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NATURAL FORESTS OF BOLIVIA

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Introduction

This report is an overview of the natural forests of Bolivia from the perspective of conservation and rational use of the natural forest resource base. The distribution and extent of ecological forest types are synoptically treated. Government of Bolivia responsibilities and activities involving the forest resource base are outlined, as are foreign assistance programs involving natural forests. The demands upon forest lands and resources, some of which contribute to loss of the forest resource base, are reviewed.

Emphasis is given to an objective discussion of the problems associated with conservation and rational use of natural forests. Major problems addressed involve conflicts with agricultural colonizations, poor utilization of forest resources, lack of policy for timber concessions, disinterest in sustained yield of timber, absence of a land-use capability classification, and low institutional capability.

Generalized Forest Descriptions

Dominated by the majestic Andes and the high intermountain basin known as the "Altiplano", Bolivia is seldom thought of as a forested country. Though the Altiplano, high Andean peaks and dry intermountain valleys are essentially treeless, 62% of Bolivia's 1,098,581 square kilometers are less than 600 m above sea level and mostly in forest. The extensive lowlands, known as the "Oriente", form a broad are from the Peruvian border in the northwest to the Paraguayan-Argentine Chaco in the southeast. Approximately half of the country lies within the Amazon drainage system and roughly one-fourth is part of the upper Plate River drainage system. (The Altiplano is a closed drainage system feeding Lakes Titicaca and Poopó and the salt flats of Uyuni and Coipasa.)

Bolivia's geographic location between 09° 38' and 22° 53' South latitude results in tropical, subtropical and warm temperate climatic regimes (Fig. 1). The 'Cordillera Real," or eastern chain of the Andes, attains a maximum width of 650 km in Bolivia and, of course, superimposes considerable orographic heterogeneity upon the sub-tropical and warm temperate latitudinal regions. The ecological consequences of the pronounced physiographic and climatic heterogeneity are illustrated in the ecological map of Bolivia (Tosi, et al. 1975). Forty-eight Life Zones (Holdridge, 1947) occur in Bolivia (for contrast, the United States east of the Mississippi contains only thirteen Life Zones), of which 21 are forest Life Zones. (The Holdridge Life Zone Classification is described in GSH-3.)

GSH-13



The tropical latitudinal region is restricted to the very northern part of the country in Pando Department. The Tropical Moist and Tropical Premontane Moist Life Zones contain very well-developed, floristically diverse forests with high volumes of potentially commercial timber. The Pando forests are in excellent condition, with the only significant human influence occurring along the Cobija-Porvenir road. Two Tropical Life Zones--moist and wet--occur as long, narrow transitional belts to Subtropical Life Zones along the low flank of the northern sub-Andean front range.

Practically the entire Beni Plain, stretching from Puerto Heath near the Peruvian border to the Serrania Huanchaca on the Brazilian border, is Subtropical Moist Life Zone. Even after deducting the extensive areas of savannas in central Beni Department and Iturralde Province of La Paz Department, this Life Zone still has the largest area in forest (171,131 km² or 16% of the country). Subtropical Moist Life Zone also occurs in the valleys of the Beni River and its tributaries (e.g. the towns of Covendu, Guanay, Mapiri, Apolo, Chulumani and Circuata). Compared with the tropical moist forests of Pando, the subtropical moist forests of La Paz, Beni and Santa Cruz Departments are significantly lower in stature, less complex in structure, much less rich in species and with lower timber volumes. The subtropical moist forests are characterized by an abundance of mahogany (*Swietenia macrophylla*), whose exploitation is the base of the timber industry in Santa Cruz.

The subtropical moist forests on the Beni Plain are under considerable pressure from savanna expansion for cattle raising, conversion to agriculture and timber operations. Tosi et al. (1975) suggest most of this forest Life Zone to be altered by human activities. (It is likely that more than half of the tropical moist forests of the Beni Plain is disturbed forest.)

The subtropical moist forests in the valleys of the Beni River and its tributaries have been largely converted to agriculture, or are in active conversion. Subtropical wet forests occur in two areas; as a narrow band along the northern front ranges and as a variable band above the moist valley floors. Except for the Caranavi Valley, the subtropical wet forests appear to have suffered little deforestation.

Subtropical Montane Wet and Rain Life Zones occur along the northern front ranges due to the combination of orographic lifting of warm air masses and decreasing temperature. These series of Perhumid and Superhumid Life Zones (Fig. 2) occur in very dissected topography with minimal penetration of human activities, and consequently are probably the least disturbed Life Zones in Bolivia.

Subtropical Lower Montane Dry and Moist Life Zones occur in deep, intermountain valleys of the eastern Cordillera, including the towns of Comarapa, Totora, Inquisiva, Tapacari, Arque and Independencia. Because the Life Zones are among the most hospitable to humans, the valleys have long been foci for human settlement and agriculture, with the consequence that very little undisturbed vegetation remains.

Subtropical Montane Moist Life Zone occurs in a few high valleys (e.g. the towns of Sacaca and Colquechaca). It is also the predominant Life Zone



of the northern Altiplano, including the towns of Achacachi and Pucarani, as well as the city of La Paz. The northern Altiplano is reputed to have once been in forest (Manuel Posnansky, personal communication).

Warm Temperate Dry Forest is the second most extensive Life Zone in Bolivia, occurring in a huge arc from Yacuiba to Puerto Suarez, as well as in some of the valleys and plateaus of the southern cordillera (e.g. Tarija, Sucre, San Pedro de Buena Vista, Valle Grande and Padilla). The forests are low in stature and generally open, but with an abundance of heavy, fine-quality timbers such as palo santo (*Bulnesia sarmienti*), cuchi (*Astronium fraxinifolium*), quebracho blanco (*Aspidosperma quebracho-blanco*) and quebracho colorado (*Schinopsis lorentzii*). Extensive pasturing of beef cattle is common and irrigation agriculture is expanding, but probably at least 75% of the Warm Temperate Dry Forests are relatively undisturbed.

Warm Temperate Moist Forest is nearly as extensive as Warm Temperate Dry, occurring along the southern sub-Andean range and in a vast region east of the Dry Life Zone to the Brazilian border.

In comparison with Warm Temperate Dry Forests, the Warm Temperate Moist Forests are taller and more species rich, but with fewer of the fine quality timbers. However, the sub-Andean forests do contain nogal (*Juglans boliviana*) of the walnut family. Except for areas around settlements such as Santa Cruz, the Warm Temperate Moist Life Zone is relatively undisturbed, particularly in the vast eastern region.

Warm Temperate Wet Forests occur on hills of the sub-Andean range exposed to southern winds. The forests are well-developed with characteristic *Podocarpus* spp. attaining 35 m in height and 100 cm in diameter, and the presence of abundant epiphytes.

Warm Temperate Montane Moist Life Zone occurs over a fairly extensive portion of the dissected southern Andes in Bolivia. Most of the ridges and upper slopes have long been used for annual crops, hence little natural vegetation remains. Much less extensive are the Warm Temperate Montane Wet and Rain Life Zones. Due to considerable excess of moisture in combination with steep topography, only minor portions of these two Life Zones have been deforested.

In summary, four major groupings of natural forests remain over appreciable areas of Bolivia: (1) the Tropical Dry, Moist, and Premontane Moist Forests of Pando (37,680 km²), that are almost completely undisturbed by human encroachment; (2) the vast Subtropical Moist Forests of the Beni Plain including the Tropical Moist-Cool Transition (187,031 km²), that are probably undergoing the most rapid rate of deforestation, but it is impossible to estimate the total loss or the rate of loss; (3) the Perhumid and Superhumid Life Zones of the subtropical region covering flanks and valleys of the northern front ranges (Subtropical Wet, Tropical Wet-Cool Transition, Subtropical Rain, Subtropical Lower Montane Wet and Rain, Subtropical Montane Wet and Rain, totalling 88,460 km²). Although the Subtropical Wet and the Tropical Wet-Cool Transition Life Zones at the base of the front ranges are undergoing very active agriculture colonization, the remaining Life Zones within the front ranges are virtually undisturbed; (4) The immense area of Warm Temperate Dry and Moist Life Zones largely in Santa Cruz Department (225,220 km²) has a very high proportion of relatively undisturbed forest.

Table 1. Potential forest lands of Bolivia. Base data for each Life Zone (Holdridge, 1947) from Unzueta (1975) modified with data from Brockman (1978) to exclude natural savannas.

LIFE ZONE	km ²	<u>Country Percentage</u>
Tropical Dry	3 000	0.27
Tropical Moist	3,680	0.33
Tropical Moist Cool Transition	15,900	1,45
Tropical Wet, Cool Transition	18,300	1.67
Tropical Premontane Moist	31,000	2.82
Subtotal: Tropical	(71,880)	(6.54)
Subtropical Dry	4,680	0.43
Subtropical Moist	171,131	15.58
Subtropical Wet	36,700	3.34
Subtropical Rain	15,160	1.38
Subtropical Lower Montane Dry	6,000	0.55
Subtropical Lower Montane Moist	3,660	0.33
Subtropical Lower Montane Wet	7,100	0.65
Subtropical Lower Montane Rain	4,070	0.37
Subtropical Montane Moist	24,700	2.25
Subtropical Montane Wet	2,860	0.26
Subtropical Montane Rain	4,270	0.39
Subtotal: Subtropical	(280,331)	(25.52)
Warm Temperate Dry	114,493	10.42
Warm Temperate Moist	110,727	10.08
Warm Temperate Wet	4,500	0.41
Warm Temperate Montane Moist	12,700	1.16
Warm Temperate Montane Wet and Rain	3,690	0.33
Subtotal: Warm Temperate	(246,110)	(22.40)
Total Forest	598,321	54.46
Total Non-forest	500,260	45.54
Total Bolivia	1,098,581	100.00

Areal Extent of Forests

Because Life Zones are defined by the bioclimatic parameters of mean annual precipitation and biotemperature (Holdridge 1947, Holdridge et al. 1971, Unzueta 1975), it is possible to estimate the extent of original forest cover prior to anthropogenic modifications. I have used the areal estimates of natural savannas in Beni, La Paz and Santa Cruz Departments (Brockman 1978) to modify Unzueta's (1975) estimates for each Forest Life Zone (Table 1). The exclusion of natural (edaphic) savannas should give a reasonably acceptable estimate of 598,321 km², or 54% of Bolivia covered with primeval forests.

Recent estimates of forest cover range from 27% (Cochrane 1973) to 51% (Brockman 1978). Even though Brockman's value is based on an analysis of

recent satellite images, the true value undoubtedly lies somewhere between the two values. The satellite imagery interpretation overestimates forest cover because clearings less than 20 ha cannot be discerned, hence most squatter or colonist clearings are undetectable until they coalesce into larger units. GEOBOL's (Bolivian Geological Service) recent map of actual land use and vegetative cover (Zerain et al. 1978) grossly underestimates the extensive deforestation by colonists of a 10-30 km strip from Puerto Patiño (Chapare Province of Cochabamba Department) to the Yapacani River (Ichilo Province of Santa Cruz Department). It also does not show the extensive colonization east of the Rio Grande (Nuflo de Chavez Province of Santa Cruz Department).

Satellite imagery interpretation is also unable to differentiate selectively-logged or degraded forest from virgin forest. The robustness of the Santa Cruz timber industry is evidence that a very large area of forest north and east of Santa Cruz must have been subjected to selective logging. Although no data exist to even give a rough idea of the areal extent of selective logging, I would not be surprised if more than half of the subtropical moist forest on the Beni Plain has already undergone selective logging.

Unfortunately, GEOBOL's vegetation classification system (Table 2) is not compatible with the ecological Life Zones depicted on the ecological map of Bolivia; hence it is not possible to use the two maps to determine the loss of forests through human activities. Nevertheless, the GEOBOL estimate of 561,482 km² of natural forests in the country is only 36,839 km² less than the 598,321 km² of potential forest cover I calculated in Table 1. This is equivalent to a 6% loss of forest cover.

Centro de Desarrollo Forestal

The Ministry of Rural Affairs and Agriculture (MACA) created a forestry department in 1954. Because of inconsistent and vague legislation concerning the forest sector, the lack of forestry policy, and a preoccupation with fiscalization of timber exploitation, the Center for Forestry Development (CDF) was created by governmental decree (D.S. 11686) on 13 August 1974 (Anonymous 1974). According to Article 67 of the Forestry Law, CDF is a decentralized dependency of MACA with independent financing, legal personnel and administrative autonomy, with the objectives to promote, regulate and fiscalize the exploitation, commercialization, industrialization, restoration, protection and conservation of the forest resources of Bolivia. The Forestry Law assigns the following functions and activities to CDF:

- (1) Formulate forestry policy for the country and plans for its application.
- (2) Administer in permanent form the national forest resources.
- (3) Promote and carry out the inventory of forest resources.
- (4) Authorize, guide and fiscalize the forest exploitations according to the dispositions of the Forestry Law.
- (5) Authorize, promote and regulate the installation and functioning of forest industries.
- (6) Apply in national production forests the means to insure the restoration of the forest resources.
- (7) Present, reprimand and sanction the depratory acts and crimes that damage the equilibrium of national forest resources.
- (8) Realize and promote experimental investigations and programs.

- (9) Orient and coordinate international technical assistance to the forestry sector.
- (10) Classify and protect the forests in watersheds.
- (11) Comply with the dispositions of the Forestry Law, its regulations and all other legal dispositions concerning the defense of forest resources.
- (12) Promote the training and formation of the personnel necessary to the application of the dispositions.
- (13) Administer the National Parks and equivalent Reserves.
- (14) Promote the agreements and conventions with public and/or private in-
- stitutions to favor development and the forest economy of the country.
- (15) Dictate the terms to regulate and classify forest products.

Chapter 15 of the Forestry Law created the National Forestry Fund (Fondo Forestal de la Nación) to provide the financial base for CDF operations. The Fondo Forestal receives annual assignments from the national budget, 75% of the timber cutting permits (derechos de monte) granted by CDF and 100% of the income from CDF sales, sanctions, fines, etc.

The regulations and by-laws of the Forestry Law were approved by the Government (D.S. 14459) on 21 February 1977 (Anonymous 1977). CDF had the active and expert assistance of the German Forestry Mission in the preparation of the Forestry Law regulations, as well as with forestry policy and organizational development (Vollmer 1977a, 1977b).

A wealth of excellent information about CDF and the forestry sector is available in a detailed analysis of the forestry sector by Stolz (1978a, 1978b). Numerous problems and recommended reforms are discussed by Stolz (1978c) in the Development Plan of the Bolivian Forestry Sector for 1978-1990. My evaluation of institutional capability will be presented in the section on problems.

Foreign Assistance

Although technical assistance to CDF from the German Forestry Mission largely ended in 1978, it is important to stress the prominent influence the German Mission had on the development of CDF and forestry policies (Haggenmiller 1977; Stolz 1978a,b,c; Vollmer 1977a,b). The German Forest Mission is cooperating with CDF in the construction and development in Cochabamba of a national forestry school for the training of technicians and forest guards. When the school opens in 1981, five German professionals will instruct 25 technicians and 25 forest guards. A three-year program is planned for the technicians, while forest guards will complete studies in one year.

FAO (Food-Agricultural Organization of the United Nations) is involved in a major cooperative project with CDF to inventory large forest areas in Beni and Pando Departments. Field work in Pando has been completed, but the analysis of data is not yet available. The inventory of the "Los Chimanes" forest in Gral. José Ballivián Province of Beni Department is part of a prefeasibility study (Sachtler 1979). The Chimanes inventory investigated 1,300,000 ha of which 340,000 ha were determined to be commercially promising. Over 230 species of trees were encountered in the study area. Average standing timber volume is 75 m³/ha, of which only 20 m³/ha of some 20 species are presently commercial. Sachtler points out that the Chimanes forest and the Choré-Guarayos forest reserves are the only two areas that will be able to provide secondary woods to the strong internal markets in the future.

Table 2. Areal e terpret the Dep	xtent (km ation of artments	2) of for recent se of Oruro	est veget tellite i and Potos	cation type mages (Bro	s by depar ckman 1978 ted from 7	rtments 8). Due the tabl	as determi to absenc e.	ned by GI e of natu	IOBOL's i ural fore	n- sts,
ł	CODE	BENI	CBBA.	CHUQUIS.	LA PAZ	PANDO	STA.CRUZ	TARLJA	NATIONA	Г(%) Г
HIGHLAND (>3000m) Evergreen	2112		1,280		1,340				2,620	(24.0)
INTERMEDIATE (300 Evergreen	0-500 m) 221	11,319	15 , 972		32,462		5,987		65,740	(11.71)
Evergreen and Semievergreen Semievergreen	221-222 222			8,891			511 1 , 377	8,605	511 18,873	(0.09) (3.36)
Semievergreen an Deciduous Deciduous	d 222-223 223			5,378			486 12,713	6,980	486 25 , 071	(0.0) (74.4)
Deciduous and Semievergreen	223-222			06			4,160		4,250	(01.76)
LOWLANDS (<500m) Evergreen Semievergreen Deciduous Deciduous and Rangeland	231 232 233 233 233	91,629 2,138	8,923	77 3 , 362	27,556	60,816	54,401 96,833 84,192 3,128	90 1,226 9,563	243,412 100,274 97,117 3,128	(17.36) (17.86) (17.30) (0.56)
TOTAL (km ²)		105,086	26,175	17,798	61,358	60,816	263,788	26,464	561,482	
Percentage		18.72	4.66	3.17	10.93	10.83	46.98	4.71	100.00	

The FAO inventory project is also carrying out exploitation, transport and marketing studies for timber from Chimanes and Pando, silvicultural work with native rubber and Brazil nut trees, and a strong program in dendrology, including development of a national forestry herbarium in Cochabamba.

There are several other foreign, bilateral, and international technical assistance projects involving the forestry sector, but they are involved mostly with reforestation and plantation projects or erosion control.

Demands Upon Forest Lands and Resources

Timber and wood products place the greatest demands upon Bolivia's forests. In 1976, the latest year of available statistics, 366,000 m³ of logs were harvested, whose products were valued at approximately US \$25 million (Table 3). Stolz (1978c) uses a value of 15 m³/ha of industrial timber, thus a minimum of 24,400 ha had to have been selectively logged to supply the timber harvested in 1976. Unfortunately, the data do not exist to differentiate the source areas, e.g. forest reserves or new areas of colonizations.

Secondary forest products (firewood, charcoal, rubber, Brazil nuts, heart of palm, quinine, etc.) play an extremely important role not only in the remote rural areas but in the Bolivian economy as a whole (Table 4). Stolz's (1978c) data for consumption of firewood appear exceptionally high. Nevertheless, rubber and Brazil nuts form the economic base for Pando Department and along the Itenez River in Beni Department. The actual revenues produced by Brazil nuts and rubber are certainly greater than those shown in Table 4 because of the substantial flow of these products to Brazil, where the subsidized prices are two to three times greater than the Bolivian prices.

The demands on forest lands for conversion to agriculture and pasture are certainly substantial, yet the data base for quantifying areas deforested and rates of conversion from forest cover to non-forest cover, are sparce. Stolz (1978c) estimates an annual loss of 45,850 ha, equivalent to 0.08% of the forest lands.

Bolivia's forest lands are sources of large numbers of skins of wild cats, peccaries and crocodiles, and of live *Sanguinus* monkeys for health research. Although there appears to be minimal effort on the part of CDF to control hunting of endangered species, the volume of contraband skins is reputed to be very large. It would take several weeks to get even a fair idea of the extent and volume of animal skins. Monkey export is done under license by CDF.

Despite an impressive list of 17 national parks and equivalent reserves (Stolz 1978b) not a single park receives adequate protection. Most are national parks or reserves on paper only and lack administration and protection from hunting or invasion by colonists. The one million hectare Isiboro-Sécure National Park was established in 1965 to protect the natural resources of the area from colonization associated with highway construction along the margin of the Amazon Basin. The park also includes the largest remaining populations of a black caiman that are under heavy hunting pressure for its fine quality skin.

Although Isiboro-Sécure National Park has the potential for an excellent park and contains an endangered species, CDF seems to have already given up

Table 3. Timber products in quantities harvested and produced and their values for the year 1976 (Data from Stolz, 1978c).

	Harvested Raw	Productio	on (m ³)	Value (U	JS \$1,000)
PRODUCT	<u>Material (m³)</u>	Internal	Export	Internal	Export
Saw timber	255,000	86,000	49,000	10,700	7,900
Railway ties	s 67,000	24,000	_	2,200	_
Posts	3,000	3,000	-	260	-
Rafts	14,000	14,000	-	530	_
Logs	19,000	17,000	2,000	810	432
Wood panels	8,000	2,000	1,000	900	1,670
Total	366,000	146,000	52,000	15,400	10,002

Table 4. Secondary forest products in quantities harvested and produced and their values for the year 1976 (Data from Stolz, 1978c).

Product	Harvested Raw Materials	Production	Value (US \$1,000)
Firewood Charcoal Rubber Brazil nuts Heart of Palm Quinine Others	3,400,000 m ³ 80,000 m ³ 3,631 ton 8,549 ton 540 ton 88 ton	3,400,000 m ³ 16,000 m ³ 2,962 ton 4,845 ton 360 ton 3.5 ton	12,500 704 4,202 2,584 293 228 6
Total			20,517

on it in the face of advancing colonization. Some CDF officials are now pushing the more remote Pilón-Lajas area for a national park as a substitute for Isiboro-Sécure. My impressions from low-level overflights of both areas suggest Isiboro-Sécure has a greater diversity of ecosystems and would be a more appropriate national park. CDF officials do not know of any black caiman populations in the Pilón-Lajas area. The Isiboro-Sécure National Park would be an excellent choice for an internationally assisted model park to provide the impetus and expertise for the development of viable national parks in Bolivia.

Recreational demands upon Bolivia's natural forests are non-existent.

Conservation and Rational Land Use Problems

1. Colonization

In both forestry and conservation sectors of Bolivia there is a broad consensus that agricultural colonization is the most serious problem confronting natural forest resources. Opinions vary as to whether spontaneous colonization

or directed colonization is more serious, but for our purposes we can consider them to be equal. Spontaneous colonization occurs along new public roads and occasionally along private timber extraction roads. The National Colonization Institute (INC) is primarily responsible for organized and directed colonization, although the Agrarian Reform Institute (IRA) is also involved in directed colonization.

Agricultural colonization receives the following criticisms: (1) practically none of the timber is harvested: (2) failure to use objective criteria in selecting areas for directed colonization; and (3) location of areas for directed colonization in forest reserves. Timbermen and conservationists alike complain that colonists burn the timber to make new agricultural clearings. According to the Forestry Law and Regulations, the timber on colonization areas belongs to the government and CDF is responsible for its exploitation. Yet the colonist claims the timber is his and he must be paid for any timber taken from his property. However, the logger or sawmill operator must pay a cutting fee to CDF, so he refuses to pay the colonist, for that would constitute a double payment. The simple compromise of deducting the payment to a colonist from the cutting fee due CDF hasn't been worked out. Spontaneous colonization often follows selective logging operations, so it is unlikely any commercial timber remains for the colonist to sell. Colonists are particularly voracious in cutting and burning much more forest than they can effectively cultivate.

Regional broad-scale environmental degradation does not appear to be a serious problem with directed colonization projects, primarily because they are located on the relatively flat lowlands. INC colonization projects are prohibited by the Colonization Law from areas with slopes exceeding 15%. In contrast, spontaneous colonization is widespread along roads through the Yungas and to the foothills of the frontal range. Colonists literally burn their way upslope from the valley floors. Removal of the natural forest cover on steep slopes has led to serious erosion problems, such as in the Yungas between Coroico and Choro.

Although INC and IRA personnel say they do soil studies before selecting suitable areas for colonization projects, the field evidence suggests that soil and land-use capability studies were not done, were ignored, or inappropriate criteria were used. The extensive spontaneous and directed agricultural colonization of the Chapare is occurring largely on soils that, in my opinion, will not support sustainable agriculture using existing technology and crop preferences.

The maps of colonization (map 5 in Stolz 1978b) and of forest reserves and national parks (map 3 in Stolz 1978c) clearly illustrate the considerable overlap of actual and projected colonization areas with forest reserves and national parks, especially in Beni and northern Santa Cruz Departments. Both the establishment of colonization areas in existing forest reserves and the designation of forest reserves in projected colonization areas have occurred.

The Forestry Law and Regulations specify that all the forests and forest lands constitute a national patrimony, regardless of original ownership, and are to be administered in the public interest by CDF. Because of the lack of adequate forest maps and the chaotic ownership status of lands in the Oriente,

the Forestry Law created a land use commission to minimize the irrational use of the country's forest resources and to adjudicate inter-institutional disputes regarding land use. Although created specifically to arbitrate conflicts between agriculture colonization projects and forest reserves, the Commission has failed to function. My discussions with government officials indicate an almost complete lack of communication between INC and CDF officials. A more important reason for the dysfunction of the Land Use Commission may be the lack of information on land-use capability.

2. Land-use Capability Classification

As mentioned in the proceeding section, a land-use capability classification is fundamental to the rational utilization of the natural resource base of the country. In the absence of such basic information, development and/or utilization is chaotic, poorly organized, often competitive, and extremely wasteful of the resource base. This all-too-familiar litany of irrational and destructive use of natural resources is characteristic of developing countries, and, of course, Bolivia is no exception.

GEOBOL has been working hard to provide the information base necessary for the rational development of Bolivia's natural resources and is reddying for publication a series of 1:250,000 maps of the Oriente showing physiographic units, soil series and land-use capability. Dr. Carlos Brockman, director of GEOBOL, kindly permitted me to preview the maps.

The fundamental problem with GEOBOL's land-use capability classification is that it is based on the USDA-SCS (U.S. Department of Agriculture Soil Conservation Service) land-use capability system, i.e. Classes I through VIII. The SCS system does not work well for tropical and subtropical soils for several reasons: Developed in the temperate zone, the SCS system is not designed to include the rapid and high rates of leaching that occur in tropical/subtropical soils nor does the SCS system adequately provide for the low nutrient pools in the majority of tropical American soils and for the very tight and efficient cycling of nutrients in tropical forest ecosystems. Thus when tropical forests are converted to non-forest uses, breaking the closed nutrient cycle, substantial quantities of already scarce nutrients are lost from the system. Slash-and-burn agriculturists use the nutrient capital accumulated by the forest ecosystem. One of the reasons for abandonment after 1-3 years of cropping is exhaustion of the nutrient capital from the original forest.

The second reason the SCS system is inappropriate for tropical/subtropical soils is that it does not give sufficient emphasis to the very high susceptibility to erosion of many tropical/subtropical soils, particularly the Ultisols. Conversion of tropical forests on Ultisols to agriculture or pasture has often resulted in disastrous surface erosion and landslides.

Another problem with the SCS classification system is that some of the classes usually include more than one major land-use, e.g. Classes III-V. Despite various restrictions or qualifications included in the description of a specific class, the tropical land-user ignores the restrictions and selects the land-use option he prefers. The SCS inclusion of pasture as an acceptable land-use on Classes III-V has been, in my opinion, the primary cause for the tremendous conversion of forest to pasture in much of tropical America. Pastures in the wet tropics are usually not economically productive operations due to extremely low carrying capacity and exuberant woody invasion.

The inappropriateness of the SCS land-use capability system for tropical and subtropical soils is exemplified by comparing two areas on the GEOBOL maps. According to GEOBOL's classification the soils of Pando (Tropical Moist and Premontane Moist Life Zones) are more suitable for agriculture than are the soils between the town of Yapacaní and the southern limit of the Choré forest reserve. The soils in the area north of Yapacaní are the best agricultural soils I have seen in the Bolivian Oriente. In my opinion most of the Ultisol soils of Pando Department will not sustain annual cropping, nor are they suitable for pasture. Beef-cattle pasturing along the Cobija-Porvenir road requires 5 ha/animal, plus numerous signs of erosion are appearing on rather gentle slopes.

GEOBOL's land-use capability map will not be of much use in resolving inter-institutional conflicts over the most appropriate land-use because only 3 map units (of a total of 48) are designated with a single land-use class. Thirty map units include two land-use classes and 15 have three or more landuse classes. Many of the multiple combinations include classes III, IV, V and VI, which offer alternative land-uses from agriculture to production forestry for a single mapping unit.

3. Utilization of Forest Resources

As is typical of countries with vast forest resources, only the premium quality timbers are used. The Bolivian timber industry, largely based in Santa Cruz, has developed on virtually one species--mahogany (*Swietenia macrophylla*). Stolz (1978a) indicates that mahogany (locally known as mara) accounted for 70% of the timber harvested in the Santa Cruz region in 1974. He further states that 6 species--mahogany, laurel (various Lauraceae species), ochoo (*Hura crepitans*), cedro (*Cedrela* spp.), morado (*Machaerium* sp.) and jacarandá (*Dalbergia* sp.)--accounted for 70 to 97% of the sawn timber in 1974.

Even though the Santa Cruz timber industry now accepts 25 species (Jose Santistévan, pers. comm.), substantial numbers of good timber species are being ignored, or worse, are cut and burned by colonists. In order to broaden the timber base, CDF is conducting wood quality and utilization tests of 25 presently unused timbers under the sponsorship of the Cartagena Agreement of the Andean Pact countries.

Post harvest utilization problems also occur because of the preference for mahogany. Solid mahogany wood is used for a variety of purposes where a veneer panel would suffice or where other perfectly good woods could be substituted. The predilection for mahogany in national and foreign markets is rapidly depleting the stock of mahogany. CDF officials in La Paz say that there is enough mahogany to last well into the 1990's. Others suggest only ten years (M. Sachtler, pers. comm.) and at least five more years (J. Santistévan, pers. comm.).

The key to improved utilization of the timber resources of Bolivia is knowledge about the tree species present in the forests and information about their wood qualities and potential uses. Knowledge and information about Bolivian trees is practically non-existent. Most of the scientific names applied to Bolivian trees come from neighboring countries, yet they are used indiscriminantly in Bolivia. Stolz (1978b) summarizes the results of 57

forest inventories conducted in Bolivia. Because of extreme vagaries in the usage of common names of trees and the lack of valid scientific names, the forest inventory results must be used very cautiously (Hartshorn 1977, 1978). For these reasons the FAO forest inventory project has placed strong emphasis on the collection of voucher specimens and the initiation of a national forestry herbarium.

4. Forest Management for Sustained Yields

The majority of the timber processed by the Santa Cruz industries comes from the Choré and Guarayos forest reserves north of Santa Cruz. According to Stolz (1978c) both reserves are in an advanced stage of exploitation of the valuable timber species. Until mid-1979, no attempt was made by CDF to protect the reserves, with the consequence that spontaneous colonizers have deforested significant areas within the two forest reserves. CDF seems to be more concerned with declaring new forest reserves than with the protection and management of existing forest reserves.

The most serious problem facing Bolivia's natural forests is the complete disinterest on the part of CDF in forest management. As mentioned earlier, all natural forests are owned by the state, thus the timber industries are completely dependent on CDF for the supply of timber. The sale of cutting rights in 1978 generated approximately US \$1 million but as best I can determine any efforts by CDF in silviculture or forest management are negligible or non-existent.

According to Sachtler (1979) the Choré and Guarayos forest reserves are the only two assured future sources of timber for the Santa Cruz industries. CDF's abdication of responsibility for the sustained production of timber from the Choré and Guarayos forest reserves can only portend drastic consequences for the Santa Cruz timber industries.

CDF grants 5, 10 and 20 year timber concessions, hence an individual concessionaire is not about to invest in forest management or silvicultural treatments to produce a second crop or a sustained yield of timber. The National Association of Timber Industries (Camara Nacional de Indústrias Madereras) have initiated a forest plantation program through an agreement with CDF. The Camara is voluntarily providing US \$300,000/year to support the program. CDF agreed to provide technical personnel, equipment and logistic support, but none has materialized to date.

The forest plantations program (PPF) has 3 projects: watershed reforestation near Samaipata, species trials on 12 sites in the Santa Cruz microregion, and species trials and natural regenerations studies in the Choré forest reserve. PPF has already constructed a quite-respectable forestry station in the Choré forest reserve.

5. Institutional Capability

Tropical American forest services are typically based on excellent forestry laws, regulations and organizational charts, but in reality are usually weak, incompetent, corrupt, bureaucratically top heavy, and preoccupied with the fiscalization of timber. CDF is no exception to the generality.

Approximately 75% of CDF personnel are primarily involved in the fiscalization of timber (Table 5). Most of the competent foresters in CDF are heavily involved in administration. The extremely few CDF foresters actually working in the field are involved in reforestation projects (e.g. Cándido Pastor, Parque Tunari north of Cochabamba).

The scientific base of CDF's technical program appears to be especially weak. CDF personnel are working with GEOBOL on the preparation of a forest map. Dr. Brockman, director of GEOBOL, permitted me to review the maps in preparation. The forest map is based on Beard's classification of Trinidad, which has a strong European bias against tropical forests. GEOBOL's map shows all the forests along the northern Andean front ranges as one forest type, i.e. covering at least 7 Ecological Life Zones. In the southern lowlands and on the Beni Plain, the GEOBOL map differentiates numerous vegetation types. Despite five years of CDF work in preparing the forest map, it appears that the map will be of minimal utility for definition of commercial forest reserves.

The development of sustained yield management systems for the forest reserves, especially Choré and Guarayos, should be near the top of CDF priorities. CDF professional personnel express little concern or interest in the principle of sustained yield or the protection of forest resources. The latter criticism also applies to national parks and wildlife.

Even though CDF is only five years old, it appears to have grown-up fast politically. There is considerable commentary in the country about the graft associated with the granting of concessions. During some of the previous military governments, hundreds of thousands of hectares of concessions in Chiquitanía were reputedly granted at the rate of \$b 1/ha (\$b 1=US\$0.05) for the Minister of Agriculture.

In sum, CDF is doing an extremely poor job in carrying out the functions assigned by the Forestry Law and Regulations, especially those related to conservation and rational use of the natural forest resources. CDF is really not much more than the government's fiscal agent for the sale of timber. The only bright spot appears to be the Forest Plantations Program (PPF) funded by the timber industry.

	Forestry	Special Ag.Engn.	Forest Techn	Special	Forest Guards	Other Professionals
		110 121011	1001111	1161 12011		1101000010110110
CDF	-					
Main office-La Paz	6	5		2	1	4
West regional office				3	14	
Northwest regional offic	e 2			3	4	
North regional office	3			1	4	
East regional office	9	5		13	22	
Central regional office	1	5		5	3	
South-central regional o	ffice			5	7	
South regional office	3	1		3	3	
Universities						
Tarija	9					
Santa Cruz	2					
Cochabamba		2				
Regional Development Corp CORDBENI CORDEPANDO	orations					
CORDEPAZ	1					
CORDECO	l					
CODETAR	5					
CODESA				2		
CORDECRUZ	1		l			
Consultants	4					
Private Industry						
Plantation Project	2					
Timber Companies				10		
Other Public Agencies						
IBTA	2					
SIDERSA		l				
CBF	3	2				
Banco Agricola	3					
Municipalities	2	l				
COFADENA						
Pilcomayo Watershed	4	2				
Professionals out-of-coun	try 7					
Professionals not in fore	stry 3					- <u> </u>
ΤΟΤΑΙ	73	24	1	47	58	4

Table 5. Professional and technical forestry personnel in Bolivia (from Stolz 1978b).

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