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DRAFT ENVIRONMENTAL REPORT  
ON BOLIVIA

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JUNE 1979

# Draft Environmental Report on BOLIVIA

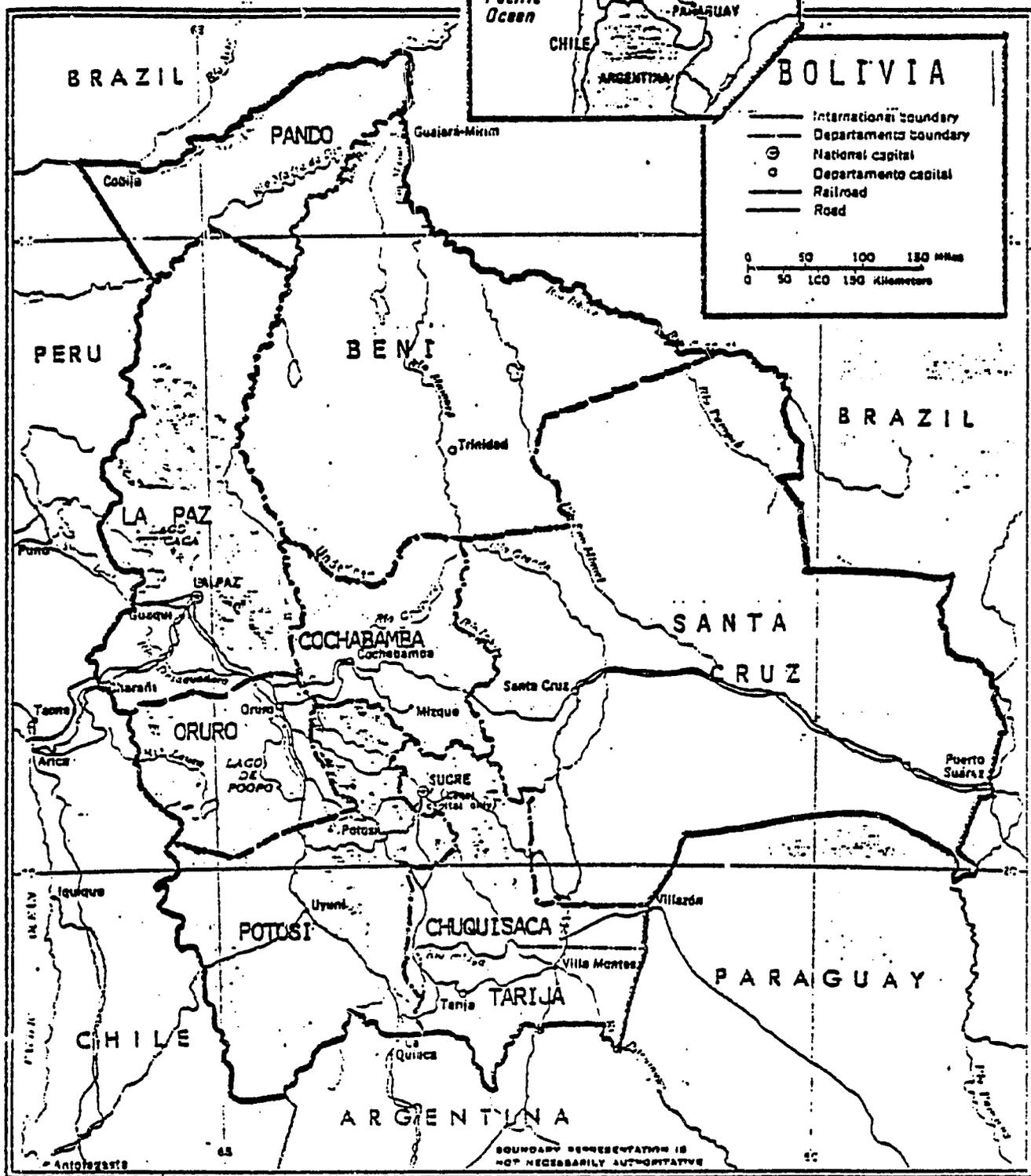
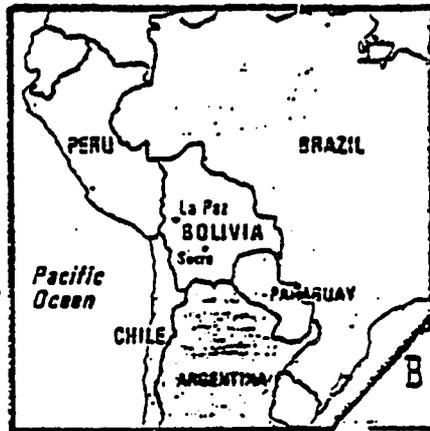
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## 1.0 INTRODUCTION AND SUMMARY

Bolivia is a landlocked nation located completely within the tropical zone of South America.

The topography of Bolivia is an important factor in considering its environmental problems and constraints. The southeastern region of Bolivia is dominated by the Andes, which traverse the country in a north south direction, cutting it into three distinct zones; the highlands the lowlands and the transition areas which come between them. The most important area in the Andean region is the Altiplano, a high plateau which runs north to south and is flanked by the high Andes to both east and west. This Altiplano, is the traditional home of the Indians who occupied this area of South America long before Bolivia became an independent political entity in the 1800's, is sparsely vegetated and has a rather harsh climate with low levels of rainfall and low temperatures. The valleys on the eastern slopes of the Andes are quite different from the Altiplano. To the north are the steeper valleys generally designated as the Yungas; these valleys are warm and subtropical and receive year round rainfall; the Valles, the name generally assigned to the Valleys of the south and central slopes, are less steep than those of the Yungas, with more gradual descents to the lowlands. The Oriente, the vast eastern region which accounts for about 70% of Bolivia territory is generally lowlying country with vegetation varying from rainforests in the far north to pampas in the midlands and the dry savannas in the Bolivian Chaco in the South.

Bolivia's environmental problems vary somewhat depending on the region of the country. One principal problem relates to the large concentrations of population in the harsh and rather unproductive land of the Altiplano. Here because of poor cultivation methods and the overgrazing of domestic animals, especially sheep, erosion, leading to loss of productivity, is the chief environmental problem. This same problem extends to the highly populated valley areas, where farmers cultivate steep slopes, usually without the benefit of more than the most basic soil conservation measures.

Erosion and loss of plant cover in the highland and valleys has resulted in poor water retention, leading to increase runoff and flooding and further loss of valuable soil resources. Furthermore, heavy runoff from highland regions results in serious flooding in the lowlands and a consequent limitation of their development possibilities. Accumulations of silt in lowland rivers have also affected the courses of lowland rivers.

Erosion is less of a problem in the Oriente, but in the agricultural area of Santa Cruz, slash and burn agriculture practiced by small farmers are increasingly leading to soil erosion and abandonment of land.

Water supply and water quality are problems throughout the country. A substantial percentage of Bolivia's diseases problems has been attributed to poor water quality. Once more the problem is most severe in the highly populated Altiplano, where the climate is relatively dry and where domestic and industrial users must compete for their share of water supply. Here problems are caused by the pollution of water not only by sewage and solid wastes from urban areas but also by effluents from the mining operations which are concentrated in this area. Pollution of streams has also led to a reduction of the numbers of fish not only in rivers but in Lake Titicaca, Bolivia's largest lake.

Bolivia is still a heavily forested country, but deforestation is becoming an increasingly greater problem as the country begins to exploit its timber resources. This is especially true in the tropical forests of the northern lowlands, where forest exploitation is said to be carried out in an irrational manner. In agricultural areas, particularly in the new lands of Santa Cruz, loss of forests to slash and burn agriculture as well as to large-scale agricultural operations is becoming increasingly a problem.

Bolivia still has a rich and varied wildlife which serves as an important source of food in some areas. However, much of Bolivia's native wildlife now is considered endangered, while some animals hunted for their skins such as the vicuna (now making a comeback because of conservation efforts) have been on the verge of extinction.

The Bolivian government has been making an effort to face its environmental problems. Recent laws have recognized the importance of forest preservation, soil conservation, and the protection of wildlife. The government's five year agricultural plan for 1976-1980 also stresses these matters. These efforts are hampered, however, by limited manpower resources and limited funding. Furthermore, the country's willingness to face its environmental problems and to realize the urgent need for a more rational approach to natural resource development has been limited by a general feeling that the country's resources—soils, forests, wildlife, and plants—are virtually inexhaustible. The recent establishment of a Division of Natural Resources and Environmental Protection in the Ministry of Planning and Coordination is an important step toward the important goal of including environmental consideration in development plans. Attempts now beginning to employ remote sensing in order to determine more accurately the actual extent of Bolivia's resource base are also of vital importance.

## 1.0 POPULATION CHARACTERISTICS

A landlocked nation situated completely within the tropical zone of South America, Bolivia, with an area of 1,098,580 square kilometers (424,160 sq. miles), occupies territory just slightly larger than that of Texas, Oklahoma, and Kansas combined.

### 1.1 General population statistics

Population: 5,200,000 (mid-1979 estimate)\*  
4,647,000 (population census: 1976)

Average annual growth rate: 2.9%\*

Birth rate: 47 per 1,000 pop.\*

Death rate: 19 per 1,000 pop.\*

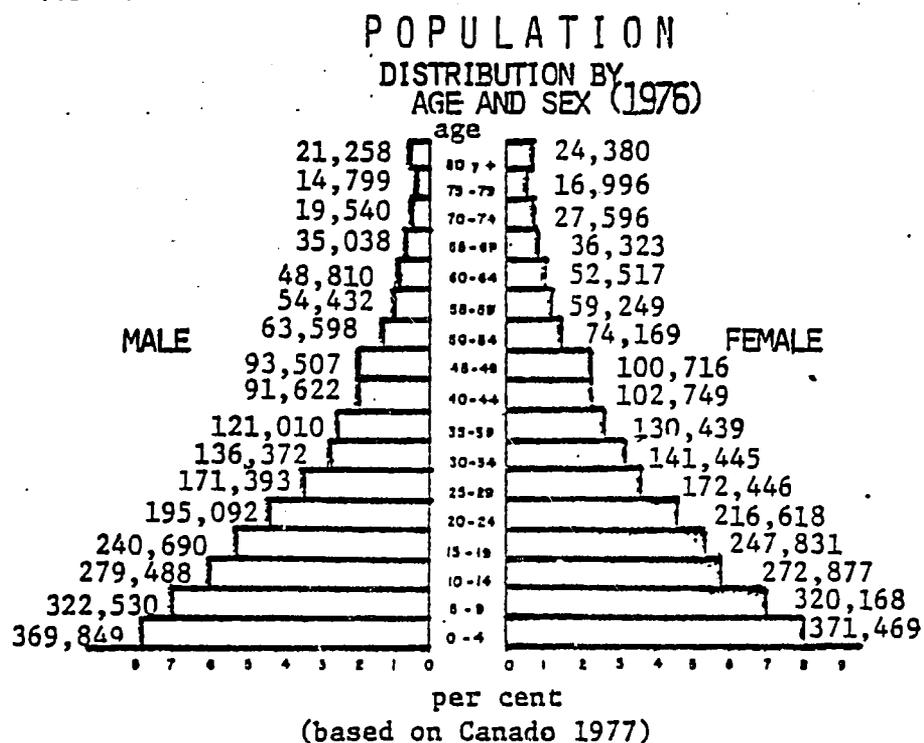
Rate of natural increase per 1,000 population: 25.6 \*\*

No. of years to double pop.: 24\*

Pop. in year 2,000: 8.7 million\*

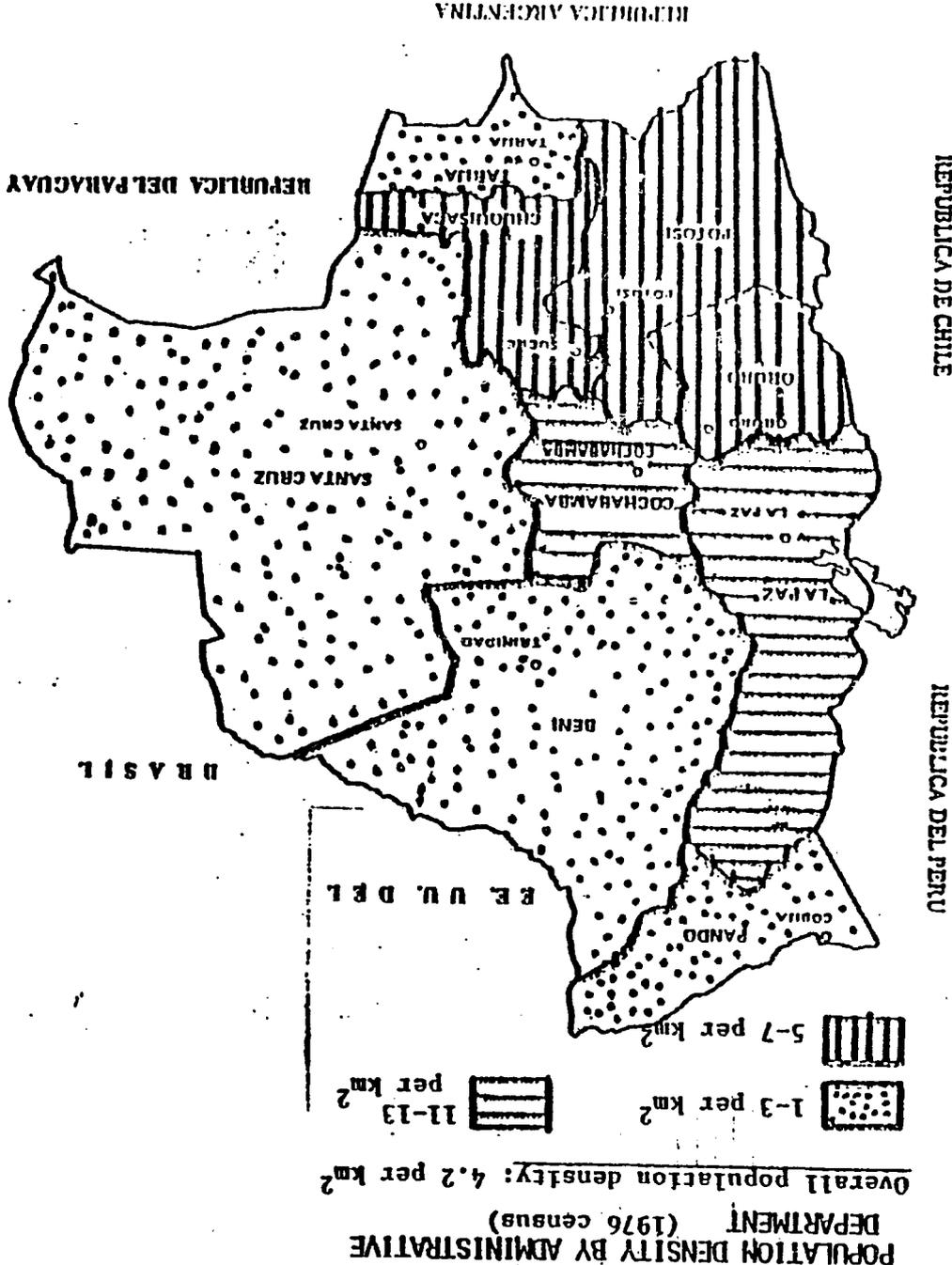
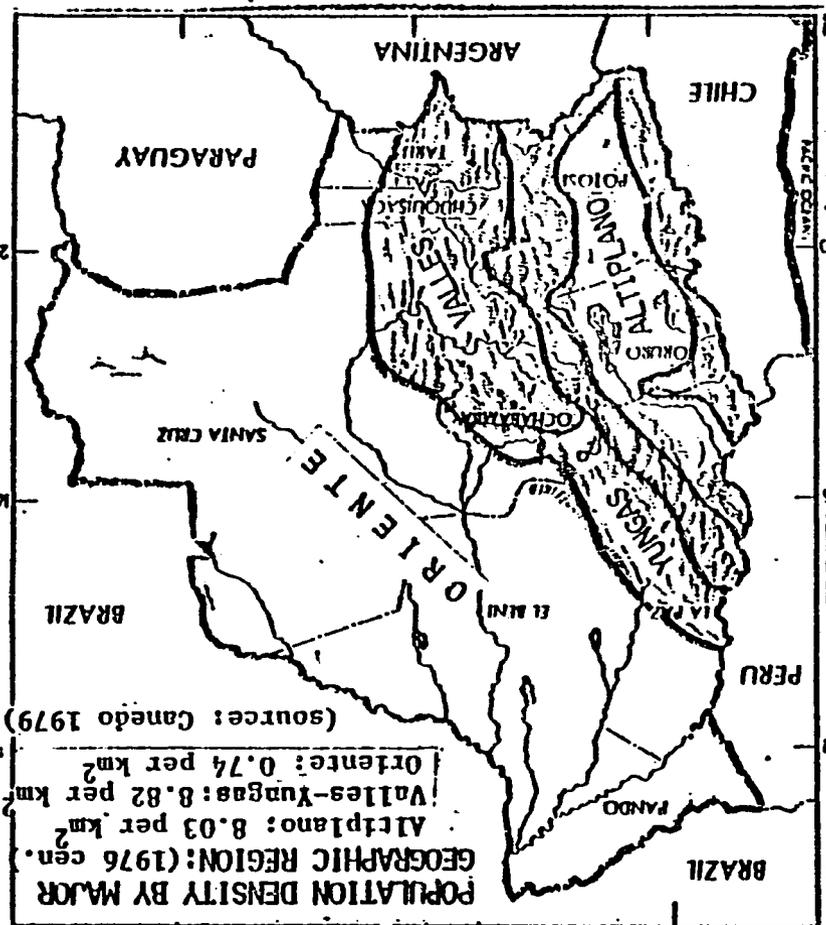
Pop. over 64: 4%\*

Population under 15: 42%.\*



\*Estimates from the 1979 edition of the World Population Data Sheet of the Population Reference Bureau, Inc., Washington, D.C.

\*\*Estimate from PAHO 1979:88.



## 1.2 Population by Administrative Department (see map, page 2)

### Population Growth by Department 1950-1976 (Canedo 1977)

	1950	1976	% of land	% pop (1976)	% annual growth (1950-1976)
La Paz	854,079	1,484,151	12.2%	31.9%	2.15
Cochabamba	452,145	730,358	5.1%	15.7%	1.86
Santa Cruz	244,658	715,072	33.7%	15.4%	4.21
Potosí	509,087	658,713	10.8%	14.2%	1.00
Chuquisaca	260,479	357,244	4.7%	7.7%	1.22
Oruro	192,355	311,245	4.9%	6.7%	1.87
Taríja	103,441	188,655	3.4%	2.8%	2.34
Beni	71,636	167,969	19.4%	3.6%	3.33
Pando	16,284	34,409	5.8%	0.74%	2.92

## 1.3 Population of Major Geographic Regions (see map, page 2)

### Population by Major Geographic Region 1950-1976 (Canedo 1977)

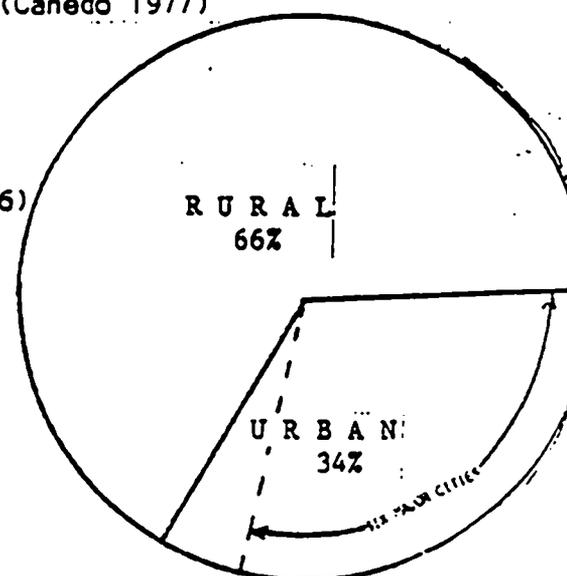
	1950	1976	% of land	% pop 1950	% pop. 1976
Altiplano	1,484,279	2,454,109	27.8%	49.2%	52.8%
Yungas and Valles	1,054,683	1,276,257	13.2%	34.9%	27.5%
Oriente	478,069	917,450	59.0%	15.8%	19.7%
	3,019,031				

As indicated by the table, the Bolivian Altiplano and the Yungas and Valles, the mountain valleys fringing the eastern ranges of the Cordilleras, regions are the most heavily populated areas of the country, accounting together for about 80.3% of the total population.

## 1.4 Urban-rural population distribution

### Major urban centers and populations 1950-1976 (Canedo 1977)

	1950	1976	% annual growth (1950-1976)	% growth (1950-1976)
La Paz	267,008	654,713	3.51	245%
Santa Cruz	41,461	254,946	7.27	615%
Cochabamba	74,819	205,002	3.95	274%
Oruro	58,558	124,121	2.93	211%
Potosí	43,306	77,334	2.26	179%
Sucre	38,404	62,207	1.87	162%
Taríja	16,398	39,087	3.40	238%
Trinidad	10,607	27,583	3.74	260%
Cobija	1,711	3,636	2.94	213%



The percentage of the population living in localities with less than 500 inhabitants has been estimated at 57.5% (PAHO 1979), while an estimated 42% lives in communities of 200 or less (PAHO 1978c:14).

Migration plans of the Bolivian government call for resettlement of populations in the lower mountain lands along the eastern flank of the Andes; the Chaco area is also pinpointed for such migrations.

Possible problems for such resettled persons include health difficulties caused by a radically new environment and changes in altitude. Lack of familiarity with the environment can also result in severe failures in the exploitation and management of new lands. (SOURCE: MAB?/)

### 1.5 Ethnic composition of the population

A large portion of the population of Bolivia is composed of Indian groups. The Aymara form about 25% of the population as a whole but 90% of the population in La Paz Department. The Quechua, who form about 30% of the population, are found throughout the Altiplano and the valleys of the Yungas and the Valles. About one-third of the population is made up of "mestizos," people of mixed Indian and European ancestry. The remaining 5 to 15% of the population is comprised of "blancos," who claim descendancy from the original Spanish settlers or later European immigrants; this group which is actually defined more by socioeconomic and cultural than by racial characteristics, is found in large and small towns, where it is heavily represented among professionals, merchants, and high government officials.

Cultural aspects connected with the large percentage of the population whose dialects, customs, and habits differ from one another and from the white and mestizo population, are said to be, among other things, impediments to the implementation of health programs (PAHO 1978b).

### 1.6 Educational characteristics of population

Percentage of literate population (1977): 67% (PAHO 1978b)

It has been estimated that only about 20% of the rural population is literate.

Percentage of population 5-14 years enrolled in primary schools (1977): 54.6% (PAHO 1978b).

Percentage of population 15-19 years enrolled in secondary and vocational schools (1977): 16.5% (PAHO 1978b)

Numbers of population with high school education (PAHO 1978b): 100,000

Percentage of population 20-29 years enrolled in University: no figure available.

School dropout figures are high for all educational levels; furthermore, many educated professionals leave the country.

## 1.7 Health characteristics of the population (PAHO 1978b)

### 1.7.1 Basic health indicators (from PAHO 1978b)

Life expectancy at birth (1970-1975): 46.8%  
(1979): 48 (WPDS)  
Death rate per 1,000 population (1975): 18.4  
Death rate 1-4 years per 1,000 pop.(1975): 14.6  
Infant mortality rate per 1,000 live births (1975): 147.3  
Number of physicians per 10,000 population(1975): 6.3  
Number of hospital beds per 1,000 population (1974): 2.3  
Average daily caloric intake: 1,890.

### 1.7.2 Major health problems in Bolivia

The level of health is inadequate, but the last few years have seen a rise in life expectancy at birth from an estimated 45 years in 1971 to 48 years by the most recent estimates. The general mortality rate, estimated at 19 per 1,000 in 1971 had dropped to 18.4 in 1975, while the child mortality rate had dropped from 154 per 1,000 in 1971 to 147.3 in 1975. Because of the poor reporting of health statistics, especially in rural areas where health care is inadequate and medical personnel are scarce, actual rates of disease and death may be much higher than figures indicate.

Communicable diseases are the principal causes of both sickness and death, with respiratory diseases assuming greatest importance. Malaria is a serious problem. Although figures are not available, exanthematic typhus, bubonic plague, jungle fever, yellow fever, Chagas' disease, hemorrhagic fever and intestinal parasitic disease are severe problems. Tuberculosis remains one of the most important communicable diseases, with an estimated prevalence of 1% in the population. Leprosy is still endemic in the eastern area of the country, while endemic goiter, a result of iodine deficiency, remains a problem in mountainous regions (PAHO 1978b:89).

Although the combination of respiratory diseases, gastroenteritis, and malnutrition is the major cause of disease throughout Bolivia, there are some differences in intensity according to geographical area, while other diseases are limited predominantly to certain areas of the country. In the Altiplano, respiratory diseases and gastroenteritis are most significant, particularly, tuberculosis, typhus and scabies. In the valleys (Yungas and Valles), the pattern is similar but leprosy and a significant amount of Chagas' disease also occur. In the tropical lowlands of the Oriente, malnutrition, complicated by high rates of infection with intestinal parasites (especially hookworm and amoebiasis), and enteritis, is of greater importance than in the altiplano and valleys areas, but respiratory diseases are of relatively lower occurrence; hookworm is estimated to infect nearly 100% of the rural populations in these areas. Some diseases with high rates of illness and death could possibly hinder development plans for these areas; these include malaria, jungle yellow fever, and Bolivian hemorrhagic fever; Chagas' disease and leprosy are also very significant. Malaria has been of particular significance in the Department of Tarija, which accounted for 50% of the 7,000 cases reported in 1973. Chagas' disease, a chronic and usually fatal disease particularly prevalent among the middle aged, may infect as much as 18% of the population in areas in which it is endemic. (Evaluation Technologies

1978:29-32).

Malnutrition and nutritional deficiencies are severe problems, particularly in rural areas. It has been estimated that 2/3 of all children under 15 years of age suffer from some degree of malnutrition, which is more pronounced in the younger age groups (PAHO 1979:89). This condition, plus the prevalence of diseases such as diarrhea and pneumonia as well as parasitic and other communicable diseases results in high infant and child mortality rates. Measles is a major cause of mortality among children under 5 followed in importance by whooping cough. Diphtheria and neo-natal tetanus are also of significance.

Silicosis is a problem among mine workers, although the incidence of the disease in 1976 was 11.9%, down from 22.8% at the beginning of the 1960's. (PAHO 1978b:96).

An additional problem area is the widespread chewing of coca leaves among highland Indian groups. Although the consumption of this drug had the immediate effect of increasing the user's ability to perform hard work under adverse conditions, the long-term effect of this habit, which is common among both men and women is a dulling of the senses and a loss of productivity.

### 1.7.3 Health Services

Bolivian health services are characterized by a large gap between urban and rural health care. The urban area, which comprises no more than 40% of the population of Bolivia, has most of the human, physical and financial resources and consequently its population has greater possibilities of access to health care on all levels. The average number of consultations for these areas runs about three per person per year. A notable exception here is the very low level of health coverage available in the shanty towns which fringe certain urban areas. Among the rural populations, 42% of which by some calculations, live in communities with fewer than 200 inhabitants, health consultations per person per year are estimated at less than one. Reasons for the difficulties in supplying rural health services are: the dispersion of the rural population, which hinders the organization of basic health services; difficult geographical access to services and limited means of access; varying levels of education; and traditional cultural patterns that limit an understanding of health problems (PAHO 1978c:14).

Medical services are provided by the Ministry of Social Welfare and Public Health (about 60%), the social security system (about 30%), and the private sector (about 10%). The rural area is served exclusively by the Ministry of Social Welfare and Public Health (PAHO 1978:14). Traditional medicine is also practiced in rural and to some extent in urban areas; the extent of these activities, which include the sale of medications, witchcraft, and midwifery, has not been documented (Evaluation Technologies 1978:39).

The Ministry of Social Welfare and Public Health's National Health Plan, drawn up in accordance with the National Economic and Social Development Plan 1976-1980, is aimed at improving health services, with special emphasis on rural and urban marginal communities. While the first phase of that

plan was designed to set the stage for expanding and improving health activities, the second phase, scheduled to begin sometime in 1978, calls for the actual extension of health services to the entire rural area that is presently unserved by health programs (PAHO 1978c:15).

## 1.8 Sanitation and water supply

### 1.8.1 Water supply

Lack of access to safe water supply is a major cause of disease in Bolivia, especially of the enteric maladies which afflict so much of the younger members of the population. In many rural areas people draw water from streams and rivers which may be contaminated.

As of 1977 a total of 1,763,000 (about 38% of total population) persons were reported to have easy access to safe water supplies; only 670,000 through house connections. A great discrepancy exists between rural and urban supplies of safe water. Whereas 72% of the urban population has access to safe water supplies (26% through house connections), only 13 percent of the rural population (which represents nearly 70% of the population) has access to safe water supplies, only 5.6% through house connections (PAHO 1978a, Table 27). The situation in urban shanty towns is said to be even worse (PAHO 1978b:89).

### 1.8.2 Sewerage and Sanitation

PAHO figures for 1977 indicated that only a total of 21% of the total population was served by sewage disposal systems, about 42% of the urban population and about 5.6% of the rural population. This marks an improvement over 1970, however, at which time only 12% of the population was served by sewage disposal facilities: 21% of the urban population and 12% of the rural population. Further figures available for 1970 indicate that only 29% of urban sewage channeled through public sewage systems was subjected to some kind of treatment (oxidation ponds), while 6% of the urban population relied on such household systems as pits, privies, or septic tanks (Van der Leeden 1965: Table 7-38).

In the nine cities of more than 20,000 inhabitants only 31% had garbage collection services as of 1975; arrangements for the final disposal of such refuse were, however, inadequate. (PAHO 1975:93).

Despite the low level of both water and disposal service available, a comparison of the above figures with those covering earlier years of the present decade indicate a steady improvement. External aid to continue the improvement of these services includes funding from the International Development Bank (IDB) for water supply and sewage disposal services in Cochabamba; from the World Bank for water supply systems in 70 rural localities and in the cities of Potosi and Sucre. Additional funding is expected from A.I.D. for rural water supply projects in the

Departments of Cochabamba, Chuquisaca and Potosí and from the IDB for sewage disposal programs in the capitals of the Departments of Beni, Chuquisaca and Oruro (PAHO 1978b:90).

#### 1.9 BIRTH CONTROL AND POPULATION POLICY

The Bolivian government has no official family planning policy. The major external assistance for family planning programs comes from U.S.A.I.D.; other assistance comes from IPPF, the Population Council, and Pathfinder.

The organization promoting population planning within Bolivia is the Asociación Boliviana de Protección a la Familia  
Casilla Exp. 7522  
Avenida Arce 2180  
La Paz.

The possibility of the enactment of a strong national population control programs would seem to be excluded by the the Health Code promulgated in 1978, which provides that couples are free to decide the number of children which are to comprise their families (Article 17).

## 2.0 ORGANIZATIONS WITH INTEREST IN ENVIRONMENT AND NATURAL RESOURCES

NOTE: Bolivia is a large land whose population tends to be concentrated in areas between which communications are often very poor. Under these circumstances the country, despite its basically centralized system of government, is actually very regionalized, the departments, the administrative regions into which the country is divided, typically playing a more important role in implementation of programs than the central government officials in La Paz. Central government offices usually have their counterparts at the departmental level, and it is most typically these offices on which the ultimate success or failure of program depends. Departmental Development Committees, for example, play an especially important role in development programs within their jurisdictions.

### 2.1 GOVERNMENT AGENCIES

#### 2.1.1 Ministry of Planning and Coordination

As the Ministry with responsibility for development planning in Bolivia, the Ministry of Planning and Coordination plays an essential policy making role; the activities of its subunits have and will continue to be of importance in attempts to include environmental consideration in development plans.

##### Office of Science and Technology

This has been one of the key government agencies in matters dealing with natural resources and environmental conservation. It has been the chief agency for Bolivia's participation in the Man and the Biosphere (MAB) Program of the United Nations as well as with the International Union for the Conservation of Nature (IUCN). The Office has been instrumental in planning for the new environment office [tentatively called the Division of Natural Resources and Environmental Protection-DNREP], scheduled to be set up by law under the Ministry of Planning and Coordination in May 1979.

##### Division of Natural Resources and Environmental Protection (DNREP).

Scheduled to be established in May 1979, this office, rather than having direct implementing authority, is to serve above all a coordinating function; its responsibilities are to include matters such as: providing technical and administrative personnel to guide, coordinate, and evaluate project execution; providing support personnel and office facilities and materials; administering training activities; and assuring the timely and participation of the operational ministries and decentralized or semi-public agencies involved in executing specific project activities. It is to work with agencies such as the Forest Development Center, relevant subunits of the Ministry of Agriculture and Campesino Affairs, the Division of Environmental Sanitation of the Ministry of Social Welfare and Public Health, and the Earth Resources Technology Satellite (ERTS) Program within the Ministry of Mining and Metallurgy. It will

-also work with provincial level organizations such as Departmental Development Committees.

Other possible facets of the work of this office would include the consideration of environmental concerns at the planning level, including environmental assessments both for planned and already existing projects. It has also been suggested that the Division establish a natural resources accounting system for taking environmental inventories. In an attempt to integrate scientific research into its program, the Division also intends to work with organizations such as the National Academy of Sciences, perhaps cooperating in the establishment of a natural history museum.

#### Instituto Nacional de Estadística (INE)

The chief statistical office of the Bolivian government, the INE is responsible for national statistical work. It was the office through which the 1976 census was conducted; it also publishes statistics relating to commerce and industry.

#### 2.1.1 Ministerio de Asuntos Campesinos y Agricultura (Ministry of Rural Affairs and Agriculture) Avenida Camacho 1471 La Paz, Bolivia

The Ministry was formed by law in 1974, combining the formerly separate Ministries of Agriculture and Rural Affairs.

#### Agriculture Section

##### Servicio de Recursos Naturales Renovables (Renewable Natural Resources Service) La Paz, Bolivia

##### Centro de Desarrollo Forestal (COF)

- Established by law in 1975, the Centro de Desarrollo, although within the Renewable Natural Resources Service, is a decentralized agency, with corporate status, administrative autonomy, and its own assets.
- Under the provisions of the National General Forest Act of 1975 it is at once responsible for the development, management, and protection of Bolivia's forest resources.

##### Functions:

- formulation of forest policy and plans for its implementation;
- ongoing administrative control of the National Forest Domain;
- the promotion and implementation of the Inventory of Bolivian

- forest resources;
- the authorization, direction, and control of forest workings as required under the Forest Act;
  - application in all National Production Forests or measures designed to secure the replenishing of forest resources and the provision of official control over similar measures in private sector forests;
  - the control of any depredatory acts or offences which disturb the equilibrium of the national forest domain, including the application of sanctions;
  - conducting and promoting research and experiment programs in the fields of forest inventory, silviculture, forest management, technology, economics, and marketing of forest products;
  - channeling and coordinating international technical assistance to the forest sector;
  - providing for the management and protection of forest cover in watersheds in coordination with other organizations operating in similar fields;
  - administration of the national wildlife law;
  - observation and enforcement of the provisions of the Forest Act;
  - manpower training:
    - promotion of the training of staff necessary for implementing its directives;
    - training of higher-level and middle-level technical forest personnel.
  - under the 1975 Law on Wildlife, National Parks, Hunting, and Fishing, the CDF is also responsible for issuing hunting and fishing permits, and the development and control of the fishing industry.

#### National Forest Guard (La Guardia Forestal)

Responsible to the CDF, the National Forest Guard is concerned with, is charged, among other things, with:

- preventing, combatting and repressing:
  - irrational utilization of the forests, wild life and natural resources;
  - illegal industrialization, transportation, trade in, or export of renewable natural resources;
  - forest fires;
  - other infractions of the General Forest Act.
- supervision and technical control of National Parks and Forest Reserves.

Under the General Forest Act, the CDF is to set up a school to train National Forest Guards.

Departamento de Vida Silvestre y Parque Nacional  
(Division of National Parks and Forestry)

P.O. Box 4923  
La Paz, Bolivia

Coming under the CDF, the Department is responsible for several recreational parks; publishes a conservation Journal.

Division de Pesquerias (Division of Fisheries)

administration:

-The CDF is to be headed by a Director General, appointed by the Minister of Rural and Agricultural Affairs (M.A.C.A.); the Director General is to hold a degree in Forestry or in agriculture with a specialization in forestry. The Director General is to be responsible for the activities of the Centre, which is to be comprised of Board (headed by the Minister of Rural and Agricultural Affairs and including representatives of other ministry and of the private section [National Forest Chamber]).

funding:

-The National Forest Fund was created by the 1975 Act to support the activities of the CDF. The fund is derived from various sources, including: annual budget allocations; proceedings of the workings of the CDF; and proceeds from sale of plants and seeds, hunting and fishing dues, and fines imposed for offences.

staff:

According to a recent report the Forest Development Center has a total staff of about 370, including forest guards and other personnel in the field. The director has, however, stated that the Center suffers from a lack of experienced staff, both in the forest sector and in the management area for maintaining natural reserves and parks; he has stressed the need for funding for training programs for staff at all levels.

Crops Section

Dirección de Riegos, Suelos E Ingeniería  
Irrigation program  
Soil program

Division de Investigaciones Agropecuarias

Instituto Boliviana de Tecnología Agropecuaria (I.B.T.A.)

-established in 1975 as a decentralized institution operating under the general supervision of the Ministry of Asuntos Campesinos y Agropecuarios (M.A.C.A.)

-the I.B.T.A. consists of a Directory (Directorio), a directorate of Agricultural Studies and an Agricultural Extension Directorate; there is a Chief and a Advisory Coordinating Committee at the Departmental level, while on the lowest level are Experimental Stations and Agricultural Extension Agencies.

Agricultural Research Stations now coming under I.B.T.A. include the following:

<u>Station</u>	<u>Location</u>	<u>Est.</u>	<u>Principal focus</u>
Belen	North Altiplano	1946	Potatoes, sheep, vegetables
Saavedra	Santa Cruz	1948	Rice, sugarcane, corn
Riberaita	Amazon Rain Forest	1952	Rubber
Patacamaya	Central Altiplano	1953	Sheep; forages,
Trinidad	Beni plains	1961	Beef, cattle, rubber
Chinoli	South Altiplano	1962	Potatoes, wheat
Toralpa	Cochabamba	1962	Potatoes
Chipiri	Yungas-Cochabamba	1964	Citrus, rice
San Benito	Valles-Cochabamba	1970	Fruit, wheat

Studies include investigations of new varieties as well as of soil suitability and possibilities for the use of fertilizers and irrigation. In addition, the Department of Studies of the I.B.T.A. is to carry out studies of insect and other pests, including a basic catalogue of plant diseases and studies of means of controlling both insect and disease infestation.

#### 2.1.2 Ministry of Energy and Hydrocarbons La Paz, Bolivia

Servicio Geológico de Bolivia  
Avenida 16 de Julio 1769  
La Paz, Bolivia

The service maintains 10 laboratories and has a specialized library. It publishes geological maps and bulletins.

Comision Boliviana de Energia Nuclear

Centro de Medicina NuclearDirección Nacional de Recursos Hídricos (National Directorate for Water Resources)

Created by Supreme Decree 11,421 of February 14, 1977, the Directorate is charged with the regulating, financing, control and coordination of

all activities related to the utilization of Bolivian water resources. It is to work with those agencies which actually operate the water resources of the country.

As stated in the decree which established it the agency was to correct the present irrational exploitation of water resources caused by the diversity of agencies charged with water utilization.

No information was available on the actual activities of the Directorate.

2.1.3 Ministry of Social Welfare and Public Health

Plaza del Estudiante  
La Paz

Under the new Health Code, promulgated in 1978, this Ministry as the chief health authority, has major responsibilities pertaining not only to public health and medical care but also to pollution control.

(MAB 1977)

Instituto Nacional de Salud Ocupacional  
Instituto Nacional de Laboratorios de Salud  
Instituto Nacional de Nutrición  
Division of Environmental Sanitation within the Min. of Social Welfare and Public Health

also from MAB 1975: Instituto Nacional de Enfermedades Transmisibles

2.1.4 Ministry of Urban Affairs and Housing

La Paz, Bolivia

Dirección de Ingeniería Urbana  
Comité de Normas

Both of these subunits of the Ministry of Urban Affairs and Housing have been involved in the preparation of standards for solid waste management as well of regulation covering potable water and drainage systems for buildings.

2.1.5 Ministry of Industry and Commerce

Responsible for the preparation of the National Plan for Industry and Commerce.

2.1.6 Ministry of Mines and Metallurgy  
Avenida 16 de Julio  
La Paz

Programa ERTS/BOLIVIA [Earth Resources Technical Satellite Program]  
C. Federico Suazo 1673  
La Paz

Although the Program has in the past directed its attention more toward matters dealing with mineral development and road construction ("Satellites..."1978), the project's recent plans call toward broader natural resources planning, including inventories of specific natural resources and the collection of information which will permit predictions about changing land use patterns. One aim is the identification of more suitable areas for colonization. The Program, which presently has a contract with A.I.D. to prepare five sets of maps (136 maps per set) at a scale of 1 to 1 million, is seeking funding from the Interamerican Development Bank (IDB) for the establishment of a natural resources data bank.

The Program's staff, said to be the highest paid in the government, boasts of 16 professionals, including a soil specialist, a forestry specialist, a hydrologist, a geologist, a geomorphologist, a geographer, and a land use specialist.

Instituto de Investigaciones Minero Metalurgicas  
Oruro

2.1.7 Oficina de Aguas Potables por Comunidades  
(Office for Community Water Supply)  
La Paz, Bolivia

2.1.8 Ministerio de Relaciones Exteriores  
Plaza Murillo  
La Paz

Comision Interministerial sobre asentamientos humanos  
Comision Interministerial sobre el medio humano

Both of these organization have been mentioned in connection with Man and the Biosphere programs.

2.1.9 Ministry of Transportation, Communications, and Civil Aeronautics

Servicio Nacional de Meteorologia e Hidrologia (SNMH)

The Service runs several meteorological stations and publishes yearly statistics indicating for these and a group of other stations information such as temperature, rainfall, wind velocity and direction, relative humidity, and, for a limited number of locations, air pressure and evaporation.

## 2.2 NON-GOVERNMENT ORGANIZATIONS

### 2.2.1 Sociedad Boliviana de Ecología (Bolivian Ecology Society)

Casilla 139  
La Paz, Bolivia

Established in mid-1978 by a group of architects, etc. the Bolivian Ecology Society is concerned above all about the degradation of the Bolivian environment through pollution, the disappearance of wildlife and native plant species, and erosion. Members have lamented that many plant and animal species present in the Altiplano area when they were young, have completely disappeared. Most of the present membership is in Cochamba by the Society has plans to set up chapters throughout the country. It intends to prepare studies designed to force the attention of government policy on environmental pollution and natural resource degradation. The present size of the membership is unknown, although the climbers' club whose members set up the Society had about 80 members.

### 2.2.2 Instituto Boliviano del Petroleo-IBP

(Bolivian Petroleum Institute)  
Casilla 4722,  
La Paz, Bolivia

Interests: Co-ordination of scientific and technological research in the oil industry, including pollution.

## 2.3 ACTIVITIES IN CONJUNCTION AND COOPERATION WITH INTERNATIONAL ORGANIZATIONS

### 2.3.1 Man and the Biosphere Program (MAB)

MAB/Bolivia was set up in 1973 by Supreme Decree through a Planning Centre for Scientific Research (CEPIC) [now DEPIC (Scientific Planning Board)], which in turn had been set up through the Rector's office of the Universidad Mayor de San Andres.

The University was appointed to co-ordinate the program which was integrated in the National Commission for Higher Education, coming directly under the presidency; DEPIC has funds for assisting scientific research programs; 50% of which are allotted to ecological studies (UNESCO MAB 1977b:10).

The MAB program for the area, as is indicated below, has several areas of interest, but Bolivia has placed priority on project 6: mountain ecosystems, the only project in which it had clearly indicated its willingness to participate. It has, however, expressed an interest in all the projects listed below as well as in projects 10, 11, and 12 (UNESCO MAB 1977b:35-37).

#### MAB project 1: tropical and subtropical forest ecosystems

Under this project three possible sites for MAB Biosphere reserves have been named: the Manuripi-Heath National Reserve in Pando Department; the Chore Forest Reserve in Santa Cruz; and a reserve in the vicinity of Trinidad in Beni Department (UNESCO MAB 1977a:56-57).

- project 2: grazing lands
- project 4: arid and semi-arid zones
- project 5: rivers, deltas, estuaries and coastal zones
- project 6: mountain ecosystems: Bolivia was appointed regional coordinator of this project in 1975

The project is concerned with training and information programs in the Andean region, with special reference to the problems of human settlements and migration, and the various possibilities of land-use, tourism and conservation; three regions identified, one of which is the extensive altiplanos of the Central Andes, which are characterized by relatively densely populated areas with significant migratory movements towards the lowlands and towns.

- project 8: conservation of ecosystems

Participation is through the Ministry of Agriculture.

### 2.3.2. PAHO (Pan American Health Organization)

Bolivia participates in many programs of the Pan American Organization. In addition, PAHO is reported to be conducting an environmental assessment for the San Julian Colonization Project.

## 2.4 EDUCATION AND TRAINING

Bolivia has a total of 9 universities which, under a 1972 law, are administered jointly as the University of Bolivia under the supervision of the National Council for Higher Education (Consejo Nacional de Educacion Superior). Under the present plan, the universities cover three geographical zones, complementary courses being offered in each zone. Although complete recent figures for university enrollment are not available, enrollment in 1969 was about 20,000 (Wilkie 1977:table 1020b). Several of these universities have programs in both pure and natural sciences, as well as polytechnic institutes, and faculties of technology. In addition the Universidad Boliviana Mayor Gabriel Rene Moreno at Santa Cruz de la Sierra has a Faculty of Tropical Agriculture.

The Universidad Boliviana Juan Misael Saracho at Tarija offers a program in forestry which provides training for professions foresters and managerial staff. Students in this program take course work in basic sciences and in economics as well as in forest resources, forest industries, forest management, and forest engineering. No figures were available for the number of students participating in this program. (Bucarey, Jose R.E. 1974/75).

Universities listed below are those which have participated in or have been suggested for participation in MAB projects.

Universidad Mayor de San Andres (MAB)\*  
Avenida Villazon 1995  
La Paz

Centro de Planificacion y Coordinacion de la Investigacion Cientifica y Tecnologica (MAB)

\*Indicates that these were mentioned as possible participants in Man and the Biosphere Program.

Centro de Calculo (MAB)

Centro Nacional de Documentacion Cientifica y Tecnologica (MAB)

Established in 1967, the Center is designed to provide information for research and development; a depository for FAO, WHO, and ILO documents, it has a library of 9,800 volumes.

Instituto Boliviano de Biología y Altura (MAB)

Instituto de Genética Humana (MAB)

Instituto de Investigaciones Físicas (MAB)

Instituto de Investigaciones Geológicas (MAB)

Instituto de Investigaciones Químicas (MAB)

Instituto de Ingeniería Sanitaria (MAB)

Facultad de Ciencias Puras y Naturales (MAB) FCNP

Departamento de Biología (MAB)

Departamento de Geociencias (MAB)

### Ecology Institute

Established in early 1979 as part of the University of San Andres, the Ecology Institute is funded and staffed by Germans representing the University of Goettingen. It is reported to have an eight-year program, no information on which was available for this paper, but according to earlier reports its emphasis would be on zoological and botanical studies (UNESCO/MAB 1977b:25).

Universidad Católica Boliviana (MAB)

Avenida 14 de Setiembre y C.2 Obrajes

La Paz

Departamento de Sociología (MAB)

Departamento de Psicología

Instituto de Investigaciones Psicológicas

Centro de Investigaciones Sociales

(MAB 1975: 36).

## 2.5 MONITORING CAPABILITIES AND BASELINE INFORMATION

### 2.5.1 Natural Resources

Bolivia has proposed the establishment, presumably in conjunction with MAB activities, of an Advanced Regional Institute for Photo-interpretation of Satellite Images, on the basis of results obtained to date in the ERTS (Earth Resources Technological Satellites) Programme. (UNESCO MAB 1977b).

Bolivia is presently covered by a ground station of the Landsat system situated in Brazil; a new ground station planned for Argentina would be capable of carrying out programs covering Bolivia

as well. Since 1972, Bolivia, with financial assistance from U.S.A.I.D. and other external aid organizations, has developed 24 remote sensing projects. Data thus obtained helped Bolivia to obtain the geomorphological, geological, and land hydrological data necessary for planning a railroad construction project from Santa Cruz to Trinidad and also helped to identify in the "Salar de Uyuni" mountains desposits of lithium and potassium which have become the object of investment plans of several international firms (Satellites... 1978:4). (See also 2.1.6).

### 2.5.2 Water

According to a CEPAL report (CEPAL 1977), Bolivia has a total of 347 pluviometric stations, six of which are equipped with evaporimeters. The findings of these stations are published by the National Meteorological and Hydrological Service (see 2.1.9). Bolivia is also reported to have 63 pluviometric stations, but details on their locations were not available. Bolivia has no wells for groundwater observations.

### 2.5.3 Air

Bolivia is reported to have one air monitoring station, presumably in La Paz (PAHO 1975:84). No details were available.

### 2.5.3 Soil studies

No extensive soil studies have been carried out in Bolivia. There are, however, reported to be published studies of the soils in the Cobija Junin-Bolpera area (Pando Department) in Pando Department, while the Army Command has published semi-detailed soil and hydrological studies for Beni Department (UNESCO MAB 1977a: 56-57). The Division of Soils, Irrigation, and Engineering of the Ministry of Rural Affairs has published soil studies, including maps, for certain areas; one such study covers an area of 12,146 hectares in Yacuiba Zone of the Gran Chaco area of Tarija Department as well as 280,291 hectares in Gran Chaco Zone of the same department (Bolivia, Ministerio de Agricultura 1969). (See also: 4.3.)

### 3.0 Legislation

#### 3.1. GENERAL

Health Code, as promulgated by Decree Law No. 15,629 of July 18, 1978

General health code which, apart from medical matters, contains a chapter devoted to environmental protection and sanitation, with sections on water, soil and solid wastes, air pollution and protection, urban sanitation, radiation protection, labor hygiene, and toxic chemicals and poisons. Article 31 stipulates that every person, natural or juridical, is obliged to contribute to the maintenance and improvement of the natural physical environment and of the created environment in order maintain public health.

For provision on water, air, soils, see appropriate sections below.

Supreme Decree 10,127 of February 18, 1972 creates the Comité de Defensa de la Flora y Fauna  
(G.O. February 18, 1972)  
[no details available]

#### 3.2 WATER

3.2.1 Law of Waters of 28 November 1906, article 20  
-actually from 1879: merely raised to the level of law in November 1906;

This comprehensive water law, which deals chiefly with matters of water rights and ownerships, was first issued as a decree in 1879 and later raised to the level of law in November 1906. Many of its provisions appear to have been duplicated by later legislation, especially by the Agrarian Reform Law of 1953 considered below.

##### groundwater ownership

The owner of land on which groundwater is discovered is expressly declared the owner of such water; his right to tap it is not subject to government supervision or permission; and he may draw water even to the detriment of third-party users. But sections 22 and following of this law authorize the tapping of groundwater on public state lands and their concession in perpetuity to those who do so with official permission; allow the issuance of permits for prospecting within certain limits of space and time during which prospectors enjoy exclusive rights to any water they discover and confer on the discoverer permanent ownership and the right to conduct such water elsewhere across the land of others.

### 3.2.2 Health Code, as promulgated by Decree Law No. 15629 of July 18, 1978

Title I, Chapter II, grants to the Health Authority (La Autoridad de Salud), the regulation, financing and control of the quality of water designed for public supply as well as all those which could constitute health dangers for the population. The Health Authority is to control policy, regulations, implementation and control of potable water supplies for the rural population.

Waters used in various types of establishments are to meet the national norms for those establishments, especially if they are concerned with food production or processing.

It is prohibited to take actions which could cause the contamination or hygienic deterioration of either surface or groundwaters. The Health Authority is empowered to take appropriate measures.

The health authority is to lay down the policy for the sanitary control of water bodies and to control water quality to the end of avoiding indiscriminate discharge of solids wastes from either industrial or domestic sources.

All present or planned industries whether extractive or processing no matter what their size, location or operation conditions, have the obligation to obtain from the Health Authority authorization for the disposal of wastes into water bodies or for the initiation or continuation of this activity.

### 3.2.3 Agrarian Reform Law (D.S. 3464 of August 2, 1953)

- provides that towns have the right to use sources of drinking water for household purposes; grants to agricultural and livestock properties the right to use water from streams for their operations, irrigation, and the watering of animals;
  - calls for a system of quotas or sharing for irrigation; generally, water entering a property may be utilized to the volume necessary for agricultural purposes without obstruction by anyone;
  - sale or commercialization of water is prohibited; any excess must be allowed to pass freely for the benefit of districts or properties that need it;
- ???regulations: have been proposed, especially as they pertain to the proper uses of water and irrigation works;

### 3.2.4 Supreme Decree 10,028 of December 3, 1971 requires the city halls, public works committees and any other entity administering water and sewerage systems to submit to the consideration of the Ministry of Urbanism and Housing any new tariff schedules for its approval

3.2.5 Supreme Decree 14,386 of February 25, 1977 approves the regulation on sanitary installations of buildings.

These regulations, issued by the Ministry of Urban Affairs and Housing through its Standards Committee (Comite de Normas) cover drinking water (five chapters) and sewerage (11 chapters).

3.2.6 Navigation and hydroelectric power

Supreme decree 14 069 of 11/1/76 creates, in the Ministry of Foreign Affairs, the Subsecretaria de Asuntos Maritimos y Aguas Internacionales in charge of the international policy in maritime matters, law, of the sea, and international waters  
(G.O. November 2, 1976)

Supreme Decree 12,683 of July 18, 1975 presents the national policy on river, lake and maritime navigation  
(G.O. July 20, 1975 and G.O. July 22, 1975)

Supreme Decree (?) 13,301 of January 7, 1976 creating CONAMAR -Comite Nacional Maritima  
(G.O. January 13, 1976)

Supreme Decree 11,421 of April 15, 1974 setting up the Comision Maritima to study the Bolivian Mediterranean problems and propose solutions

Supreme Decree 12,803 of 8/29/75 transfers to the SNMH the hydrometric functions performed by ENDE [Empresa Nacional de Electricidad]

3.2.7 Water resources

Supreme Decree 15,377 of 3/23/78 creates the Comite Nacional Coordinador para el Programa Hidrologico Internacional  
G.O. March 30, 1978

Supreme Decree 14,367 of 2/14/77 creates the Direccion Nacional de Recursos Hidricos  
(G.O. February 25, 1977)

### 3.3 FORESTS

#### 3.3.1 Decree Law No. 11686 of August 13, 1974 promulgating the National General Forest Act (G.O. August 15, 1974)

This act consists of 132 articles broken down into 12 titles and twenty-five chapters.

The object of the act is the "promotion, regulation and administration and working, marketing, processing, restoration, protection and conservation of forest resources with a view to securing the development of this sector for the social and economic benefit of the country." It is declared a matter of public interest to secure these aims.

Ownership: forests and forest land are declared to be state property and public utility assets and are subject to the provisions of the act no matter what their ownership status;

#### Powers and duties of the state under this act:

1. to prevent and otherwise control soil erosion;
2. to protect watersheds by means of conservation, the improvement or creation of forest stands, and the provision of watercourse containment and regulation works;
3. to provide for the conservation and amenity aspects of forest areas to be set aside for tourists or leisure purposes;
4. to ensure that the rural population share in the benefits of forest product and development;
5. to promote the planting and upkeep of protection belts and wind-breaks in land settlement areas;
6. to promote the establishment of forest stands for the protection of urban and rural population centers;
7. to provide for the preservation of natural stands and for re-forestation as a means of protecting roads and railways;
8. to promote the construction and improvement of logging roads in areas declared to be suitable for forest working.

#### Chapter III "Classification of Forests"

Five classifications are set up:

- permanent production forests: forests for working and production of forest products;
- permanent protection forests: fundamental function is the protection of other resources or activities or the environment;
- closed forest reserves: reserves withheld from working until declared as forest reserves, private property or national parks;
- special forests: mixed-production forests or forest with special characteristics, such that their use is not principally the extraction of timber but harvesting of bark, fruit, seed, etc.

multiple-use forests: forests combining functions of production, protection, recreation, wildlife conservation, and studies on and protection of the environment;

#### Chapter IV "Forest Regulations"

Regulations governing the administration, working, marketing, processing, management, official control, research, protection and conservation of forests or equivalent plant cover are to be issued by the Forest Development Center

#### Chapter V "Management of Permanent Production Forests"

Plans for the management of permanent production forests are to be drawn up by the Forest Development Center, acting through its regional agencies; such plans are to deal with the sources of financing, production targets, logging programs, and forestry techniques.

#### Chapter VI "Forest working: Authorizations for felling and Logging"

Authorizations granted by the Forest Development Center are required for fellings and exploitation of secondary forest products in permanent production forests belonging to the state and in publicly owned forests on unfarmed land. Such authorizations are of four basic types, the conditions for which are to be detailed in regulations pursuant to the act: once-only fellings; yearly fellings; short-, medium- or long-term fellings (these are to be granted under contract with the Forest Development Center); and authorizations for harvesting secondary forest products.

#### Chapter VII: "Circulation and Marketing of Forest Products"

The circulation of roundwood, sawwood, worked timber, and secondary forest products, whether in the natural state or processed for marketing purposes is to be governed by Regulations under this act. The government is to determine price policy for both primary and secondary forest products.

#### Chapter VIII: "Close Seasons and Classified Protection Areas"

The Forest Development Center may declare partial, total, temporary or indefinite prohibitions on forest workings as the result of ecological, economic, or social circumstances.

Plant cover is to be protected in such areas under orders issued by the Forest Development Center, which is responsible for initiating procedures for the declaration of permanent protection areas.

Any closed area of more than 1,000 hectares is a "classified watershed," a closed area of less than 1,000 hectares is a "protection area." Such areas are declared for the conservation of

forests, soil and water; plans covering these areas of to be formulated by the Forest Development Center, and all agencies dealing with matters such as dams, hydroelectric plants, aqueducts, irrigation works, and similar facilities are to cooperate with the Center in its efforts.

#### Chapter IX: "Reclamation on land under private or equivalent ownership"

Land under public or private ownership in an advanced state of depletion of natural fertility or compaction or in immediate danger of erosion is subject to reclamation operations, the object of which is: limitation and control of grazing; soil stabilization; provision of protection belts and windbreaks; dune fixation; erosion control; protection of the plant cover. If owners do not comply the Forest Development Center may institute proceedings for the expropriation of that land or for its reversion to the State Domain.

#### Chapter X: "Forest fires, pests, and diseases"

Forest Development Center is responsible for forest fire control.

Those who undertake clearance burning (chaqueos) of land for farming or grazing must take appropriate precautions.

Measures are prescribed for the prevention and control of forest fires.

Measures for the control, prevention and eradication of pests and diseases attacking plant cover and forest species are declared a matter of public interest. Such measures are to be carried out directly by the Forest Development Center or, on privately owned forest land, by the owners under the Center's supervision.

#### Chapter XI: Forest Clearance

Publicly owned national forest on unfarmed land are to be subjected to a detailed ecological survey before conversion to farming land.

The Forest Development Center may prescribe that in land settlement areas or on farming property, a given proportion of the area remain under natural forest cover; measures for the preservation of this cover are to be carried out under the supervision of the Forest Development Center.

Forests and other kinds of natural plant cover on slopes of 45% or more shall be declared to be permanent protection forest without any special classification procedure.

On slopes of between 15 and 45% the Forest Development Center is to determine those areas to be classified as protection areas, taking into account technical and legal provisions.

## Chapter XII Protection stands and windbreaks

Such stands and windbreaks are as a matter of public utility under permanent protection.

The Forest Development Center is to promote and provide technical assistance for the creation in the country of plantations, protection stands, and windbreaks for the purpose of protecting crops, roads, dams, and other activities or constructions calling for protection by means of forest stands.

Such protection is mandatory on:

- land associated with catchment areas, spring, watercourses, and other sources of water supply for population centers;
- land comprised within catchment areas, irrigation systems, and land on which flood-generating torrents originate;
- land adjacent to population centers that is conducive to health and could be used for recreation.

## Chapter XIII Forest Stand Planting (Reforestation)

The Forest Development Center is to formulate plans for the planting of forest stands, and is to receive the cooperation of executive agencies, municipalities, decentralized regional bodies, and official and private institutions in these efforts.

The Center is also to promote reforestation by private investors or owners.

Enterprises or owners who have undertaken plantings may dispose of products subject to the prior approval by the Forest Development Center of their management plan.

## Chapter XVI Forest taxes and customs

Forest taxes are those on the profits of industrial enterprises, and duties on both exported and imported forest products. Forest dues are the prices paid for contractual working of State forests.

## Chapter XVIII and XIX Forest Industries and Products

Forest industries are defined and enumerated; such industries are to be classified by the Forest Development Center. It is prohibited to use circular saws on woods classified as "fine woods" by the Forest Development Center.

The Forest Development Center is to establish standards relating to forest products and is to promote forest products most conducive to the country's development.

## Chapter XX Incentives

Special credit is to be made available for the carrying out of both industrialization and reforestation programs. Tax exemptions are available, among other things, for investments in new forest stands or forest nurseries.

## Chapter XXI "Education"

Provides for the establishment of the necessary forest schools and for the encouragement of forest studies in order to produce qualified technical services at all levels: managerial cadres; forest engineers or specialized agronomists for surveying, research, and forest management; middle-level technical staff, assistant technical staff and forest guards for the administration of forest resources; and skilled workmen for timber-using industrial enterprises.

Education efforts are to extend to broadcasts of forest education programs, the inclusion of materials on forests in school textbooks, and the declaration of December of each year as Forest Month.

## Chapter XXII Research

The Forest Development Center's research efforts is to encompass:

- the country's forest potential;
- the classification of forests;
- identification of forest species and appropriate uses of them;
- Industrial alternatives for the various types of forests in the country;
- physical and mechanical properties of the principal species;
- promotion for the use of little-known species;
- Introduction of exotic species of high industrial values that can be adapted for Bolivia;
- areas suitable for afforestation and the establishment of the necessary forest reserves;
- forest management and planning;
- forest species in danger of extinction and possibilities for their preservation.

The Center is to set up a specialized body for forest research.

## Chapter XXIV Offences and Penalties

Offences, the penalties for which are to be established by regulations, include:

- destruction or unlawful use of Bolivia's forest products;
- failure to carry out contractual obligations;
- the causing of forest fires;
- unlawful settlement in the country's forests;
- any other acts which cause damage to or impair the value of the forests as determined in regulations.

## Chapter XXIV Forest-Dwelling Tribes

Forest Development Center is to be responsible for such tribes, who are to be given preference in employment for forest operations. The Center is to determine those areas appropriate for the survival of forest tribes and guarantee and protect their sources of game and fishing.

Note: A recent bill would reportedly grant the Forest Development Center even greater supervisory and managerial powers, authorizing it to place restrictions on private and public land ownership.

- 3.3.2 Supreme decree 14,459 of March 25, 1977 elevates to the rank of supreme decree the supreme resolution 18,2304 of 2/21/77, which approved the regulation of the national forestry law.

This regulations, which were unavailable for discussion in this profile, consist of 11 titles, 28 chapters, 158 articles, and 4 annexes.

- 3.3.3 Supreme Decree 7779 of August 3, 1966  
-forest reserves

Area between the Grande, Mamorecillo, Chapare, Ichilo, Chore, Yapacani, Palometillas and Piray Rivers (900,000 hectares) declared as a forest reserve, thus prohibiting the placement of settlers, the cutting of trees or clearing of forests for agriculture.

- 3.3.4 Supreme Decree 12,172 of January 17, 1975 creating the Comisión Nacional Para el Estudio de los Problemas del Carbon Vegetal (G.O. January 17, 1975)

- 3.3.5 Decree Law no. 12539 of May 30, 1975

A law of 6 chapters and 17 articles protecting quinine resources and providing for their rational management. To be enforced and regulated by the Forest Development Center.

### 3.4 WILDLIFE

- 3.4.1 Decree Law 12,301 of March 14, 1975 approves the law on wildlife, national parks, hunting and fishing (G.O. March 17, 1975).

This is the major law regulating hunting and the protection of wildlife. As stated in Title One of the law, its general purpose is : the protection, management, utilization, transport and commercialization of wildlife and its products; the protection of endangered species; the conservation of the habitat of flora and fauna; and the declaration of national parks, biological reserves, refuges, and sanctuaries intended for the conservation, development and utilization of these resources. No implementing regulations have been issued in pursuance of this law.

#### Provisions:

Study and management of wildlife (Title two)

-study and management of wildlife is assigned to the Forest Development Center, which is to issue regulations dealing with these areas of concern;

### National Parks, Reserves, Animal Refuges, and Wildlife Sanctuaries

- parks are declared by the Supremo Gobierno, as a result of studies undertaken by the Forest Development Center
- a special regulation is to be issued specifying such planning;
- activities in such parks and reserves, etc. are limited to those specified in the regulation by which they were created;

### Utilization of Wildlife

- regulated by the Forest Development Center:

- Hunting: four types of hunting are identified: 1) hunting for domestic and subsistence purposes; 2) sport hunting; 3) commercial hunting; and 4) scientific hunting;
- licences specifying what type of hunting is being permitted are required for each type of hunting; those for sport and commercial hunting are to specify the species which are to be killed or captured; special licenses may also be issued for hunting of dangerous animals;
- hunting arms are controlled by the Forest Development Center in conjunction with the Ministers of National Defense, Interior, Migration, and Justice;
- certain hunting methods are expressly prohibited, such as hunting with explosives, night-hunting with lights, flushing out animals by burning;
- hunting seasons and areas are to be established by the Forest Development Center;
- hunting is prohibited in national parks, wildlife refuges and sanctuaries; nature reserves; and areas close to residential sections; hunting for scientific purposes may, however, be permitted in such areas, as well as other hunting specifically authorized by the Forest Development Center;

### Protected species

- the list of protected species as well as of those open for hunting is to be established by the Forest Development Center; hunting applies only to those animals specified on the list;
- protected species, to be more specifically listed, include in general:
  - songbirds and other decorative birds;
  - animals of special benefit to forestry, agriculture, livestock raising, and public health;
  - animals whose products can be utilized without their being killed;
  - rare species protected under the IUCN (International Union for the Conservation of Nature);
- it is also generally prohibited to disturb nests or remove eggs except for scientific purposes or for the control of dangerous species;

- transport and commerce in wildlife products (includes, meat, hides, furs, eggs, and feathers):
  - it is necessary to obtain an authorization for the Forest Development Center for most activities relating to commercial hunting and exploitation of wildlife, including the export of live animals or of animal products;
- penalties on the following offenses:
  - to be subject to the penalties listed in the Law on Offenses against the National Economy; sanctions are to be applied by the Forest Development Center;

#### 3.4.3 D.S. 5912 of October 27, 1961 [presumably still valid]

- hunting; protection of certain species; reserves; exploitation
- declares as a national reserve all lagoons in the Departments of Pando and El Beni;
- allows the hunting of alligators and lizards only in the months of August, September, October and November and sets certain minimum requirements for such hunting;
- sets up hunting license for reptiles;
- rules prescribed for hides and prices fixed.

#### 3.4.4 Agrarian Reform Law, D.L. 3464 of August 2, 1953

- protection of plants and animals; rational use of land
- plant products such as quinine, fine woods, and other species, and animal products such as furs and plumage, and those used for industrial purposes, and which are in the process of extinction, must be under national protection

### 3.5 FISHERIES

#### 3.5.1 Decree Law No. 12301 of March 14, 1975 approving the law on wildlife, national parks, hunting and fishing

Titles VIII-X deal with fishing and fish resources ;

- declares as domain of the state, lakes and permanent or temporary lagoons inhabited by plants, fish and other aquatic life;
- the government through the Forestry Development Center, is responsible for legislating, regulating and funding the conservation, utilization, transport and commercialization of fishing;

#### provisions:

- the introduction and breeding of new species of fish and other aquatic animals is prohibited without previous authorization from the Center of Forest Development;
- types of fishing enterprise: 1)subsistence; 2)commercial and industrial fishing; 3)sport fishing; 4)scientific and experimental fishing;
- fishing methods: to be determined by regulation;
- denominated as fishing zones are natural and artificial lakes and rivers which are rich in fish products;
- exploitation of both public and private bodies of water requires an operational plan to be presented by the interested party to the Forest Development Center for approval, according to requirements outlined in fisheries regulations;

3.5.2 Decree Law of November 3, 1977 establishes the fishing fees to be charged nationally which are regulated by the Forestal Development Center and to taxes to be paid on the sale of fish.

### 3.6 AIR AND THE ATMOSPHERE

Health Code as promulgated by Decree Law No. 16629 of July 18, 1978  
Articles 43,44 and 45

Assigns to the Ministry of Social Security and Public Health (as the Autoridad de Salud) the responsibility for regulating and controlling the emission into the air of substances arising from different human activities within the national territory;

Every industry present or to be established in the future within Bolivian territory, no matter what its size or location, which produces emissions into the atmosphere, has the obligation to request authorization from the Health Authority to begin or continue functioning.

Noise: the Health Authority is to establish regulations to control noise emerging from different activities within the national territory.

### 3.7 MINERAL RESOURCES

Mining legislation rests basically on the royalty system or public right, according to which mines, like all other property not under private ownership, belong to the State by virtue of the right of eminent domain, which is derived from its sovereignty.

D.L. 7148 of May 6, 1965 : Mining Code [replaced code of 1925]

-388 articles, divided into two volumes

-among matters dealt with are: ownership; exploration, exploitation and processing; easements and expropriation; procedure for obtaining exploitation concessions and dumps, slag heaps and washings and processing and smelting plants

-does not cover petroleum and other hydrocarbons nor mineral and medicinal waters;

-establishes the principle of a universal concession of mineral concession, but under the domain of the state are placed deposits of salt, as well as gypsum, limetstone, quarrrystone, and other building materials;

-ownership: all minerals substances, regardless of their origin or form of deposit, belong to the domain of the State, whether underground or on the surface of the land; thus the State grants the right to explore, exploit, process and smelt mineral substances to natural persons or legal entities that apply for such right, in accordance with the provisions

of the Mining Code;

-rights and obligations of concessionaires:

- has the right to free use of public land unfenced and not under cultivation; may freely make use of pastures, timber, building materials, firewood, and sod for household use;
- may undertake any work necessary (road building, etc.) for rational exploitation;
- right to use water flowing through his claims for producing hydraulic power or any other purpose applicable to exploration, exploitation or processing of minerals, with the obligation of returning them to the normal channels after use; if waters are under private ownership, they may be used by agreement with the owner or by expropriation unless they are a source of water supply for a town; a concession holder becomes owner or any underground stream or water table, which he may utilize for any purpose, and if the waters are in the public domain, they will be adjudicated as prescribed in the Code;

March 28, 1972, D.S. 10, 170 : General Law of Hydrocarbons

general provisions:

- ownership: deposits of hydrocarbons in any physical state are directly, inalienably and imprescriptibly a part of the domain of the state;
- principles and norms covering hydrocarbons to be fixed by the Ministry of Energy and Hydrocarbons
- Yacimientos Petroliferos Fiscales Bolivianos (YPFB)
  - exploration and virtually all matters dealing with the development of petroleum resources given to this organization, which may exercise them by itself or, in some cases, through joint public-private companies or third parties, in conformity with the provisions of this law, its regulations or other laws in force for each case
- all natural or juridical persons entering into contracts with Y.P.F.B are required to, among other things, adopt adequate measures for the preservation of the fauna and flora and all other natural resources of the country.

### 3.8 SOILS

#### 3.8.1 Decree Law no. 11686 of August 13, 1974 promulgating the National General Forest Act

Under this act measures are required which would lead to the protection of soils and the prevention of soil erosion. The prevention and control of soil erosion are, in fact, major duties imposed on the government by the act.

See especially, under 3.3.1 above, Chapter VIII (Close Seasons and Classified Protection Areas); Chapter IX (Reclamation of Land under Private or equivalent ownership); Chapter XI (Forest Clearance), Chapter XII (Protection Stands and Windbreaks)

#### 3.8.2 Agrarian Reform Law, D.L. 3464 of August 2, 1953:

-declares as forest land or pasturage all lands with a slope of more than 15%, prohibiting the destruction of forests or pastures thereon, except in the yungas and places of dense population with sparse cultivable land, where they may be worked by terraces and leveling systems.

### 3.9 LAND USE AND AGRICULTURE

#### Agrarian Reform Law, D.L. 3464 of August 2, 1953

The major agrarian reform law under which large estates were broken up and provisions were made for the redistribution of land to the landless.

### 3.10 HEALTH AND SANITATION

#### 3.10.1 Health Code as promulgated by Decree Law No. 15629 of July 18, 1978 Articles 39 and 40

##### solid waste management

The Health Authority is to lay down the policy for and the systems for rational solid waste management within Bolivia. It is to determine the policy, regulation, and implementation of simple systems for the sanitary disposal of excrement in the rural environment.

#### 3.10.2 Supreme Decree 14,368 of February 14, 1977 approving the general regulation for the handling of solid waste.

Laid down by the Division of Urban Engineering of the Ministry of Urban Affairs and Housing through its Standards Committee, this

regulation contains the standards which municipalities must follow in the handling and treatment of solid waste. The preamble to this announcement of the regulation, which consists of six chapters and 101 articles, stresses the necessity of developing a uniform national system for the treatment of solid wastes.

## 4.0 RESOURCES OF BOLIVIA

### 4.1 WATER RESOURCES

#### 4.1.1 General water situation

Although Bolivia taken as a whole has abundant water resources, they are not evenly distributed throughout the country. The areas of greatest rainfall, for example, are the sparsely populated subtropical zone and the northern plains. Other areas, receive as little as 50 mm. per year. (UNWC 1976:17-18). Bolivia is thus faced with the situation in which some areas face critical water shortages; such an area is the Altiplano which is critical not only because of the large concentrations of population requiring water for domestic and other populations but also because of the need of water for mining operations. (CEPAL:1977:22-23). Another area of water shortage is the Chaco of southern Bolivia, where increased water supplies could greatly enhance the grazing potentialities (CEPAL: 1977:22-23). On the other hand some areas are critical because of excesses of water arising chiefly from seasonal flooding; flooding of the Beni plains of northern Bolivia, for example, severely limits the otherwise great potential of that area for cattle grazing (CEPAL: 1977:page 23).

#### 4.1.2 Rainfall and Climate (see table and map page 35a)

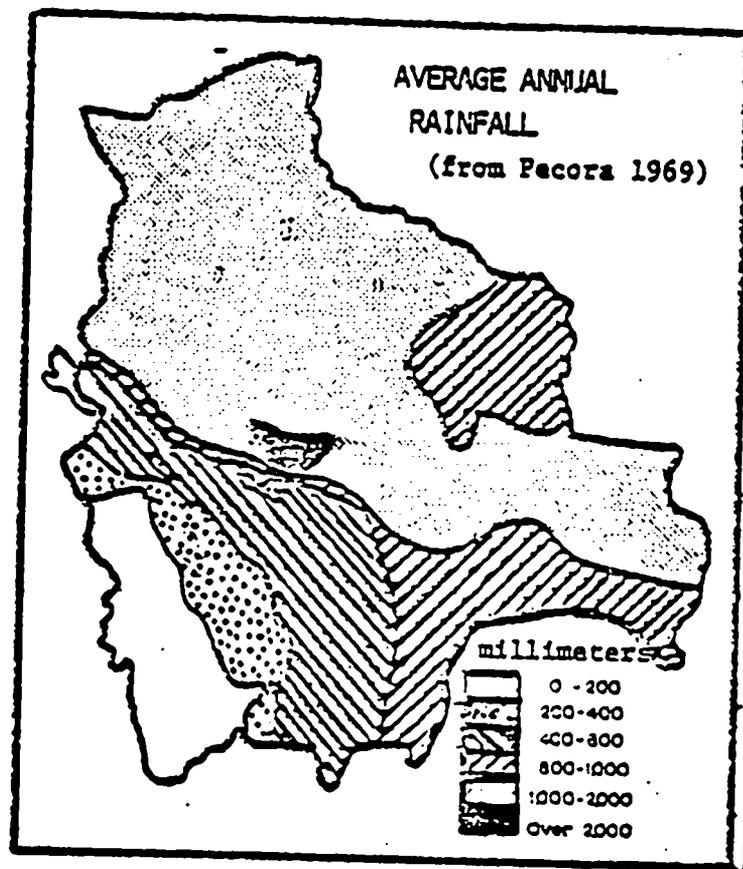
##### 4.1.2.1 The Resource

Because of its varied topography, Bolivia has several climatic regimes, conditioned for the most part by altitude. At the highest points is the terra nevada, with snow-covered mountains over 5,000 meters in height.

The Altiplano, the plateau between the peaks of the Andes, is known as the terra fria; here, at an altitude of 3 to 4,000 meters, yearly average temperatures do not exceed 10 degrees centigrade, and rainfall is sparse; dry season in this area runs from 4 to 7 months and in many years no rainfall may be recorded in the driest months (June and July).

The tierra templada, as represented by the deep cut valleys of the Yungas and Valles, with heights ranging from 300 to 2800 meters, is a warm humid subtropical climate with average temperatures of up to 18 degrees centigrade, and annual precipitation of over 1300 mm. in the areas of heaviest rainfall. Dry season in this area most typically ranges from four to seven months.

The last great climatic region is the tierra caliente, the eastern sector of the Oriente (sometimes called the Llanos)--where temperatures average 25 degrees centigrade in the north and 27 degrees centigrade in the south. Precipitation in this region is highest in the north--about 2000 mm per year--and decreases as one moves towards the Gran Chaco region of the south. Although rainfall is lowest during the period June to July there are seldom more than 2 months which could be called dry.



Rainfall figures for Selected Stations: 1969-1975 averages in millimeters

(based on figures in Anuario Meteorológico [Servicio Nacional de Meteorología et Hidrología] 1969-1975)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
La Paz [La Paz] As 3,632m	138.4	84.1	62.1	27.4	7.1	5.4	5.1	15.0	22.4	32.4	32.4	88.4	520.0
Oruro [Oruro] As 3,704m	134.4	102.5	38.2	14.4	2.9	2.6	2.8	13.6	10.7	12.0	15.3	51.4	351.1
Chulumani [La Paz] As 1,811m	238.2	203.5	136.9	83.6	37.3	50.3	23.4	90.3	84.3	101.3	136.3	191.7	1579.5
Cochabamba [Cochabamba] As 2,569m	133.2	107.9	41.9	15.7	3.3	1.6	1.0	8.4	5.3	14.0	44.2	84.3	457.7
Tarifa [Tarifa] As 1,850	140.4	150.3	86.3	31.0	5.0	3.1	3.4	0.6	9.1	22.0	63.7	126.6	638.9
Cobija [Pando] As 280m	274.4*	307.3	288.6	238.0	96.6	59.0	34.2	54.0	116.0	239.1	228.6	313.2	2257.3*
Riberaite [Beni] As 172m	308.7	258.6	252.3	140.1	66.6	40.4	18.1	40.3	73.6	135.0	198.7	207.4	1785.5
Concepcion [Santa Cruz] As 490m	143.2	147.2	112.4	94.8	74.0	27.2	34.2	23.3	50.1	84.9	120.5	150.9	1039.2
Puerto Suarez [Santa Cruz] As 145m	129.4	111.3	123.0	97.4	45.4	48.1	21.4	19.5	44.6	112.4	117.6	116.0	986.2

\*six year averages; data for 1969 not complete  
As=altitude



Average rainfall for selected stations representative of Bolivia's climatic regions are presented in the table on page 35a. The map on the same page indicates general rainfall zones. Evaporation, monitored by only a handful of Bolivia's meteorological stations, is especially high in the Altiplano.

Heavy precipitation during the rainy season, complicated by the problem of the reduced water holding capacity of the soil resulting from deforestation and destruction of the plant cover by excessive numbers of livestock, frequently results in flooding and landslides. Areas of La Paz and Beni departments are regularly flooded, often necessitating emergency efforts to bring food to people in affected areas. In a recent incident torrential rains in La Paz led to the an avalanche of clay and stones which descended from the hills surrounding the city to destroy most of the buildings in which emergency relief in the form of food and blankets was being stored for flood victims in Beni and La Paz departments. ("New Floods..."1969).

Bolivia periodically suffers from excesses of rainfall or from drought. The latter was a problem, for example, in 1976.

#### 4.1.2.2 Utilization of rainfall

Most Bolivian agricultural still typically tends to be conducted under rainfall conditions; according to FAO estimates for 1976 only about 120,000 hectares of the land devoted to harvested and permanent crops (about 3.6%) was under irrigation.

Rainwater collected in cisterns may also serve as a source of drinking water during dry periods, as, for example, in the Mojos Plains of Beni Department (Carter 1971:23).

#### 4.1.3 Surface water resources

##### 4.1.3.1 Rivers

##### 4.1.3.1.1 The resource (see map page

Bolivia has 63 national river basins and about 1,036 river basins which form part of the vast international Amazon and La Platte River Basins. About 21% of the area of the country forms part of the La Platte River drainage basin; about about 14% of the rivers drain into the closed system of the Altiplano; while by far the largest part of the country (about 65%) forms part of the system which ultimately drains into the Amazon. (CEPAL 1977:Table 1). There is very little drainage to the Pacific; only one river, the Loa, maintains a year-round flow.

##### 4.1.3.1.2 River utilization

##### 4.1.2.1.2.1 Navigation

Navigation on Bolivian rivers is limited, especially since many streams are only seasonal in nature. Furthermore, because of the mountainous nature of the country with its sometimes abrupt plunges from mountain

to plain, rivers can not serve as a link between the great eastern plains of the country and the heavily populated region of the Altiplano. However, rivers serve as important communication links on a regional or local level, especially in those river systems such as the Madeira River system, which form part of the greater Amazon River drainage system. Navigation, depending on the nature of the river, is by small boat or by shallow-draft paddle wheel steamers or barges.

#### 4.1.2.1.2.2 Hydroelectric power

The estimated hydroelectric potential of Bolivia is greatly underutilized. Hydroelectric potential has been estimated at 14,700 megawatts; installed capacity as of 1974 was, however, only 241 megawatts, which represents about 68.8% of the 350 MW installed electric potential of the country. In 1974, the country produced 764 GWh of hydroelectric power, 76% of the total 993 GWh produced (CEPAL 1977: table 7).

Recent government plans, however, have emphasized the importance of rural electrification as a means of improving the lot of the rural poor. Under such plans, advantage would be taken of the many waterfalls formed by streams plunging from the heights of the Andes through the valleys and gorges of the cordilleras. Plans currently being developed by Bolivian government agencies and public corporations (including the Ministry of Energy and Hydrocarbons, ENDE-Empresa Nacional de Electricidad, and INER-Instituto Nacional de Electrificación Rural) and U.S.A.I.D. call for the construction of from five to ten mini-hydroelectric plants with capacities ranging from 200 to 1,000 KW each. There are also plans calling for multipurpose large scale schemes supplying not only hydroelectric power but also drinking water, and water for irrigation.

#### 4.1.2.1.2.3 Water supply

Local water supply in many areas comes from rivers and small streams. In some areas, as for example, Trinidad, the capital of Santa Cruz, it has been customary during the dry season for water peddlars to bring water in barrels from the Mamore River for sale to residents (Carter 1971: 23).

#### 4.1.2.1.2.3 Fisheries

Bolivia's waters are said to be rich in fish; however, only the waters of the Pilcomayo appear to play an important role in fish production.

#### 4.1.2.1.2.4 Irrigation

Irrigation is playing an increasingly important role in Bolivian; government development plans call for irrigation schemes of varying sizes (Bolivia, Ministerio de Asuntos Campesinos y Agropecuarios 1976).

Recent estimates place the total amount of irrigated land at 120,000 hectares or about 3.6% of the land currently devoted to permanent or harvested crops.

Development plans relating to water call for the irrigation of over 600,000 hectares under the Abapo-Ozozog, the Parapeti River, and the Villamontes projects. There are also long-range plans for the hydroelectric plants of Angosta de Bala and Misicuni, the latter of which is a multi-purposes scheme also involving irrigation and drinking water supply for the inhabitants of the Cochabamba Valley (UNWC 1976:17-18). Most of these large-scale projects (those involving from 40,000 to 470,000 hectares) call for the diversion of river water, although some call for the use of a combination of river and groundwater. (Bolivia, Ministerio de Asuntos Campesinos y Agropecuarios 1976:140).

#### 4.1.2.1.3 Pollution of Rivers

Many of the high lakes and streams are severely contaminated with discharges from mine operations (Adams 1979). Work performed by an Israeli technical mission in 1973-74 documented mineral contamination in Lake Titica, the Desaguadero River (which links Lake Titica with Lake Poopo to the south), and other water bodies as well ("Bodies"...1974).

A general problem throughout Latin America can be attributed to the common practice by which sewage and industrial effluents are simply discharged into nearby streams without any kind of treatment. Such contaminated waters may affect other uses, as in, for example, the case in La Paz (CEPAL 1977:24). The problem is especially severe in the case of the Choqueyapu River, which runs from north to south in La Paz. This river receives all urban and industrial wastes, frequently including solid wastes and all kinds of organic wastes, while in rural areas waters discharged from mining operations is a source of pollution. The actual extent of such pollution and its effects on human and other forms of life has, however, not been documented, although unsafe water supplies are said to be one of the major causes of health problems in Bolivia.

Erosion is also a source of pollution, washing materials into rivers and thereby limiting their value for fish, livestock, and human beings (A.I.D. packet, page 4).

#### 4.1.2.1.4 Problems with rivers

Rivers are also a source of the most frequent type of disaster in Bolivia: flooding. There is extensive flooding especially of the pampas of the Beni region with adverse results for human life as well as for both wild and domesticated animals. Populations are regularly forced to abandon their homes and housed in areas above the level of the flood waters (Adams...1979). Such flooding can be traced directly to increased runoff finding its way into rivers from deforested and eroded highlands which have suffered severe loss of their waterholding capacity, in many areas being eroded down to bare rock (A.I.D. packet, page 4). For this reason, reforestation of watershed areas must be of special importance for Bolivia. Flooded rivers are also responsible

for the loss of important soil resources, as they rush through valleys, eating away soils and often leaving only gravel deposits (A.I.D. packet, page 5). Many streams carry such heavy sediment loads that the courses tend to meander.

#### 4.1.2.2 Lakes

##### 4.1.2.2.1 The resource

Bolivia has many lakes, the most important of which is Lake Titicaca, which it shares with Peru. The shores of Lake Titicaca are the most populated area of Bolivia, and the many islands scattered on the lake are the home of various Indian tribes. The only outflow from Lake Titicaca is the Desaguadero River, which flows southward into Lake Poopo, the saline body of water which is Bolivia's second largest lake. Further south are mudflats and the extensive salt flats such as the Salar de Uyuni, the last remnants of what was once a vast lake covering the entire southern Altiplano.

##### 4.1.2.2.2 Utilization

Fishing is of great importance in Lake Titicaca. Rainbow trout has been taken in commercial numbers from the lake, while salmon trout, an especially prized species which has grown to large sizes in this and other Bolivian lakes has served as an important protein source in mountain villages. However, the practice of dynamiting in Titicaca and other lakes as well as pollution has begun to deplete seriously the amount of fish available for human consumption.

##### 4.1.2.2.3 Lake pollution

In addition to the problems caused by dynamiting of lakes, pollution is also becoming a problem, especially in Lake Titicaca, which receives effluents from mineral processing facilities such as Mina Matilda; these pollutants are already reported to have contributed to a reduction of the numbers of trout in the lake (Adams 1979). Effluents from the Mina Machacamarcá discharged into the Desaguadero also river also find their way into Poopo Lake ("Natural Resources...").

##### 4.1.2.3 Groundwater and its utilization

Little data was available on groundwater resources, and there are no indications that extensive groundwater surveys have been conducted. Wells tapping groundwater are, however, used for domestic water supply and the installations of such wells forms an important part of most agricultural colonization schemes. Groundwater is also available for irrigation purposes; the Ingavi Project, which covers some 800 hectares in the Altiplano near La Paz, uses deep wells for the irrigation waters so essential for the success of the project ("Saying Cheese..." 1979). Groundwater is also planned to provide irrigation for the 40,000 hectares of the Valle Alto scheme in Cochamba, while the gigantic 470,000-hectare Abapo-Izozog scheme in Santa Cruz is to use both groundwater and the waters of the Grande River (Bolivia, Ministerio de Asuntos...1976:140).

## 4.2 FORESTS

### 4.2.1 The Resource

Estimates of the extent of forest cover in Bolivia range from 40-42%; a substantial portion of the country (an estimated 463,440 square kilometers) remains under forest cover.

The Altiplano is the least forested area of Bolivia; here there are no native trees, although occasion willows grow near La Paz and introduced eucalyptus trees, the only large tree which will mature in the Altiplano, can be found in sheltered valleys and in the area around Lake Titicaca, whose banks are thickly grown with totora reeds from which the Indians construct reed boats known as balsas. The most common vegetation in this area, which becomes increasingly barren in its southern extents, is ichu or paja brava (savage grass), which serves not only as forage for the llama but also as matting and thatch for houses. There are also hardy shrubs such as the tola and mounds of q'uta, both of which are used as fuels.

In the Yungas the natural vegetation is montane rain forest (low selva), which differs from the rain forest of the Amazon: trees are smaller and more openly distributed and the undergrowth is denser and demonstrates a greater variety. Tree species include mahogany, cedar, walnut, laurel, lignum vitae, ceiba and dyewoods in the valleys, while in the lower reaches palms appear. The cinchona tree (the source of quinine) was once of great economic importance in this area, but over-exploitation of the species led to its depletion towards the middle of the nineteenth century. Other importance species are vanilla, saffron, and vica, a source of tannin. Coca plants (Erythroxylon coca) are also common in the Yungas.

In the Valles—the eastern slopes of the Andes in the south of Bolivia—there are at higher elevations only grasses and occasional stunted trees. The valleys and basins are covered by drought-resistant (xerophytic) scrub and small trees, while a strip of semi-deciduous forest fringes the easternmost area from about Santa Cruz down to the Argentine border. In this area grow, among other things, the walnut and the quebracho (Quebracho santiqueno and Q. colorado), a hardwood tree (its Spanish name means axebreaker) used both for timber and as a source of tannin.

In the northern part of the Oriente grows tropical, largely evergreen rainforest, in which the trees, hung with lianas, parasitic vines and orchids, reach heights of from eighty to 100 feet, their crowns forming dense canopies that exclude the sun from the ground below. This area is said to contain many hardwoods (by some estimates there are 300 species suitable for timber or resin or oil extraction [Gonzales 1974:44]), but these have not been extensively exploited because of difficulties in transporting timber. However, the forests have been the source of mahogany, rubber, and quinine and important

export items such as almonds and Brazil nuts.

In the southeastern Oriente and covering most of western Santa Cruz, is semideciduous tropical forest with vegetation intermediate between rainforest and the dry forest of the Chaco further to the south. Here there are woodlands alternating with natural grassland and low vegetation. Coarse tropical grasses, palms and heavier tropical woodland are found in the Plains of Moxos, an area of low-lying basins that is shallowly flooded in rainy season.

In the Bolivian Chaco, south of the Santa Cruz Plains, grows dry forest with quebracho trees, thin scrub, and cacti. There are also in some areas stunted trees and coarse savanna grassland, with stands of palms in moister places.

#### 4.2.2 Utilization of forests

##### 4.2.2.1 Timber

Bolivian forests are said to contain nearly "inexhaustible" supplies of valuable woods. The principal timber species are mahogany, ochoo, nogal verdadero (green walnut), quebracho blanco and colorado, palo maria (pole wood), and palmera negra (black palm).

However, large quantities of these woods are found in the dense tropical forests of the northern oriente, and, because of problems of transportation, are not readily exploitable. A substantial portion of Bolivia's forest exploitation would seem to involve those more easily accessible woods of the Chaco and Yungas, specifically the quebracho. An estimated 40 percent of all forestry operations are carried out in Santa Cruz department (Weil 1974:304).

The major part of Bolivia's timber production is destined for internal use: about 52% is consumed in La Paz, while Cochabamba, the nation's second largest city, absorbs another 27% (Gonzales 1974:44). As of 1969, there were about sixty-three sawmills in operation as well as one plywood factory and fifty-eight furniture factories. To promote export of wood products, about twenty of the sawmills formed an association in 1972 with the support of the Inter-American Development Bank (Weil 1974:304). The U.S. and Argentina have been supplied the chief markets for Bolivia's limited but continually increasing exports (Gonzales 1974:45).

WOOD PRODUCTION (In thousands of Metric tons)

Figures from the FAO Yearbook of Forest Products 1974 and 1976.

Except for 2,000 metric tons of coniferous roundwood production reported for 1976, all figures refer to non-coniferous woods.

	1963	ex- port	1966	ex- port	1972	ex- port	1974	ex- port	1976	ex- port
<u>Roundwood production:</u>	4,335		4,735		4,189		3,936		3,850	
<u>Fuelwood and charcoal:</u>	4,250		4,600		4,000		3,570		3,550F	
<u>Industrial roundwood:</u>	85		135		189		366		300	
Sawlogs and Veneer	72		115		139		331		265	
Sawnwood and ties	35		55		83		165		192	
Sawnwood	29	-	52	5	80F	31	143	67	132F	48
Ties	5		3		3		22		20	
Wood based panels	1		1		1		2		2F	
Plywood	1		1		1		2		2F	
Pitprops	13		20		20F		20F		20F	
Other Industrial rw.	-		-		30		15		15F	
<u>Value of imports</u> (thousands of \$)	818		1,850		3,482F		3,482F		3,482F	
<u>Value of exports</u> (thousands of \$)	28		1,245		2,586		10,917		22,000	

F=FAO estimate

As indicated by the table the value of timber exports has increased over the past decade; the table also indicates that wood used for fuelwood and charcoal has decreased, while wood for industrial purposes has generally increased. While other sources support these figures in identifying an trend toward increased exports of timber, no other indications of a decrease in the use of fuelwood and charcoal were found.

#### 4.2.2.2 Other forest products

In the rain forests of northern Bolivia (in Pando and Beni), production of nuts and gums have traditionally been more important than timber production. There are well over 5,000 independent workers in Pando and El Beni who not only tap rubber-yielding trees but also gather brazil nuts and almonds. In addition, there is one large rubber plantation near Riberalta in El Beni.

Rubber production reaches about 3,200 tons annually; about 60% is used by local industries and about 40% is exported. Other forest products include, copal, incense, and vanilla. Cocoa and cinchona (quinine)

have been important products of the forests of the Yungas.

Nut production comes to about 600,000 22-kilogram cases per year. Plants for the cleaning, grading, and packing of Brazil nuts are located in Bella Flor, Cobiya, Cachuela Esperanza, Becker and Cia; these provide work for more than 500 families. Under an agreement reached in 1973, about 70% of total production is to be processed by local industry, and the remainder is to be exported (Gonzales 1974: 46).

#### 4.2.2.3 Firewood and charcoal production

As indicated by the table above by far the greatest utilization of Bolivia's forest production (92.2% in 1976) is for firewood, which also accounts for the greatest part of energy consumption for most of the country. A recent estimate of energy consumption for a prototypical village in the Bolivian Andes shows that of 11.66 million kilocalories of energy used per person per year, 8.33 million kilocalories (71.4%) was in wood fuel, 0.83 (7.1%) in human energy and 2.50 million kilocalories (21.4%) in animal labour (Arnold and Jongma 1978:5).

#### 4.2.3 Deforestation

Deforestation is said to be one of the major environmental problems of Bolivia. A recent projection places the rate of deforestation at from 187,000 hectares per year between 1962 and 1985, while another estimate places the loss at from 250,000 to 300,000 hectares in the last few years (Parhman 1978).

One major cause of deforestation is the gathering of wood for fuel and charcoal production. Deforestation also results from the irrational exploitation of timber resources; lumber companies are said to cut both young and mature without any concern from the continuance of the forests. Furthermore, concern has been expressed that the lifting in April 1973 of the duties on quebracho colorado, may lead to the extinction of this species, the last world reserves of which are in the Bolivian Chaco (Gonzales 1974); the tree is judged to be virtually extinct in both Paraguay and Argentina.

The clearing of forest land for agriculture, especially that involving the use of slash and burn methods, accounts for loss of forest cover. Forest is being cleared at a rapid rate; in the Santa Cruz district alone, some 200,000 hectares a year are used for shifting agriculture (UNESCO MAB 1977a:43). The almost uncontrolled manner in which some settlement has taken place means that forests are cleared in areas actually unsuitable for agricultural production. Moreover, as roads are built into colonization areas, as in the lower plains of the Beni River and the Chaco plain, extensive extraction of woods such as mahogany takes place, while the commercially unimportant wood is simply cut down and burnt on the spot (Adams 1979).

Since slash and burn usually takes place in August, the driest season of the year, fires frequently get out of control, leading to the disappearance of forests and their replacement by savannas and non-productive pastures. One recent forest fire (1973) is estimated to have destroyed nearly one million hectares of forest (UNESCO MAB 1977a:43).

Deforestation takes place not only as a result of small-scale farming operations but comes about through indiscriminate clearing of forests for sugar plantations, cotton plantations, and land for other farm products.

#### 4.2.4 Forest policy and forest development

Bolivia policy is directed at one and the same time at the development of the forest industry and the protection of forest resource. The major law on forests (1974) has this dual function as has also the Centro Desarrollo Forestal, which is charged with both exploiting and protecting the forest wealth of the country. Reforestation is called for in the 1974 law (see above) as is also the protection of forests in watershed areas and the the establishment and protection of windbreaks in areas of cultivation. A major two volume study of forest policy and administration was completed by the Germans in 1974; this document is said to serve as the basis for Bolivian forest policy.\*

The 1974 law also calls not only for media efforts to bring the importance of forests to the attention of the public but also for the inclusion of materials on forests in school textbooks. The government has also declared December as the Month of the Tree; ceremonies in La Paz in recognition of the occasion have been highlighted by speeches by government officials and the planting of trees by city officials, residents, and youth organizations. In 1973 the Month of the Tree was also marked by short radio courses in gardening, supplemented by practical classes ("Month..."1973).

Although the Centro is the chief agency responsible for reforestation programs and activities, reforestation and tree planting also take place on the local level. It was reported in early 1974 that 160,000 trees had been planted on the periphery of Sucre in an effort to give that city a forest belt. The city development committee, which is responsible for the plantings and whose plans called for the planting of about one million trees over a three year period, cited the ecological necessity of these plantings. However, it was also reported that the plantings in the Sucre region are also directed at future lumbering possibilities ("Trees..."1974).

The municipality of La Paz also has a Bureau of Forestation, which has been attempting to encourage the afforestation of the La Paz hydro-graphic basin. In late 1973, the office of the Mayor of La Paz reported that over half a million trees, including pines, eucalypti, and other species had been planted. Reforestation plans include the slopes around the city, where the prevention of soil erosion and the consolidation of the soil are the principal concerns. La Paz is said to suffer particularly from lack of parks and wooded areas. ("Month..."1973).

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\* A copy of this study is reportedly available at the A.I.D. Mission in La Paz.

### 4.3 SOILS

#### 4.3.1 The resource

Because of large variations in both topography and climate within the country, Bolivian soils are said to offer possibilities for a rich and varied agriculture. The actual composition of Bolivia's soil does not appear to be well documented, however, although spot surveys for areas have been conducted. Most of the data used for the construction of the Bolivian section of the FAO-UNESCO Soil Map of South America was derived from "general information with local soil observations"; only a small section of the country (an area of the Yungas) had actually been covered by systematic soil surveys.

The information tabulated below is based on data used for the construction of the soil map. It deals with the 788,800 square kilometers of the country--about 72% of the country--characterized as humid tropical. As such it is representative of the underdeveloped section of Bolivia at which much in the way of colonization efforts has been directed.

#### Humid tropical soil areas according to suitability [Nelson 1973:12]

<u>CROPPING</u>	mils/ha.	% of htl	% of total
<u>alluvial:</u> [developed from recent deposits and located in flood plains and deltas]	2.7	3.4%	2.5%
<u>hydromorphic:</u> [on flat or depressed landscapes where lack of runoff possibility creates a drainage problem]	10.8	13.7%	9.8%
<u>good upland:</u> [undulating or level topography, well drained, not susceptible to serious erosion, medium to high fertility]	0.6	0.07%	0.05%
<u>marginal to low fertility:</u> [upland typ but with very low natural fertility; with appropriate crops and fertilizers, reasonable yields may be expected]	12.3	15.6%	11.2%
<u>marginal shallow or steep:</u> [special problems due to shallowness or slope, heavy texture or sandiness; they occur primarily in highland areas and are susceptible to severe erosion]	2.2	2.8%	2.0%
TOTAL CROPPING LAND:	26.6	33.8%	24.2%
<u>PASTURE, PLANTATIONS, FORESTRY OR RESERVE</u> [soils unsuited to normal crop production because of major limiting factors such as steep topography, poor drainage, low fertility, sandiness, heavy texture, and rock outcrops or stones]	52.2	66.2%	47.5%
TOTAL HUMID TROPICAL LANDS	78.8	100.0%	71.8%

#### 4.3.2 SOIL TYPES: SEE APPENDIX A

#### 4.3.3 SOIL EROSION: CAUSES AND PROBLEMS

Soil erosion resulting in the loss of an important part of Bolivia's natural resource base represents one of the most pressing environmental problems of Bolivia. This phenomenon is most severe in the Yungas and Valles areas of the country because of the steep slope of the land but it is also a major problem in the Altiplano and other areas of the country as well.

There are several causes of erosion. In the Altiplano soil erosion can be attributed to agricultural practices, improper range management, and forest clearing. Overgrazing of this area, especially by sheep, which strip the land of its meager plant cover and compact the soil are the major causes of erosion in the Altiplano. However, farming techniques in this area involve long fallow periods during which the land has no plant cover to shield it from rains or to hold water.

In the Yungas and Valles, where problems are exacerbated by the steeply sloped terrain, the same phenomena occur, although goats rather than sheep are responsible for overgrazing, especially in Cochabamba, Chuquisaca, and Tarija. This problem extends to both old and new lands.

Soil depletion and erosion in Bolivia appear to have been worsened by the land reforms of 1953 which opened up for small farmers the lands once held by large landowners; the reform made new areas accessible for grazing, cropping, and firewood gathering but did not at the same time bring with it proper attention to soil conservation needs and practices. The results have been increased erosion, more frequent abandonment of fields, and a drop in crop yields on the steeper slopes (Eckholm 1976:88). One example is afforded by the "spontaneous" colonization of the Caranavi area of the Yungas, where the farming without soil conservation practices or fertilizers of predominantly sloped land in an area classified as essentially unsuitable for agriculture resulting in erosion, exhaustion of soil nutrients, and drastic declines in crop yield after the first few years (Nelson 1973:161).

The loss of plant cover and the resulting poor water retention of the soil in the Altiplano and Yungas-Valles regions leads to heavy runoff which not only causes immediate damage to agricultural land but also accumulates in rivers, causing flooding which damages fields and terraces, eats away at soils, and often leaves unproductive gravel deposits. Such floods originating in the Altiplano adversely affect the Oriente, particularly the plains of Beni, which are covered with waters that frequently drown cattle and generally limit the agricultural productivity of this area. Large silt loads carried by swollen rivers often affect the courses of lowland rivers.

Wind erosion is also a problem, especially in the area of Santa Cruz.

Soil erosion also results in large quantities of dust in the air. This is a problem in La Paz, where the air is often hazy with soil blown from the eroded hillsides surrounding the city.

#### 4.4 WILDLIFE

##### 4.4.1 The resource

Bolivia has a rich and varied wildlife resource. On the Altiplano are found the indigenous animals of this area: the llama, which domesticated serves as a beast of burden as well as a source of wool, meat, and leather; the alpaca, which is exploited for its wool; and the now rare vicuna and guanaco, both of which are hunted for their skins. Other Altiplano mammals are the increasingly rare chinchilla and its long-haired relative the vixcacha, the Patagonia hare, and the guinea pig. Birdlife includes the condor in the high Andes and the rhee (South American ostrich) in the southern stretches of the highlands, while in the area of Lake Titicaca are gulls, duck, geese, widgeon, the Titicaca grebe (unique to this area), plover, avocet, ibis, and hummingbirds. Further south, along Lake Poopo are flamingoes.

In the plains and forests of the Oriente as well as in the lower reaches of the Yungas is the greatest variety of wildlife. This is the habitat of the capybara and the 80-pound swimming river hogs, as well as of river seals, otters, deer, jaguars, ocelots, pumas, badgers, anteaters, peccaries, armadillos, opossums, sloths, and many varieties of monkey. Birds of this region include parrots, ducks, turkeys, partridges, and herons, while the numerous reptiles include alligators, river turtles, snakes, boas, and large frogs. In the Bolivian Chaco is the large marsh deer.

##### 4.4.2 Utilization of wildlife

As mentioned above, the llama and the alpaca have both been domesticated and now serve as important sources of food and animal labor. Furthermore, various animals such as the chinchilla, and the vicuna have been hunted for their skins, both to the point that they are now listed as endangered species. In one instance poachers completely exterminated the population of the tree chinchilla (*C. laniger*), which had been found in the Kenua Forest in the high Andes. However, it has been suggested that once the numbers of the still endangered vicuna are recovered, this animal, if rationally managed, could become a continuous source of wool, fur and meat, not to mention its value as a tourist attraction.

Wildlife serve as an important source of protein in many areas of the country. In certain parts of the lowlands of the Oriente, for example, the local population eats animals such as armadillos, wild pigs, coatimundis (a raccoon-like mammal), alligators, snakes, and certain birds.

At least some of the rare species of Bolivia are in demand for zoos and collections in other parts of the world. A report in the New York Times of May 23, 1979, for example, tells of a harpy eagle illegally brought into the United States via Canada and sold to the Oklahoma City City zoo for \$1500. According to the article the present asking price for the harpy eagle is between \$2,000 and \$3,000 dollars.

## 4.4.3 ENDANGERED SPECIES OF BOLIVIA: \*

MammalsChinchilla brevicaudata boliviana ChinchillaHippocamelus antisensis - North Andean Huemul

[small deer with simple forked antlers]

-occurs at high altitudes in the Andes; its numbers have been depleted because of overhunting; occurs in National Parks or Reserves in Bolivia; (Cowan and Holloway 1973:247); listed as vulnerable by Cowan and Holloway;

Panthera onca JaguarFelis widelli - MargayFelis pardalis - OcelotFelis jacobita - Andean catPteronura brasiliensis - Giant otterLutra platensis - La Plata OtterLutra longicaudis - Long-tailed otterVicugna vicugna - vicuna

About 2,000 individuals are said to exist in Bolivia; its numbers have increased considerably as a result of conservation measures, including the establishment of reserves (Salvadori and Florio 1978:106).

Chrysocyon brachyurus - maned wolf

-eastern zones of Bolivia

endangered deer: [Cowan and Holloway 1973: not on the list for the U.S. Fish and Wildlife Service]Blastocerus dichotomus Marsh deer-occurs in swamps and marshlands in northern Bolivia; eastern Bolivia is one of its major areas of concentration;  
-its numbers continue to decline as a result of agricultural development and overhunting.Ozotoceros bezoarticus Pampas deer

-Southwest Bolivia: O.B. leucogaster

-central South American pampas is its major area but it is also adapted to woodland.

BIRDSHarpia harpyja -- Harpy eagle

-see below under trade in endangered species;

Mitu mitu mitu -- MituPterocnemia pennata -- Darwin's rheaSpinus cucullatus -- red siskin - listed as endangered throughout South America.

\*see U.S. Department of the Interior, Fish and Wildlife Service.

Endangered and Threatened Wildlife and Plants. Federal register July 14, 1977, part v

REPTILES

??Podocnemis expansa -- South American turtle -- listed as endangered in the Amazon River basin.

??Podocnemis unifilis -- South American turtle (same as above)  
Calman yacare -- Caiman (yacare)

4.4.3.1 Protection of endangered species4.4.3.1.1 International agreements

Bolivia signed the Convention on Trade in Endangered species in 1974; it has not yet ratified the Convention, however.

With regard specifically to the endangered vicuna, Bolivia, Peru, Argentina and Ecuador in 1969 signed the La Paz Treaty promising ten years of total protection for this animal. These "vicuna nations" are scheduled to meet in September 1979 to discuss extending the treaty, and a great deal of controversy already surrounds the stated plans of Peru to begin rationally exploiting the now considerably recovered animal (Tinker 1979:264).

4.4.3.1.2 National parks and nature preserves

The 1971 United Nations-IUCN 1971 listing of National Parks and Equivalent Reserves notes that although legal provision relevant to national parks and reserves exist, they had not been implemented. As discussed under the legislation section, a new law covering hunting and wildlife management was promulgated in 1973. No regulations implementing this legislation have been issued.

4.4.3.1.2.1 Parks meeting IUCN standards

As of 1975, only one reserve, Ulla Ulla, was found to meet the standards of the International Union for the Conservation of Nature for national parks and equivalent reserves.

Ulla Ulla N.F.R.

established: 1972

extent: 200,000 hectares. ----

-established for the protection of high Andean flora and fauna, including the vicuna, the small relative of the llama;

With an average altitude of about 4,300 meters, Ulla Ulla is one of the highest Vicuna areas in the Bolivian Andes; also has the Condor, and the Giant Coot, as well other waterfowl, including flamingos and geese; there are also reports of puma or mountain lion.

4.4.3.1.2.2 Parks and Reserve Areas not meeting IUCN standards.

Information on these areas is from the 1971 IUCN-United Nations listing of National parks and nature preserves; no additional information has been found on these areas; these areas have not been listed in subsequent IUCN listing, which are considerably abbreviated in their format as compared with the 1971 edition.

Mount Sajama National Parkestablished: 1939

-contains the Kenua Forest (4,900 meters), the highest forest in the world, whose dominant species is Polyiepis tarapacana, a rosaceous tree.

The national park was declared in 1939, but in order to meet demands of charcoal for La Paz, the forest was exploited by charcoal burners, who by 1946 had left only a few isolated trees. Almost simultaneously poachers exterminated the populations of tree chinchilla (*C. laniger*), which had populated the Sajama massif. The United Nations states, however, that in 1954 measures for the reforestation or rehabilitation of about 75,000 ha had been announced by the then newly established Forest Service; no data on the success of this venture was available.

Miriquiri National Parkestablished by law: 1945

The law promulgating the park called for the establishment of a Committee to fix the boundaries and investigate the area; no action had been reported as of 1970.

National Parks of Huanana Potosi, Chacaltaya and Milluri Peaksestablished by law: July 4, 1942

In the Andean cordillera; hunting is prohibited, but the parks are under the special section of a Sports Association.

Mallaza National Parkestablished by law: November 1956      extent: 74 hectareslocation: near La Paz

Regulations governing the operations of the park had not been issued as of 1965.

Smaller parks on which not information was available include La Barranca, established in 1966 (247 hectares), and Cerro Comanche, established in 1963 (50 hectares).

4.4.3.1.2.3 Planned parks

Three projects for important new parks were under consideration in 1967; none of these had been established by 1975 and no information on the status of the plans was available:

Yapacani-Ichilo National Park	836,000 ha
Rio Negro-San Martin National Park	736,000 ha
Guanay Norte National Park	403,750 ha.

## 4.5 FISH AND FISHERIES

### 4.5.1 The Resource

Fish are said to be abundant in many of the streams and Lakes of Bolivia. Prominent species are the salmon trout, a giant species which populates Lake Titicaca and other Bolivian lakes, rainbow trout, and a kind of bass known as the boqa. Fish in the Pilcomaya river of the Valles are reported to be so numerous that they are stranded in great numbers on the banks of that river during low water seasons. Fish are also abundant in the Oriente, whose rivers contain not only edible fish but also the piranha and a type of stingray.

### 4.5.2 Utilization

The fish capacity of Bolivia's three major basin areas (the Amazon, the La Plata, and the Altiplano—about 2,000,000 hectares of water), has been estimated at 400,000 tons per year (Gonzales:39), but this resource is utilized only to a limited extent. The principal fishing centers are the Pilcomayo River in southern Bolivia and Lake Titicaca in the north. In the heaviest fishing season, when the river is at its highest, it is estimated that the Pilcomaya at Villa Montes yields about 20,000 shad and dorada weekly for the markets of Bolivia (Gonzales 1974:40).

FAO statistics indicate a total fish catch of 1,600 tons for 1970, of 2,200 tons for 1972 and 1973 and of 1800 tons for the years 1974-1976. Of these fish 800 tons were rainbow trout, most likely from Lake Titicaca. This is the lowest fish catch reported for any South American country, although Paraguay, Bolivia's equally landlocked neighbor, is not far ahead (a reported catch of 2700 metric tons in 1974). (Yearbook of Fishery Statistics, vol. 42, Catchings and Landings). Bolivia does import a certain amount of fish: an estimated 2,900,000 metric tons were reported for 1972, the last year for which FAO figures are available; fish exports at a value of \$3,000 (35,000 mt) were reported for 1970, while exports at a value of \$2,000 were reported for 1972; figures for later years were not available.

It has been estimated that the national consumption of fish in Bolivia comes to only 2,400 tons per year. There are no industries derived from fishing.

### 4.5.3 Pollution and fishing

See 4.1.2.1.3 and 4.1.2.2.3.

#### 4.6 MINES AND MINERALS:

##### 4.6.1 The resource

Mining has been an important economic activity in Bolivia since the days of the Spaniards. Exploitation of silver deposits in the area of Potosi began as early as 1545, and by 1650 that city, with a population of 160,000, was the largest in South America.

The silver mountain of Potosi has, however, long been depleted, but today minerals, especially tin, still play an overweening role in Bolivia's economy, accounting for about 13% of the country's gross domestic product and about 66% of its exports earnings. Despite the prominence of the mining sector, it offers employment to only about 3% of the population.

##### Mineral production: 1974-1976 (in thousands of metric tons)

	1974	1975	1976
Tin	29.0	30.3	29.8
Tungsten (Wolfram)	3.4	3.2	3.0
Antimony	12.0	14.0	15.3
Lead	17.6	16.0	16.4
Zinc	46.0	46.5	48.5
Copper	7.4	5.9	4.8
Silver	0.1	0.2	0.2
Petroleum (thousand cubic meters)	2,639.6	2,342.2	2,361.9

##### 4.6.2 Pollution from mining operations

Water pollution from mining operations affects the waters in some of Bolivia's most populated area, particularly the Rio Desaguadero and Lake Titicaca, both of which contain large loads of minerals. Poisonings of fish from this pollution has resulted, for example, in the reduction of the numbers of salmon trout in Lake Titicaca.

## 5.0 THE ECONOMY OF BOLIVIA

### 5.1 General Economic Picture (figures from National Basic Intelligence Factbook: January 1979).

GNP: 3.5 billion (1977, in 1977 dollars)

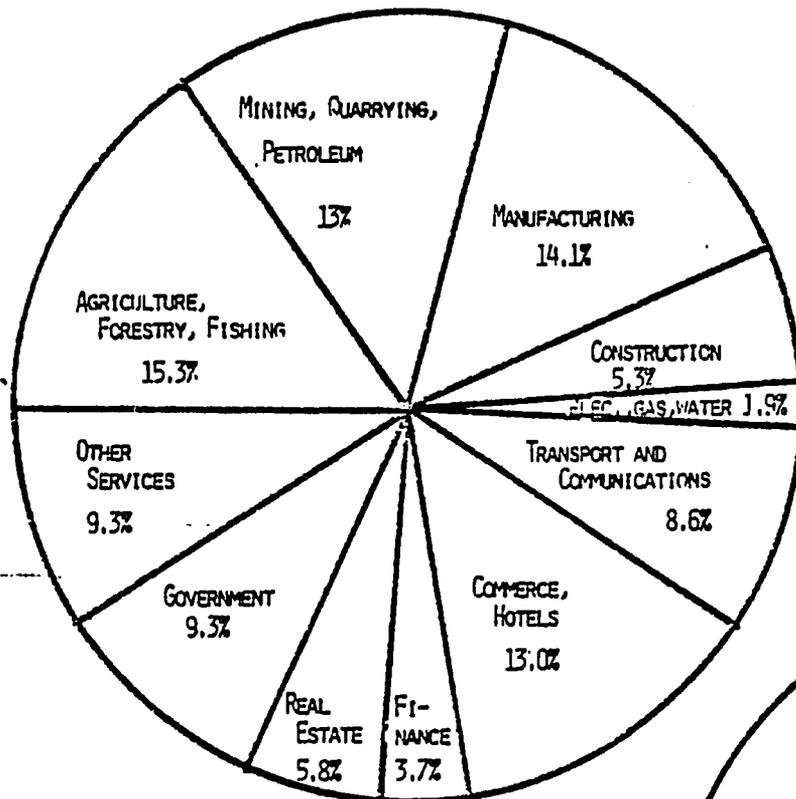
Per capita share of GNP: \$730

Real growth rate (1972-76): average 6.4%

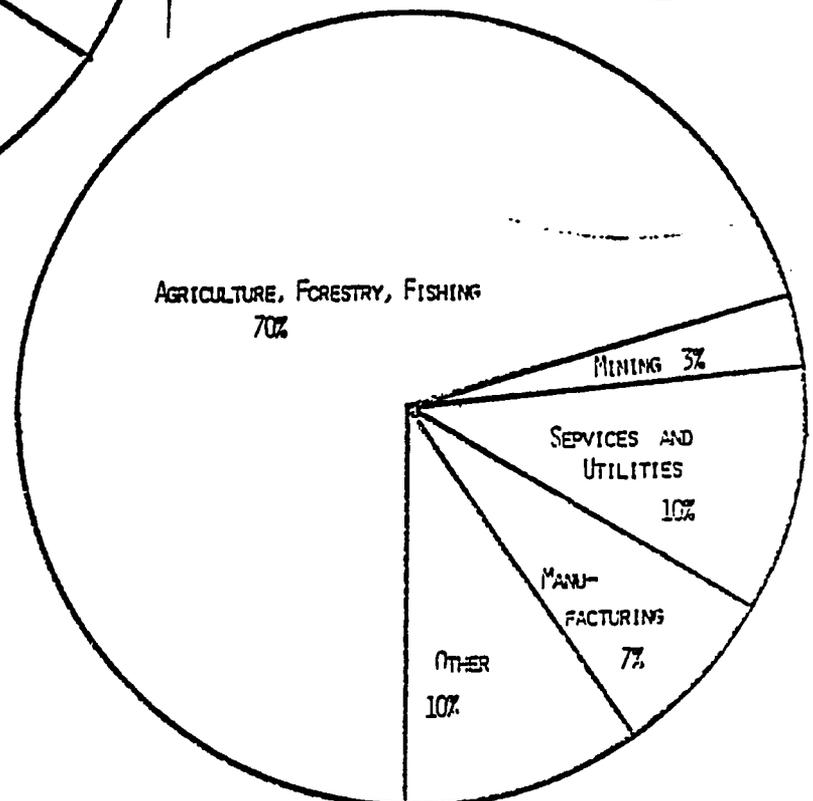
1976 growth: 6.0%

Monetary conversion rate: 20 pesos=US\$1

#### Gross Domestic Product(GDP) by sector (1975) (from Evaluation Technologies 1978)



#### Employment by Sector (1977) (National Basic Intelligence 1979)



## 5.1 GENERAL ECONOMIC PICTURE

Bolivia remains one of the poorest countries in Latin America, ranking in terms of GNP per capita ahead of only Haiti, Grenada, and Dominica in the Latin American and Caribbean region (WPOS 1979). In terms of constant 1970 prices the Bolivia Central Bank estimated per capita income by the end of 1978 at \$324. Of this the poorest 20% of the population received about 4% while the wealthiest 20% received about 60%. (A.I.D. 1979). Bolivia's poverty is also reflected in its low ranking on the Physical Quality of Life Index (PQLI), a measure that summarizes human well-being based on three indicators--infant mortality, life expectancy at age one and literacy; Bolivia's PQLI as most recently reported in early 1979 was 39 (of a possible 100), the lowest in the Latin American and Caribbean region (WPOS 1979).

After six years of healthy growth of about 6-7% in real terms, the rate of real growth of the Bolivian economy slowed to 4.8% in 1977, dropped to 4.0% in 1978, and is presently projected to be less than 4% in 1979. Reasons for this decline have been a decrease in petroleum exports and a decline in the production of tin, Bolivia's major mineral export. Increased public sector spending in anticipation of increase revenues which, however, have not materialized, has also complicated the economic picture and has led to an increase in both the internal and external national debt (A.I.D. 1979).

Bolivia is, however, endowed with great wealth, including minerals in the highland areas, petroleum and natural gas resources in the lowlands of Santa Cruz, and valuable stands of timber, particularly in the lowlands of the north. Bolivia's economic development has been hindered by several factors, not the least of which is its terrain, which limits communication and transportation within the country.

## 5.2 Agriculture

### 5.2.1 General

Bolivian agriculture occupies as much as 70% percent of the population but provides only about 15.3% of the nation's Gross Domestic Product. By some estimates, about 7.8% of Bolivia's land can be classified as prime agricultural land, but over half of this has never actually produced crops. Of the land actually in the production process, only about 12% is normally under cultivation, the remainder, in accordance with the traditional crop rotation system practiced in the Altiplano, lying fallow (Wennergren and Whitaker 1975:107). Agricultural practices tend to be primitive. Furthermore, most of the agricultural population is crowded in the unproductive highlands of the Altiplano, Yungas, and Valles, where soils are poor and land is limited. The typical rural family cultivates only 1 to 2 hectares of land and derives its income principally from potatoes, barley, wheat, rice, vegetables, and coca. This small farm sector has accounted for as much as 80% of farm production and has occupied as much as 95% of the rural population (Wennergren and Whitaker 1975:81).

In contrast to this typical small-scale farm enterprise concentrated in the highlands, the more modern agricultural sector with relatively large-sized holdings is confined to the Santa Cruz and Beni regions of the Oriente and involves less than 5% of the rural population. Whereas the small farm sector relies heavily on human labor for all aspects of production, the large farm sector employs more modern techniques, especially in the production of cotton and sugarcane in Santa Cruz (Wennergren 1975:82).

## 5.2.2 Crop Production

### 5.2.2.1 Crops in different agricultural regions

The most important crops of the northern Altiplano are potatoes; barley; quinoa (a native cereal); legumes, including peas, vetch, and broadbeans; onions and other vegetables; and forages such as alfalfa. In the colder, drier central Altiplano, where livestock is the principal agricultural product, subsistence cropping includes barley and quinoa, which are also fed to sheep. In the southern Altiplano, livestock production is once more the principal agricultural activity.

The steep subtropical valleys of the Yungas produce a variety of crops, the most important of which are coffee, coca, citrus, and bananas. The chief crops of the Valles regions are potatoes, corn, wheat, barley, grapes, and deciduous fruits.

The different zones of the vast Oriente yield varying agricultural products. In the northern tropical forest zone, gathering of wild products such as rubber and nuts are the most important activities, while on the Beni plains to the south of this zone, cattle are the principal product. Extending to the north from the general vicinity of the town of the town of Santa Cruz in an area defined by the Rio Chapare to the west and and the Rio Grande Rivers is the Santa Cruz zone, the most recently developed agricultural region of Bolivia. Here grow corn, rice, and other tropical and subtropical crops, as well as crops important for their export value, cotton and sugar cane. The remainder of the region is principally cattle-raising country, but small farmers in this area as well as throughout the Oriente as a whole produce various crops for subsistence consumption, including yuca, beans, bananas and plantains, citrus and tropical fruits, and vegetables.

### 5.2.2.2 Crop quantities and markets

Corn occupies the largest amount of land of any given crop (about 243,500 hectares in 1977); significant amounts of land are also planted to potatoes (125,515 hectares), barley (111,920 hectares), wheat (73,415 hectares), rice (62,915 hectares), and vegetables (38,250 hectares).

In terms of production value, potatoes, vegetables (including sweet corn, onions, tomatoes and green peas), and corn have been the most important crops. These and most other Bolivian crops are produced for subsistence consumption, with excesses made available for sale in urban markets.

Bolivia's chief export crops are cotton and coffee, both of which have increased in production since the early 1960's. Sugarcane, production of which also showed considerable growth over the same time period, is also exported to some extent, but increased production of this crop as well as of rice has been important chiefly in allowing Bolivia to save needed foreign exchange on these previously imported items. In contrast to the more traditional Bolivian agricultural products, coffee, cotton, sugarcane and rice have received extensive financial backing from both the public and private sectors of the Bolivian economy (Wennergren 1975:88-91).

#### 5.2.2.4 Use of fertilizers, pesticides, farm machinery

The use of fertilizers is low, the high cost of such products being the chief constraint on their use. In frontier areas where land is plentiful, small farmers, rather than investing in fertilizers to encourage continued productivity of their land, simply move on to new land when the natural fertility of the land they are working has been exhausted.

Phosphate and nitrogen fertilizers have accounted for about 97% of the fertilizers in use (Wennergren 1975:111). Animal dung, which could be an important fertilizer especially in the Altiplano region, is most often dried and used as fuel instead.

The use of pesticides, all of which are imported, is concentrated in the Santa Cruz region in the production of cotton, sugarcane and rice. Increased use of pesticides has been associated principally with increasing cotton production (Wennergren 1975:113).

- Modern farm machinery is in only limited use in Bolivia, being employed chiefly in cotton and sugarcane production in the Santa Cruz region. Bolivia has the lowest level of tractor use in South America (Evaluation Technologies, 1978:67).

Irrigation is still limited but is growing in importance (see 4.1.2.1.2.4).

#### 5.2.2.4 Limits on agriculture

Agricultural production is limited by several factors. In the Altiplano eroded and depleted soils are an important limiting factor as well as low rainfall and the risk of frosts. Because of the high erodibility of soils, terracing, often requiring a higher level of refinement than most farmers are capable of, is necessary for the working of slopes.

Although climatic conditions are more favorable in the Yungas, the slope of the land means that proper management practices, usually beyond the capabilities of Bolivian farmers, are required to avoid erosion and soil depletion. In the Valles, where centuries of farming have also led to the depletion of the soils, erosion is also a problem,

In the Oriente, the overwhelmingly greatest portion of which is con-

sidered to be more suitable for pasturage or forests than for crop production, flooding and poor soil drainage limit agricultural production especially in the northern areas, while wind erosion is a problem in the agricultural areas south of Santa Cruz.

Primitive farming methods also constrain agricultural production. The wooden hoe is still the principal tool of the Altiplano, seeds are generally sown by hand; residues and animal manure, although often used for fertilizers are more commonly employed as fuels, while commercial fertilizers are generally too expensive for the rural subsistence farmer. Crop rotation is generally the only conservation method employed by poor farmers.

Principally because of inefficient methods, domestic food production has increased only 2% per year, whereas demand for food has increased about 4%. (Evaluation Technologies 1978:53).

### 5.2.2.3 Adverse environmental effects of agriculture

The farming of land which, as is often the case in Bolivia, is highly subject to erosion because of the nature of the soil or the steepness of slopes requires a level of agriculture technology usually beyond that of the Bolivian farmer. Inadequate management therefore leads to depletion of soils and to erosion.

Slash and burn agriculture, a practice particularly common among small farmer in the new settlement areas of Santa Cruz, leads to both abandonment of land and to erosion problems. It is also a cause of deforestation. Farmers clear land, burning trees and brush in the process, work the land about three to five years until its productivity is lost, and then abandon it in order to clear new land.

Massive clearing of forest for large-scale grazing and crop production are also causes of deforestation in the Oriente.

### 5.2.3 Livestock

Livestock play an important role in the agricultural sector of Bolivia, large portions of the country are really only suitable for grazing and pasturage.

Cattle production is important in the northern Altiplano, especially in the region of Lake Titicaca. Sheep are raised in the plains, while llama and alpaca are kept in the higher, colder mountain regions. Farm families also maintain chickens, rabbits, and guinea pigs for meat. In the colder, drier central and southern Altiplano sheep, alpaca, and llama are of greatest importance, although cattle are also prominent in the central region.

Goats are found in the Yungas, while in the Valles there are dairy cattle, poultry, pigs, and goats.

Beef cattle are the most important product of the oriente, the greatest concentrations of these animals occurring in the Beni Plains and in Santa Cruz. Cattle are raised mostly under native range conditions without supplemental feeding. The poultry industry is also of great importance in Santa Cruz.

Livestock production is primarily a subsistence activity, most small farmers holding some livestock. Livestock numbers tend to be large in relation to the carrying capacity of grazing land, especially in the sparsely vegetated Altiplano. This results not only in overgrazing with its adverse environmental effects but also in a lowering of the quality of the livestock. Lack of feed for dairy animals, which tend to be concentrated in the Cochamba Valley, has limited the expansion of the dairy industry (Wennergren 1975:104).

#### 5.2.3.1 Adverse environmental effects of livestock production

Overgrazing of livestock is one of the principal causes contributing to soil erosion in Bolivia. The problem is particularly severe in the Altiplano where large numbers of sheep have stripped the vegetation cover and compacted the soil. The Yungas and Valles also suffer from overgrazing, with goats said to be the chief culprits in Cochabamba,

Ghuquisaca, and Tafiya. Small farmers grazing their animals on communally owned land reportedly do not consider in their interest to cultivate forage or to attempt to rotate or rejuvenate natural forage through rest periods (A.I.D. Bolivia 1976:A10).

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## APPENDIX A

## SOIL TYPES of BOLIVIA

The classification given below is taken from Soil Maps IV1 and IV2 of the Soil map of the world, FAO-Unesco, as explained in Volume IV, South America. This classification is based on exploratory studies performed by A.C.S. Wright (Wright 1964), and information from the Ministry of Agriculture and San Simon University. The FAO reported in 1971 that soil capability surveys had been carried out for about five percent of the country, mostly for areas in the eastern lowlands but also for the borders of the Mamore River. A British reconnaissance mission is also reported to have carried out a survey of the foothills and piedmont of the eastern lowlands at a scale of 1:200,000. (FAO-Unesco 1971).

Soils are listed by the dominant soil type in a given area; soils, however, occur in various associations; such information can be obtained from a closer reading of the FAO Soil Map.

ACRISOLS A\*

extent: 28,396,000 hectares/ 26.6% of land area

Orthic acrisols Ao

extent: 14,407,000 hectares

terrain and texture: predominantly level terrain; medium-fine texture;

vegetation: tropical deciduous forest, tropical semideciduous forest, tropical wet evergreen forest (about 12,646,000 hectares);

agricultural suitability:

traditional: low fertility limits their use under traditional farming methods;

improved: fertility can be improved but other serious problems, such as susceptibility to erosion remain; because they tend to occur on predominantly rolling to hilly topography, the use of tractors is limited;

Plinthic acrisols Ap

extent: 13,989,000 hectares

terrain and texture: level terrain; medium-fine texture;

vegetation: tropical forest and swamp forest; swamp savanna, de Mojós, and gallery forest (about 13,805,000 hectares);

agricultural suitability:

traditional: grazing, but there are serious limitations in terms of nutrient deficiencies (phosphorus, sodium, potassium, copper, and cobalt)

improved: drainage is a problem; a hardened layer may occur in dry season, while waterlogging may increase in wet season; greatest suitability is for grassland but rice, jute, and rubber can also be grown;

\*Symbol used for the soil on the FAO-UNESCO soil map.

**LITHOSOLS 1** (Lithosolic areas are represented by striped areas on Map)

**TOTAL EXTENT:** 24,386,000 hectares/ 22.9% of land area

All lithosols falls within FAO's slope class c: strongly dissected to mountainous.

According to the FAO's soil map, lithosols are not suitable for either traditional or modern (improved) farming and are usually idle or use for extensive grazing. Because cultivation of such soils could result to heavy soil erosion, leading to situations in which reforestation could become impossible, the FAO soil map finds that they are best used for forestry, wild life, and recreation.

As indicated by the striped area on the map, lithosolic combinations predominate across most of the cordillera regions of Bolivia.

Major combinations in which Lithisols dominate:

Lithosols

extent: 4,050,000 hectares

vegetation: upper montane grassland and Polylepis forest in the west; montane forest in the Subandean ranges;

Lithosols+Dystric Cambisols 1-8d

extent: 867,000 hectares

vegetation: montane rainforest, dry forest and xerophytic woodland of the Intermontane valleys

Lithosols+Dystric Cambisols+Eutric Cambisols 1-8d-8e

extent: 820,000 hectares

vegetation: lower montane rainforest

Lithosols+Dystric Cambisols+Humic cambisols 1-8d-8h

extent: 860,000 hectares

Lithosols+Dystric Cambisols+Orthic podzols 1-8d-Po

extent: 1,555,000 hectares

vegetation: montane rainforest

Lithosols+Dystric Cambisols+Dystric Regosols 1-8d-Rd

extent: 4,478,000

vegetation: subtropical rainforest

Lithosols+Eutric Cambisols 1-8e

extent: 1,789,000

vegetation: montane and upper montane rainforest and cloudforest, parama, and alpine tundra;

Lithosols+Eutric Cambisols+Chromic Luvisols 1-8e-Lc

extent: 1,964

vegetation: montane grassland, xerophytic woodland, and montane dry forest

Lithosols+Humic Cambisols 1-8h-c

extent: 409,000 hectares

vegetation: parama, alpine tundra

Lithisols+Chromic Luvisols 1-Lc

extent: 977,000 hectares

vegetation: montane forests, xerophytic intermontane formations

Lithisols+Vitric Andosols I-Tv  
extent: 6,617,000 hectares  
vegetation: upper montane steppe and desert

## LUVISOLS L

TOTAL EXTENT: 13,360,000 hectares/22.9% of land area

### Chromic luvisols Lc

extent: 3,052,000 hectares

terrain: principally strongly dissection to mountainous

vegetation: montane evergreen forest with transitions to chaco woodland;  
 montane dry forest, xerophytic woodland, and grassland  
 (2,751,000 hectares)

#### agricultural use and suitability:

In Bolivia chromic luvisols in the drier Andean valleys are used for farming potatoes, maize, wheat, vegetables, oats, fruits, alfalfa, and grass for milk and meat cattle.

traditional: moderately good for agricultural, with usually medium to high fertility levels; water is, however, an important limitation (such soils occur in areas with extensive dry seasons) as is also strong erosion susceptibility, which calls for careful management, including terrace-building;

improved: fertilizers and irrigation can increase crop yields substantially; mechanization may be limited by slopes; erosion control is desirable.

### Ferric luvisols Lf

extent: 4,899,000 hectares

terrain and texture: level terrain; medium to fine texture;

vegetation: tropical deciduous and semideciduous forests

#### agricultural use and suitability:

In Bolivia they are used mainly for grazing.

traditional: good because of medium to high fertility;

improved: use of fertilizer is necessary under modern agriculture and both soil erosion and drainage problems may occur.

### Plinthic luvisols Lp

extent: 5,409 hectares

terrain: level; medium texture;

vegetation: tropical semideciduous forest and savanna

## PLANOSOLS W

TOTAL EXTENT: 8,326,000 hectares/ 7.8% of land area

#### agricultural use and suitability for Planosols in general:

These soils are inundated during part of the year, and are most often used for rice or sugarcane cultivation or grazing.

However, these soils are characterized by an impervious subsoil, which hinders grassland growth during dry years. Soils are good for irrigated rice cultivation both under traditional and modern management but irrigation water should be low in salt content.

Eutric planosols Weextent: 4,324,000 hectaresterrain: levelvegetation: wet palm savannas, swamps, campo cerrado, tropical seasonal forestMollic planosols Wmextent: 4,001,000 hectaresterrain and texture: level terrain; medium texturevegetation: swamps and tropical semi-deciduous forests; tropical deciduous forest, and savanna (3,535,000 hectares);XEROSOLS X

TOTAL EXTENT: 8,070,000 hectares/ 7.6% of land area

Haplic xerosolsextent: 8,070,000 hectaresterrain: predominantly levelvegetation: montane and altiplano steppe; xerophytic deciduous forest (about 3,700,000 hectares with a saline phase);agricultural use and suitability:

Used for extensive grazing. In the central altiplano of Bolivia, they are used for grazing llamas and sheep as well as alpaca and, to a lesser extent, cattle.

They are of restricted suitability for the cultivation of a few adapted short-season crops but the irregularity of the rainy season makes production risky. Extensive grazing is feasible only to a limited extent because of the necessity of allowing the sparse vegetation to recuperate. Irrigation is difficult because certain layers in the soil tend to impede drainage. Supply of plant nutrients tends to be high but high soluble salt content may complicate the use of fertilizers in irrigated areas.

CAMBISOLS B

TOTAL EXTENT: 5,160,000 hectares/4.8% of land area

Dystric Cambisols Bdextent: 3,980,000 hectaresterrain: levelvegetation: tropical seasonal forestagricultural use and suitability:

Rarely used for agriculture; attempts to grow coffee on Andean slopes in Peru were unsuccessful. Low fertility tends to be a problem. They tend to respond poorly to improved management because of slope, depth, and stoniness. They are generally more suitable for pasture and forestry than for crop cultivation.

Calcic Cambisols Bk -lithosolicextent: 1,180,000 hectaresterrain: undulating to mountainousvegetation: upper montane grassland with polylepis incana forest; lower montane cactus formation;

Eutric cambisols Be

These occur in Bolivia in predominantly lithosolic areas (see above). High levels of plant nutrients make them good soils suitable to crop cultivation in humid areas, but in areas of high rainfall these basically shallow soils are subject to severe erosion.

Humic cambisols Bh

Occurring in the high slopes of the Andes in lithosolic combinations, (see above), these are acid soils used mainly for grazing of llama, alpacas, goats, sheep, and cows. Low fertility level puts them on a medium level of usefulness for traditional farming (potatoes). They are best used for grazing.

GLEYSOLS G

TOTAL EXTENT: 4,721,000 hectares/4.4% of land area

agricultural use and suitability for gleysols in general:

These soils all suffer from drainage problems, and are used chiefly for grazing when not inundated and rice cultivation in some areas. Under improvement management these soils can be put to good use, depending on factors such as texture, clay mineralogy and groundwater depth.

Dystric Gleysols Gd

extent: 4,126,000 hectares  
terrain: level  
vegetation: campo varzea swamp forest

Mollic Gleysols Gm

extent: 535,000 hectares  
terrain: level  
vegetation: swamps

KASTANOZEMS K

TOTAL EXTENT: 3,361,000 hectares/3.2% of land area

agricultural use and suitability for Kastanozems in general:

Because of strong seasonal water deficiency these soils have only limited suitability under traditional management, but marginal yields are possible under dry farming and extensive grazing is possible if cattle density is restricted. Improved farming can be successful with irrigation but drainage problems may occur and salinity of irrigation waters can create difficulties.

Haplic Kastanozems Kh

extent: 3,229,000  
terrain: level (about 50%); level to rolling (about 50%)  
vegetation: xerophytic deciduous woodland; xerophytic thorn woodland

Luvic Kastanozems Ki

extent: 132,000 hectares  
terrain: level  
vegetation: altiplano steppe

YERMOSOLS Y

TOTAL EXTENT: 2,412,000 hectares/2.3% of land area

agricultural use and suitability of Yermosols in general:

Yermosols are not suitable for either traditional or improved agriculture because of water deficiencies; they are rarely irrigated.

Haplic Yermosols Yh

extent: 1,998,000 hectares

terrain: predominantly level

vegetation: desert tundra and altiplano steppe (1,998,000 hectares);  
montane desert

Luvic Yermosols Yl

extent: 384,000 hectares

terrain: level

vegetation: montane desert

ANDOSOLS T

TOTAL EXTENT: 2,203,000 hectares/2.1% of land area

agricultural use and suitability of Andosols in general:

Andosols are difficult to farm under traditional methods because of problems of high acidity and phosphate fixation. Andosols are subject to erosion.

Mollic andosols Tm

extent: 529,000 hectares

terrain: level

vegetation: altiplano steppe

Vitric andosols

extent: 1,674,000 hectares

terrain: level (about 1,200,000 ha); mountainous

vegetation: altiplano steppe; river meadows; montane desert, puna steppe

REGOSOLS R

TOTAL EXTENT: 2,173,000 hectares/2.0% of land area

Dystric regosols Rd

extent: 470,000

terrain: mountainous

vegetation: tropical evergreen forest

Eutric regosols Re

extent: 1,703,000

terrain: level

vegetation: savanna with palms and shrubs

ARENOSOLS Q

TOTAL EXTENT: 1,537,000 hectares/1.4% of land area

Ferralic arenosols Qf

extent: 1,537,000

terrain: level

vegetation: tropical seasonal forest-semideciduous

FERRALSOLS F

TOTAL EXTENT: 1,115,000 hectares/1.0% of land area

Orthic ferralsols Fo

extent: 894,000 hectares

terrain: undulating

vegetation: tropical evergreen forest

Xanthic ferralsols Fx

extent: 221,000 hectares

terrain: level

vegetation: tropical evergreen forest

FLUVISOLS J

TOTAL EXTENT: 802,000 hectares/0.7% of land area

Eutric fluvisols Je

extent: 802,000 hectares

terrain: dissected to mountainous

vegetation: gallery forest, wet palm savanna, swamps;  
lower montane cactus formation, grassland;  
altiplano steppe

SOLONETZ S

TOTAL EXTENT: 532,000 hectares/0.5% of land area

Mollic solonetz Sm

extent: 458,000 hectares

terrain: level

vegetation: swamps

Orthic solonetz So

extent: 74,000 hectares

terrain: level

vegetation: swamps, xerophytic woodland