRO PLANTS: AVERAGE TYPICAL SYSTEM

h	=	10 m
E	=	m x g x h (joules)
E	=	energy
g	=	gravity
h	=	head
P	=	* Q * g * h (joules/seg or watts)
P_d	=	power available
	=	H_2O density
v	=	volume

Where:

= 1000 kg/m^3

G = 9.8 m/s^2

Q	=	Flow (m/s)
no	=	Total efficiency (0.4 - 0.6)
Pn	=	Net power
Pn	=	no * P * Q * h * g (watts)
Pn	=	no * 1000 * Q * 9.8 * h (watts)
Pn	=	no * Q * 9.8 * h (watts)

When no = 0.5

Pn	=	5 * Q * h kW (estimated)
Q	=	0.03 m/s Pn=15 kW.
h	=	100 m

Equation: *Rnet = (Er * Cr) - (Ep * Cp)*

Where:

Er	=	produced energy reference case (or base line)
Cr	=	carbon intensity of produced energy in the reference case.
Ep	=	energy produced in the project case
Cp	=	carbon intensity of energy in the project case

Carbon content of fossil fuel:

Coal	=	0.024	Carbon content in the fuel ton-C/GJ
Coal	=	0.24	Carbon intensity of electricity ton-C/MWh

Net efficiency at 36%

Hydro Plant factor: 0.65

Ep = Er = 15kW * 8760 h/year * 0.65

= 85410 kWh/year

= 1,281,150 kWh

$$Rnet = \frac{1{,}281{,}150\ KWh}{1{,}000} * 0.24\ tC/MWh$$

Rnet = 1,281.15 MWh * 0.24 tC/MWh

Rnet = 307.47 tC

307.47 * 40 sites =12,299.04 tC

Cost calculation (average for 40 sites):

cost/kW = $1,800/kWh

Cost of Generation:

15 kW * $1,800/KW	=	$27,000.^{00}
COST OF T & D:		$30,000.^{00}
TOTAL COST/UNIT:		$57,000.^{00}
TOTAL UNITS (40):		$2,280,000.^{00}
TOTAL tC:		12,299.^{04} tC
PRICE OF tC hydro:		US$ 185/tC in 20 years
PRICE OF tC/year		US$ 9.25

Typical Hydroelectric Project

Location: Jones, Zacapa
Head: 32 M (h)
Flow: 0.20 m 3/5 (Q)
Power: No * p * Q * g * h watts

: 0.5 * 100 * 0.20 + 9.8 * 32
: 32 kW
Energy : 32 KW * 8760 h/yr * 0.65
: 182,208 kWh
: 182.208 MWh
Rnet : 43.72 tC

Life of project: 15 years

Net tC: 864.40 tC

Estimated cost generation: US$ 80,000.00

COST (US$/hW):	US$ 2,500/hW
Estimated cost T & D:	US$ 30,600.00
TOTAL COST:	US$ 110,000.00
Cost/Family:	US$ 1,100.00/family
Cost/tC:	US$ 6.8 / tC

Appendix 4

METHODS USED IN ORDER TO CALCULATE CARBON SEQUESTRATION FOR THE SIERRA DE LAS MINAS BIOSPHERE RESERVE

1. Site Selection

According to Holdridge there are 4 life zones within the Sierra de las Minas Biosphere Reserve: Premontane Very Wet Forest (bmh-PM), Lower Montane Very Wet Forest (bmh-MB), Lower Montane Wet Forest (bh-MB), and Lower Montane Pluvial Forest (bp-MB). In order to determine the amount of carbon fixed 4-5 permanent measuring plots were selected within each life zone. In addition, 4-5 reference plots were selected in each life zone in order to determine the amount of carbon fixed by cropping patterns in the area.

Life Zone	Watershed	Plot Location	Reference Plots	Reference Crops
Bmh-PM	Las Canas	Los Amates La Palmilla	Vista Hermosa	Coffee and Corn
	Naranjales	Naranjales	San Marcos	Corn, Cardamom, Abandoned Fields
	Zarco	Las Pacayas	Las Pacayas	Cardamom, Corn, Abandoned Fields
	Tinajes	Finc Schleshinger	San Jorge	Corn, Cardamom, Abandoned Fields
Bmh-MB	Pueblo Viejo/Tinajas	Santo Toribio	None	None
	Mayuelas	CONAP Finca (nr Canital)	Mal Paso	Coffee, Beans, Corn
	Pasabien	Santa Rosalia	San Lorenzo	Abandoned Fields
	Hato	Albores	Albores El Carmen	Corn, Coffee
	La Palmilla	Fnca El Jabali	Mirador	Corn, Beans
Bh-MB	Rio Colorado	San Lorenzo	San Lorenzo	Corn, Abandoned Fields
	Rio Jones	Monte de los Olivos	Cajon de Jones	Sugarcane, Corn, Abandoned Fields
	Lobo y Mayuelas	Finca Las Victorias	None	None
	Mululja	La Pinada	La Pinada	Corn, Abandoned Fields
Bp-MB	Chilasco	Lousiana	Concepcion	Corn, Abandoned Fields
	Hato	La Cabana	Vega Larga	Corn, Abandoned Fields

This sampling gave us a total of 16 permanent plots and 30 reference plots.

2. Sampling Plot Size

2.1 Forest Plots

Broadleaf Forest	50m x 50 m = 2500 m^2
Mixed Forest	20m x 40 m =1000 m^2

2.2 Agricultural Fields

Annual Crops	50 m^2
Permanent Crops	4-5 plants

2.3 Cattle Ranching Areas
20 m^2 plots

3. Sampling Methodology

Carbon fixed was determined by measuring:

a. Surface Biomass
b. Belowground Biomass
c. Soil Biomass
d. Leaflitter Biomass

In each plot the following variables were also considered:

a. local climate
b. soil texture
c. drainage
d. soil pH
e. topography
f. distance to A soil Horizon
g. root zone, soil depth
h. plot location

4. Data Processing

4.1 Forest Plots

For Forest Plots we calculated individual biomass of each tree and determined Total biomass/plot using the following formula:

$Y=34.4908 - 11.7883\ D + 1.19256\ D^2 \qquad R^2=0.78$

Where Y=tree biomass (kg)
D=diameter of tree

Source: Brown, S.; Gillespie, A.J.R.; Lugo, A.E. 1989. Biomass estimation methods for tropical forests with applications to froest inventory data.

Water content of the samples was used in order to determine dry biomass for the herbaceous layer and leaf litter. Lab tests (apparent density and %OM) were used to establish organic carbon content of the soil. Results were converted to tons of biomass/ha for each part of the system and multiplied by 0.5 to obtain tC fixed.

4.2 Reference Plots

Reference plots refer to plots located in areas impacted by human activities such as annual agriculture, permanent agriculture (coffee, cardamom), and cattle ranching.

We used harvest estimates provided by owners of the plots, which were converted to kg./plot. Leaf litter left after harvest that is incorporated into the soil, was used to estimate Plot biomass in kg/plot. Lab tests were used in order to establish total carbon content of soil. All results were converted to tons of biomass/ha for each component of the system and multiplied by 0.5 in order to obtain tC fixed.