PDWA5887

Population Estimate for the Chapare Region, Bolivia

DESFIL

Development Strategies for Fragile Lands

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Tropical Research and Development, Inc.

in association with:

Earth Satellite Corporation
Social Consultants International

POPULATION ESTIMATE FOR THE CHAPARE REGION, BOLIVIA

Prepared for:

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2

TABLE OF CONTENTS

	Page
LIST OF FIGURES	ii
LIST OF TABLES	ii
LIST OF PLATES	iii
ACKNOWLEDGEMENTS	iv
SUMMARY	1
1.0 INTRODUCTION	2
2.0 BACKGROUND	3
3.0 OBJECTIVES	5
4.0 METHODOLOGY	6
4.1 Implementation	7
5.0 ANALYSIS AND RESULTS	14
5.1 Land Use	14
5.2 Field Survey	17
5.3 Population	18
5.3.1 Dwelling Units, Persons per Dwelling Unit and Total Cultivated Area	18
5.3.2 Persons per Hectare	20
5.3.3 Persons per Cultivated Hectare	22
6.0 RECOMMENDATIONS	26
REFERENCES	
APPENDIX A: Field Team Technical Report	

3

LIST OF FIGURES

		Page
Figure 1:	Chapare Population Estimate Study Area with 1:50,000 Scale Map Sheet	8
Figure 2:	Field Survey Sample Form	11
Figure 3:	Survey Tabulation Form for Grid Cell Data	13

LIST OF TABLES

		Page
Table 1:	Chapare Micro-Regions Cultivated/Developed Areas and Unsettled Areas	15
Table 2:	Relative Rankings of Chapare Micro-Regions by Total Area, Total Cultivated/Developed Area and Cultivated/Developed Density	16
Table 3:	Distribution of Field Samples by Micro-Region	17
Table 4:	Chapare Population Estimate by Dwelling Unit per Cultivated Hectare (DU/CH) x Persons per Dwelling Unit (P/DU) x Total Cultivated Area (TCA)	19
Table 5:	Chapare Population Estimate Using Aggregated Micro-Region Means of DU/CH and P/DU	20
Table 6:	Persons per Hectare by Micro-Region	21
Table 7:	Chapare Population Estimate Range Persons per Hectare Aggregated Micro-Regions	21
Table 8:	Summary of Chapare Micro-Regions - Estimates for Total Population and Population Densities (Persons per Hectare - Persons per Cultivated Hectare)	23

4

LIST OF PLATES

Plate 1: Landsat Mosaic, Chapare Region

Plate 2: Landsat TM, Chapare West

Plate 3: Landsat TM, Chapare East

5

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6

CHAPARE POPULATION ESTIMATE

SUMMARY

This report presents population and land use estimates for the Chapare Region of Bolivia. In generating these estimates a field survey was conducted and the results integrated with available remotely sensed data. The primary premise for making the estimates was the definition of cultivated and settled land, then the exploration of these variable's relation to the number of inhabitants. In the population estimation procedures, the variables served as surrogates in place of traditional population counting techniques.

The study area was defined as consisting of 404,184 hectares of which 115,525 hectares were identified as cultivated or developed through Landsat satellite image analysis. The Chapare study area was divided into eight micro-regions, based on ecological characteristics. The estimates were then extrapolated from survey samples of the eight micro-regions and aggregated for the total study area.

Three population estimation procedures were performed, all based on the variable's relationships to the number of inhabitants. The three resultant population estimates have a numerical range of approximately 196,000 to 234,000. These estimates are for that population associated with dwelling units, a primary field survey sample unit and variable. They do not include migratory populations that may temporarily reside within the Chapare. The central tendency for all three estimation's statistical means is approximately 205,000 to 218,000 people. This range is the base estimate for this study.

1.0 INTRODUCTION

This report provides estimates of land use and population for the Chapare, Bolivia. The study was implemented as part of the Chapare Regional Development Project (CRDP) - Development Strategies for Fragile Lands (DESFIL) Buy-In (P10/T No. 511-0543-4-70035.02). Data acquisition, project document review, analysis, field survey and report preparation were conducted between May 19, 1987 and July 23, 1987. The study team consisted of a Project Director, an Environmental Planner/-Scientist, a Geographer, and seven Field Surveyors. Approximately 80% of the consultants' time was spent in the Chapare, Cochabamba and La Paz, Bolivia. The remaining time was used for data acquisition and analysis at the consultant's office in Chevy Chase, Maryland.

8

2.0 BACKGROUND

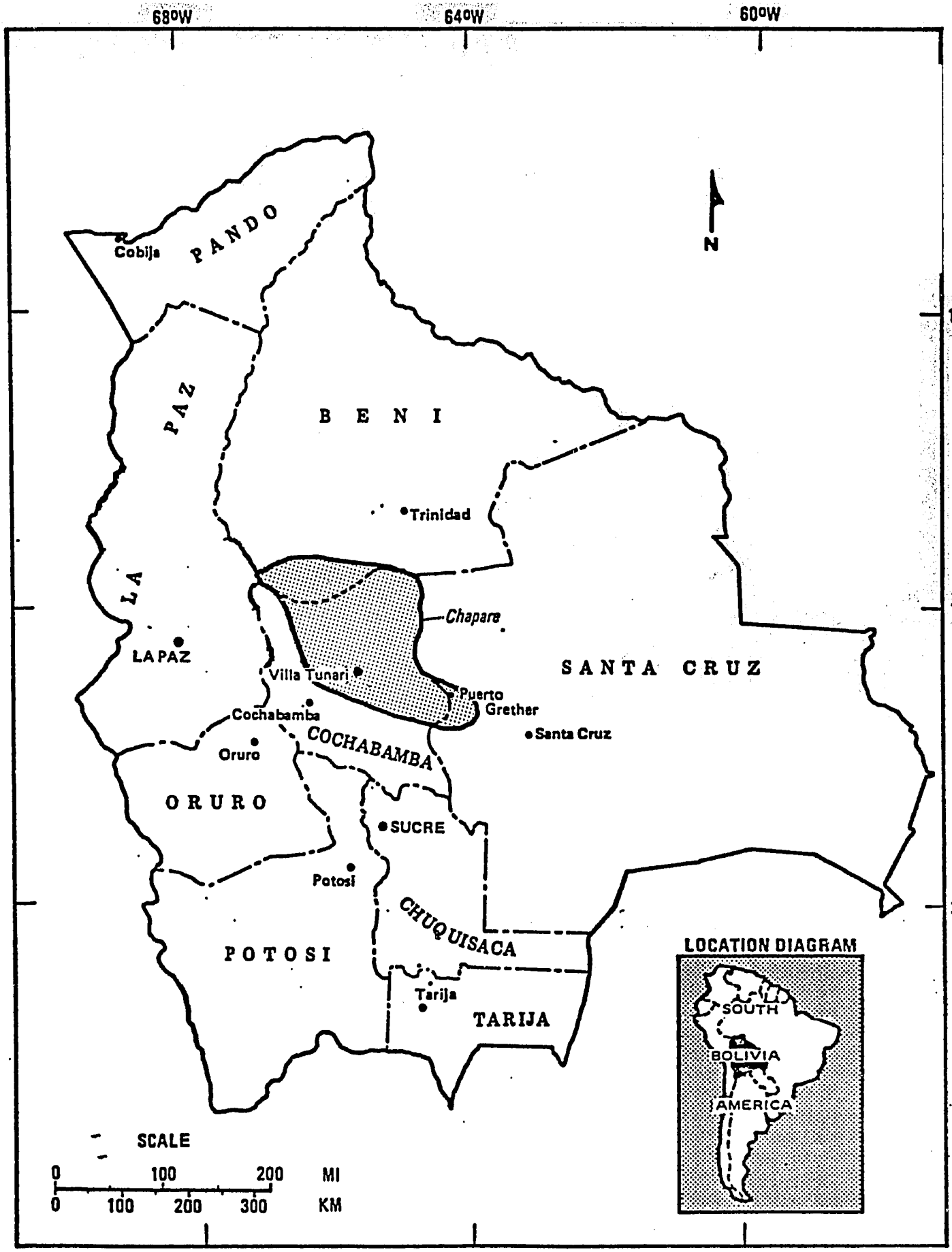
One of fourteen provinces in the Department of Cochabamba, the Chapare region is approximately 150 km northeast of the city of Cochabamba in an area of broad low plains and low hills. It is in a tropical rainforest region, characterized by high temperature, high humidity and excessive rainfall. Plate 1 is a color mosaic based on 1983 Landsat images providing a regional overview of the Chapare.

Chapare colonization began in the 1920's, and has accelerated since the mid-1960's. In the 1980's, population increases have continued with expansion of road networks which open new lands to colonization.

The Chapare has experienced explosive population growth spurred by continuing colonization and labor demand linked with coca production. Migration into the Chapare has had the effect of expanding cultivation/-development throughout the region. This expansion is not well understood spatially nor has it been quantified. While the most recent coca control program may have temporarily reversed or halted the upward trend, present land use and population estimates for the region are based on unreliable and non-quantifiable information. One of the most current population estimates, that of 75,000 to 250,000, is of little value because of its wide variance and lack of statistical documentation. Other estimates have only added to the uncertainty and confusion. Narcotics control personnel in the U.S. Embassy/La Paz have estimated that there may have been 300,000 or more inhabitants in the Chapare prior to recent (1986) coca eradication and enforcement efforts.

Regardless of these disparate Chapare population estimates, it is acknowledged widely that colonists have expanded into the frontier areas, new urban centers have developed, and a transient migrant popu-

9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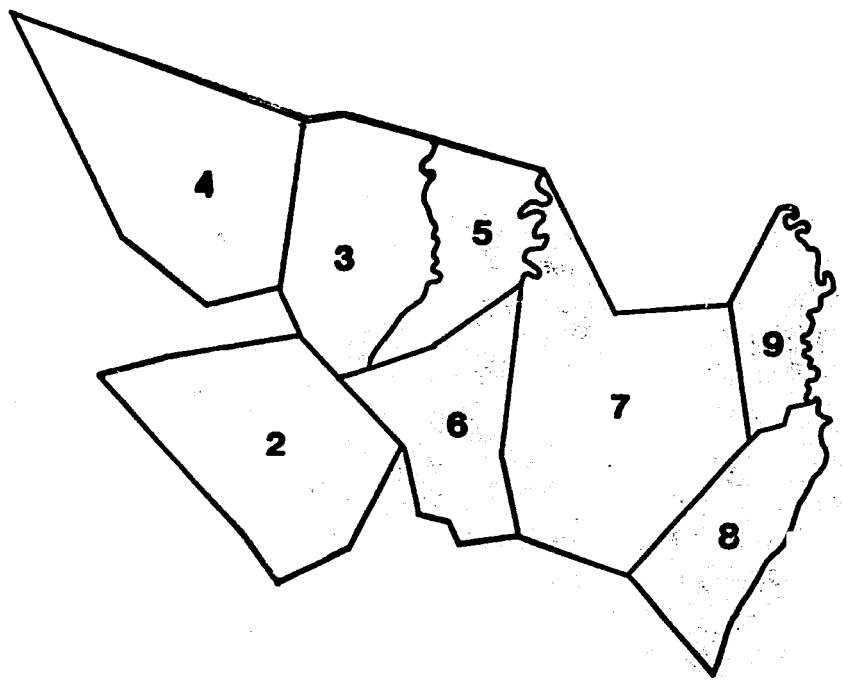
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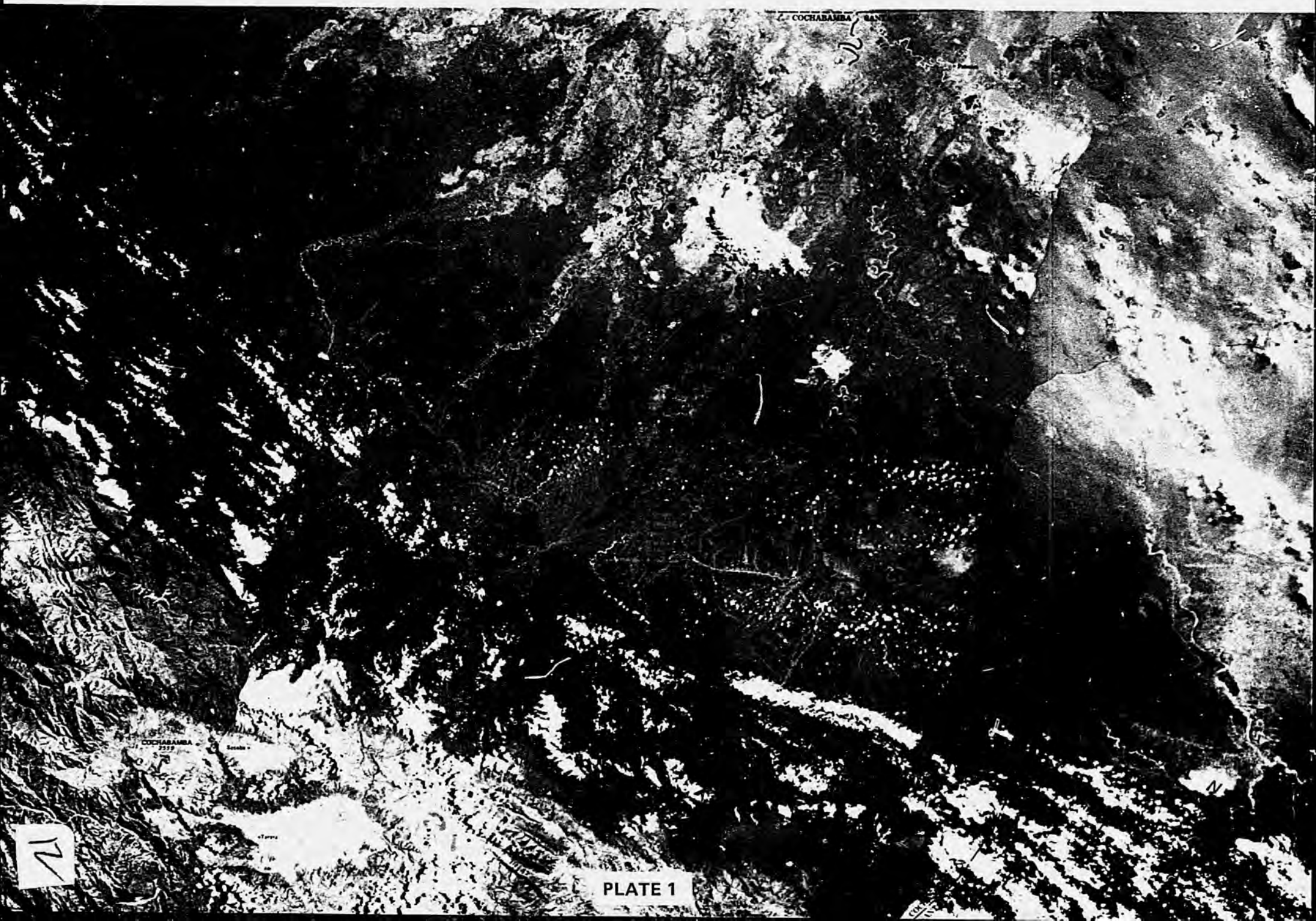


PLATE 1

lation (florantes) linked to coca production and its illicit processing/distribution has emerged. Inherent characteristics of these factors - inaccessibility of frontier regions, security concerns, and a constant dynamism - have and will continue to hinder traditional methods of land use estimation and in particular, population estimation.

In an attempt to overcome these estimation obstacles while providing an acceptable degree of accuracy, USAID/Bolivia through the DESFIL Buy-In decided to employ an approach that utilizes current remote sensing technologies. Thus, a methodology was developed that adapted to the unique constraints of land use and population estimation in the Chapare.

Beginning in mid-May 1987, Earth Satellite Corporation (EarthSat) staff, as part of the DESFIL team, began acquiring and analyzing digital and photographic data that would provide the basis for a proposed estimation approach. In mid-June a field survey team of Bolivian nationals was dispatched to the Chapare to collect "ground-truth" data. In early July, the field team met in Cochabamba with EarthSat and USAID/Bolivia staff and presented their field survey results. These data were than integrated with and used to calibrate the data acquired from the remotely sensed sources.

The following report provides a discussion of the objectives, methodology, analysis, and study results as well as sets forth a set of recommendations for future consideration.

3.0 OBJECTIVES

The objective's for the Chapare population estimate study, as put forward in the Scope of Work, were to:

a. Stratify the Chapare region into a set of sub-regions based on agricultural settlement density to provide a framework for field sampling and related data collection.

b. Determine the area of unsettled and settled lands within a pre-defined Chapare region.

c. Develop a data base to document population estimates, including density estimates by sub-region in coordination with the SARSA anthropologist.

d. Determine points of origin of Chapare colonists.

e. Prepare analyses of population density/location, settled and unsettled, and potential settlement locations based on recent settlement capacity and physical constraints.

All of the objectives were achieved during the course of the study. It was beyond the scope of methodology to provide quantitative data and analysis for objective "d." However, the data gathered by the field team can provide insight and qualitative information regarding this question.

4.0 METHODOLOGY

The Chapare population estimate methodology was designed within two primary constraints: a relatively short study time (eight weeks from data acquisition to report preparation) and access only to existing and readily available remotely sensed data. In addition, varying dates of acquisition for different sources had to be reconciled within the study design. These factors provided the parameters for methodology development.

The methodology developed relies on the use of independent variables as surrogate indicators of population size. Past studies using remotely sensed data to estimate population variables have included: structures, dwelling units, dwelling unit density, impervious surface, and various land use classifications (Hsu, 1971; Collins and El Beik, 1974; Kraus et al., 1974; Adeniyi, 1976; Henderson, 1979; Lo and Chan, 1980). A set of independent variables was defined for the rural character of the Chapare structures, dwelling units and cultivated/-developed land use. The methodology was implemented through the identification of the variables and the quantification of their relationship to the population.

This estimation procedure is biased toward the population that is associated with dwelling units. In the Chapare where a significant migratory population is believed to exist, this bias may lead to underestimation.

4.1 Implementation

The first step in methodology implementation was the definition of the study area and the disaggregation of the area into a set of subregions. This was ac eved through the use of a map, "Mapa de Capacidad de Uso Mayor de la Tierra." The CUMAT map had defined nine ecological micro-regions within the Chapare. The CUMAT micro-regions were modified after visual comparison with 1985 Landsat imagery. The modifications were deemed necessary because of visible land use dynamics that occurred subsequent to the CUMAT analysis. The modifications are as follows:

a. Deletion of micro-region 1, the Las Tablas region extending southwest from Villa Tunari. This region consisted primarily of steep slopes with little cultivated/-developed land use evident.

b. Extension of the study area northwest of micro-region 4. Increased cultivation/developed was evident with indications that this was major new settlement area.

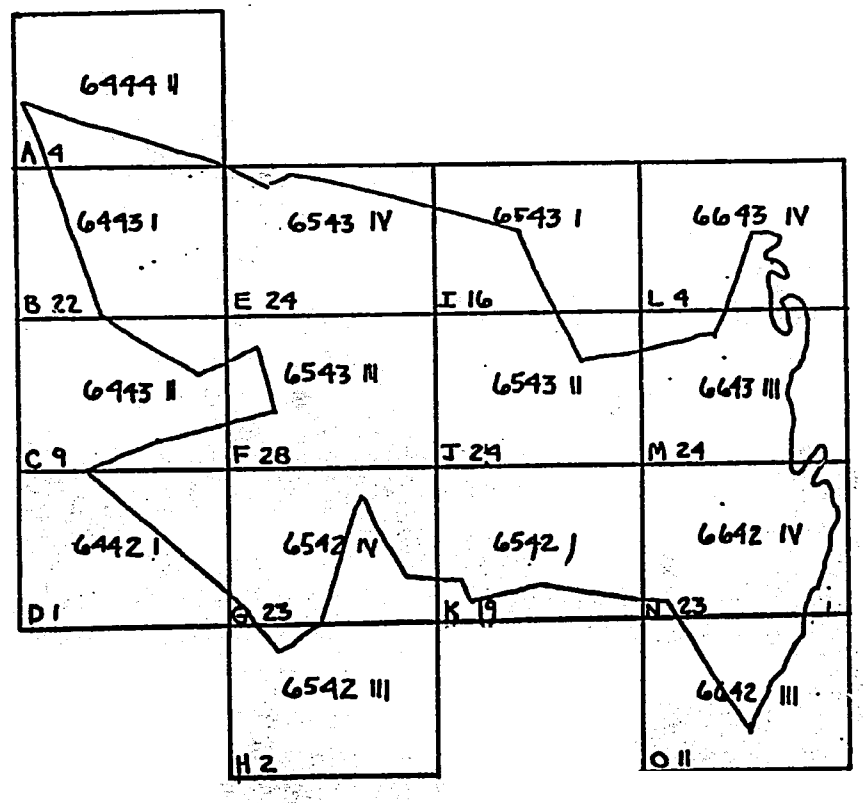
c. Enclosing the areas between micro-regions 8 and 6. (Figure 1 is a map of the newly defined area.)

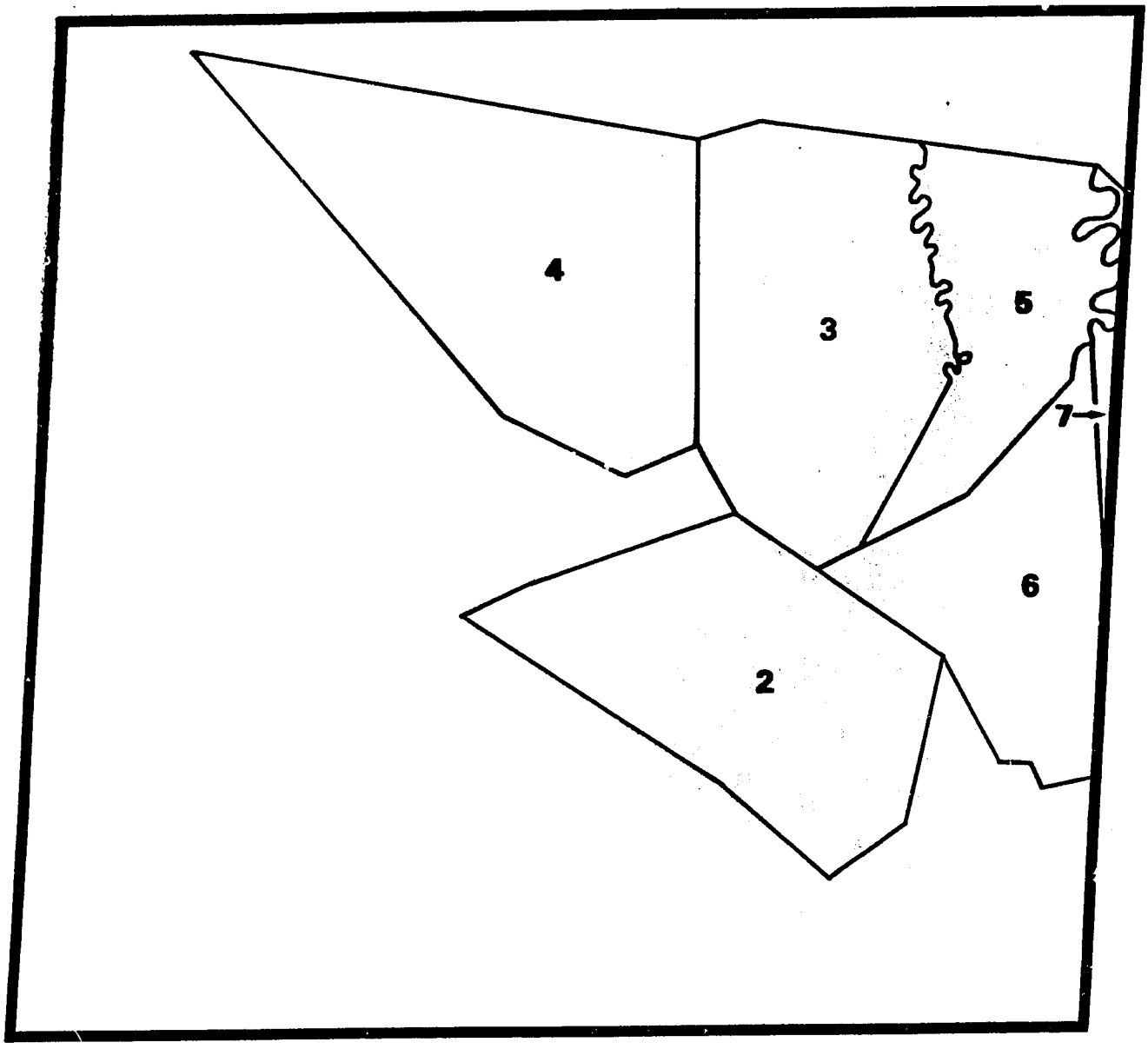
The modified Chapare Study Area (CSA) encompasses an area of approximately 404,184 hectares. This represents a decrease of approximately 18,000 hectares from the originally-opposed study area. The decrease was due largely to the deletion of micro-region 1.

Aerial photography (August 1984) at 1:50,000 scale and Landsat Thematic Mapper (TM) imagery (August 1985) were obtained for the study area (Plate 2, Chapare West and Plate 3, Chapare East). The Landsat data was processed at both 1:100,000 and 1:50,000 scales. Topographic maps at 1:50,000 scale also were obtained for the study area. The aerial photography and processed Landsat imagery were overlaid with grid

16

FIGURE 1: CHAPARE POPULATION ESTIMATE STUDY AREA WITH 1:50,000 SCALE MAP SHEETS

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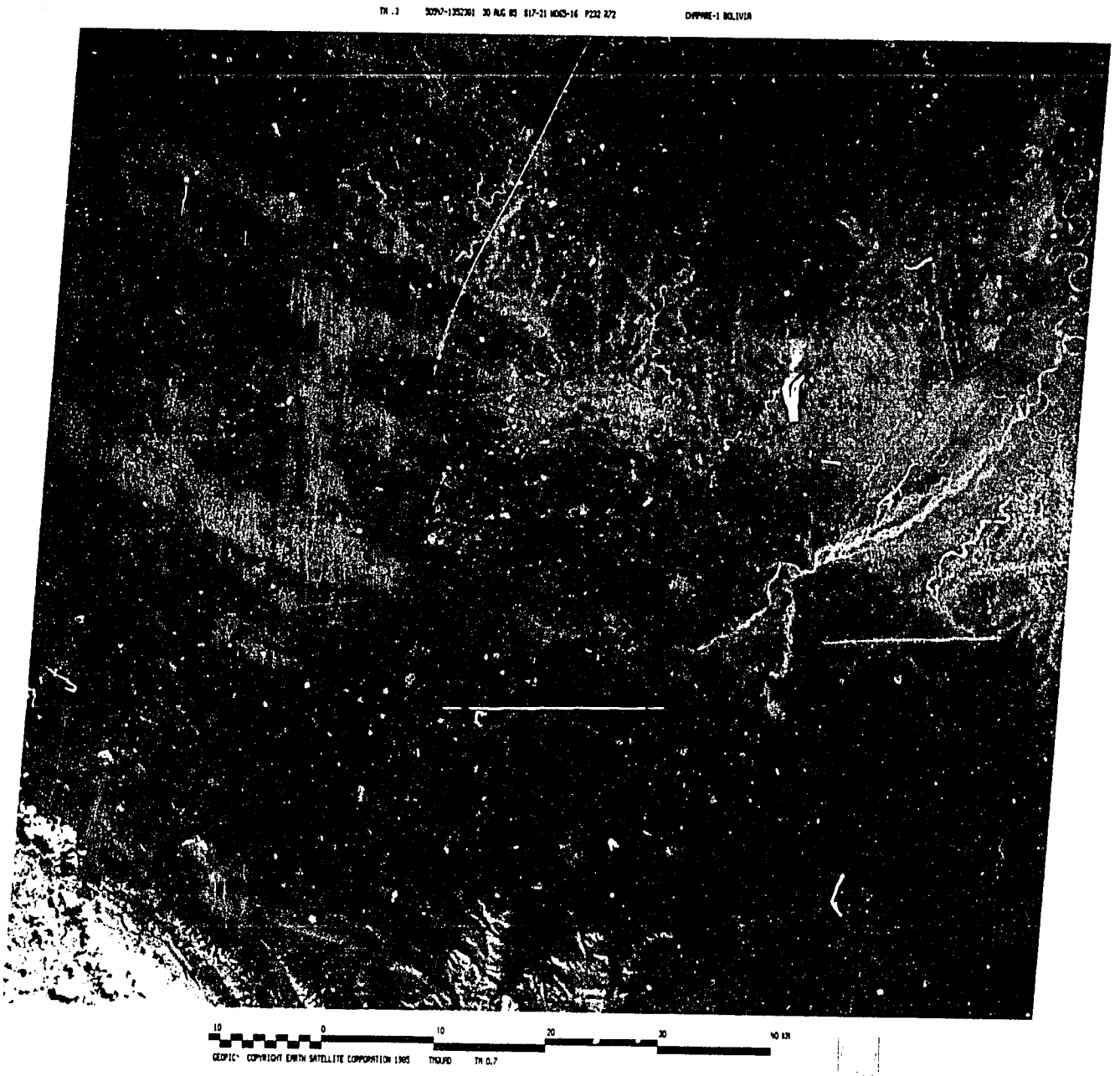
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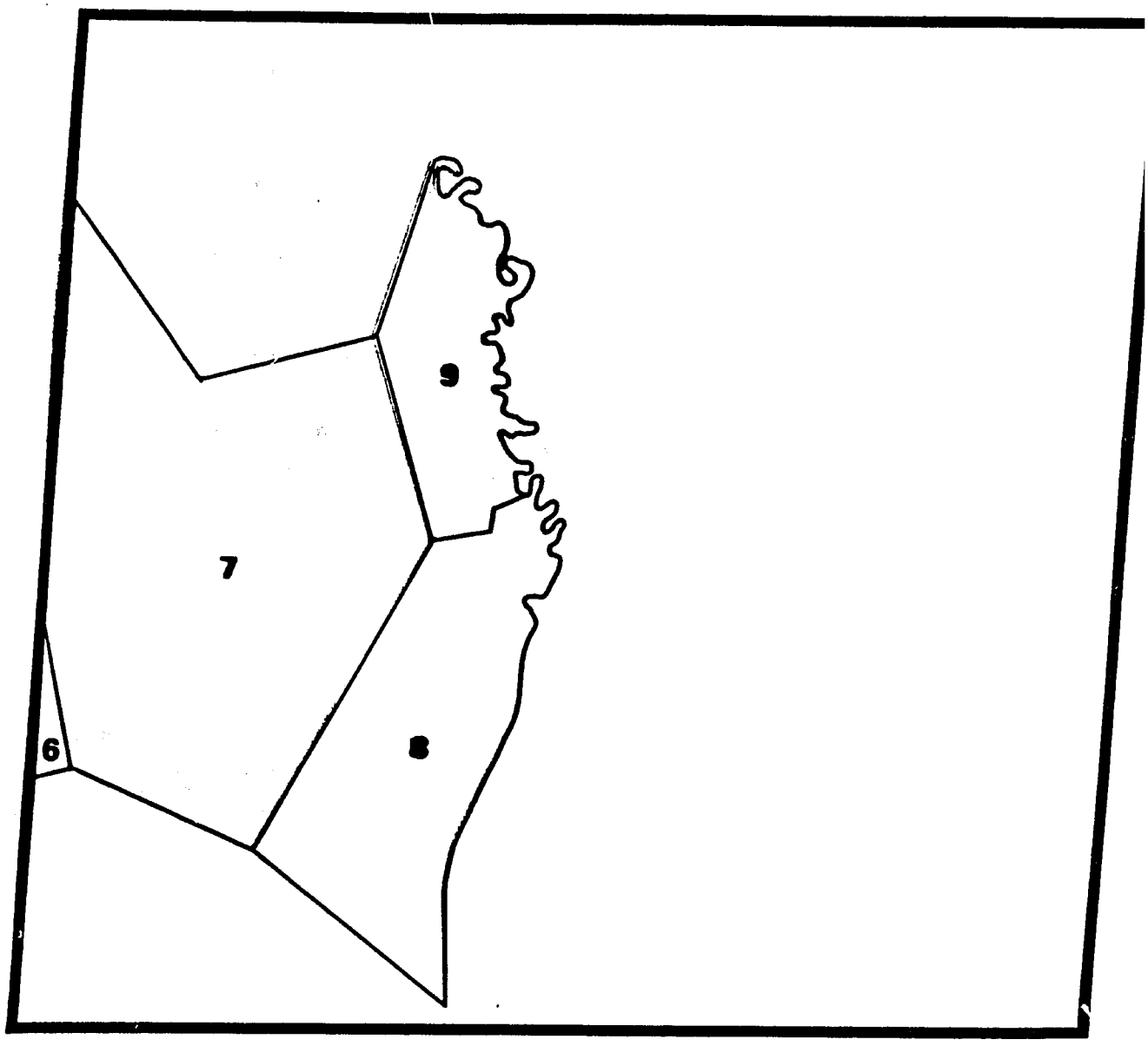
PLATE 2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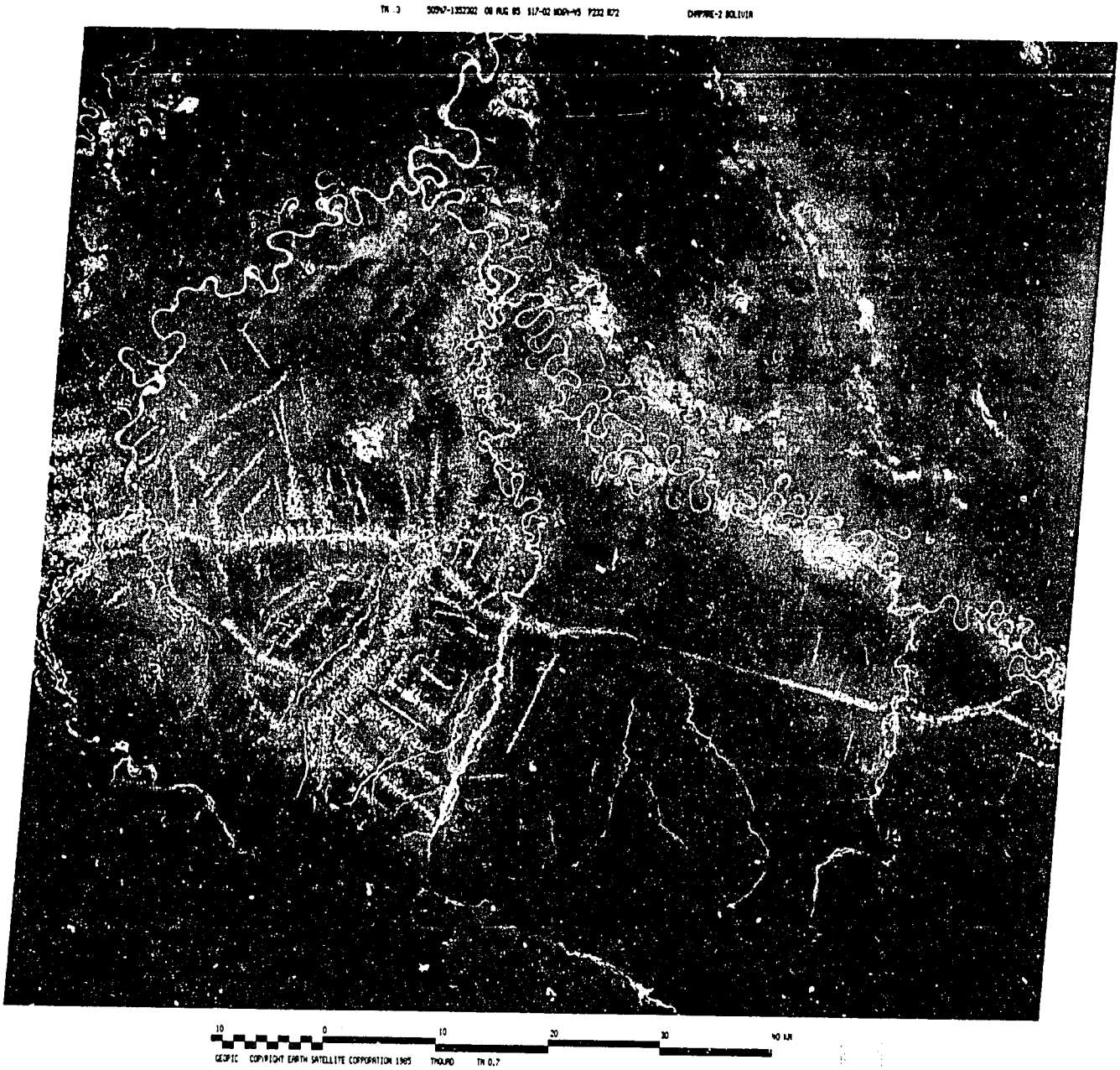
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PLATE 3

cells measuring 1 km x 1 km (100 hectares), georeferenced to the UTM grid overlaying the Topo maps. Each cell was given a unique identification and served as the basic sample unit for subsequent analysis and field survey.

Delineations were made manually on the Landsat imagery defining areas of cultivated/developed land and undeveloped/unsettled land. These were then measured and quantified, by micro-region, through a digitization process on EarthSat's PRIME 750 minicomputer. Digitization is a process of converting area delineations into planar coordinate (x,y) form for computer processing. Once the polygons, in this case representing cultivated/developed land, are converted, area estimates can be generated. The 1984 aerial photography was analyzed through a manual process using a dot grid to estimate the number of structures and cultivated area by sample grid cell. The 1984 sample cell data was tabulated and used to calibrate the estimation of cultivated area provided by the Landsat imagery delineations. The relationship between number of structures and cultivated area was quantified.

At this point data has been either estimated or quantified for the CSA as follows:

- Cultivated/developed land (1985)
- Undeveloped/unsettled land (1985)
- Number of structures (1984)
- Structures per cultivated/developed hectare (1984-85)
- Structures for total area (1984-85)

All of these data were recorded for each of the eight micro-regions and aggregated for the entire CSA.

21

In early June, the field survey team was assembled in Cochabamba. Over a three-day period, meetings were conducted with the consultant's project director to prepare field survey materials and coordinate field activities and procedures. Current security issues were of major concern, and current status reports were reviewed and contingency plans were prepared. In fact, events on June 5 resulted in a one-week delay, from June 8 to June 15, for field team initiation of survey activities.

A field survey team was sent into the Chapare to collect current "ground-truth" data for the estimate. The field survey was conducted by three interview teams (two persons to a team). The individuals were selected because of their familiarity with the Chapare. The basic survey unit was the 100 hectare grid cell. Two hundred and thirty-four grid cells had been randomly selected for the field survey. This sample represented approximately 23,400 hectares or 5.8% of the CSA. The sampling design was based on the areal extent of the CSA.

A field survey form had been developed by EarthSat staff and Dr. Michael Painter, SARSA Anthropologist. See Figure 2 for an example of the field survey sample form. The survey form was designed to record quantifiable data on structures (number and type), and number of inhabitants (total and by structural type). In addition the form contained space for entering more specific demographic data such as: place of origin, age, time in the Chapare, specific crop cultivation, and any other observations the interviewer felt appropriate. The field team members were instructed to pursue this more specific information only through "opportunistic" samples, that is if an informant appeared willing to provide the information. Instructions on the "opportunistic" samples were based on security concerns for the field team and the relatively short time available to collect the field samples. The

28

DATOS DE CAMPO

No. de Mapa _____ No. de Muestra_____
Nombre_____

A. Estructuras - Sumario de Muestras

Número de Residencias	_____	R
Número de Total de:		
- Otros estructuras rurales	_____	X
- Iglesias	_____	I
- Escuelas	_____	E
- Correo	_____	C
- Posta Medica/Sanitario	_____	P
- Municipalidad	_____	M
- Mercado/Plaza	_____	M/P
- Tiendas y Talleras	_____	T
- Otros	_____	O

Total: Número de Estructuras _____

B. Población - Sumario de Muestras

Número Total de Personas _____

Número de Personas por Residencia (Promedio) _____

Nombre del Encuestador_____ Fecha____

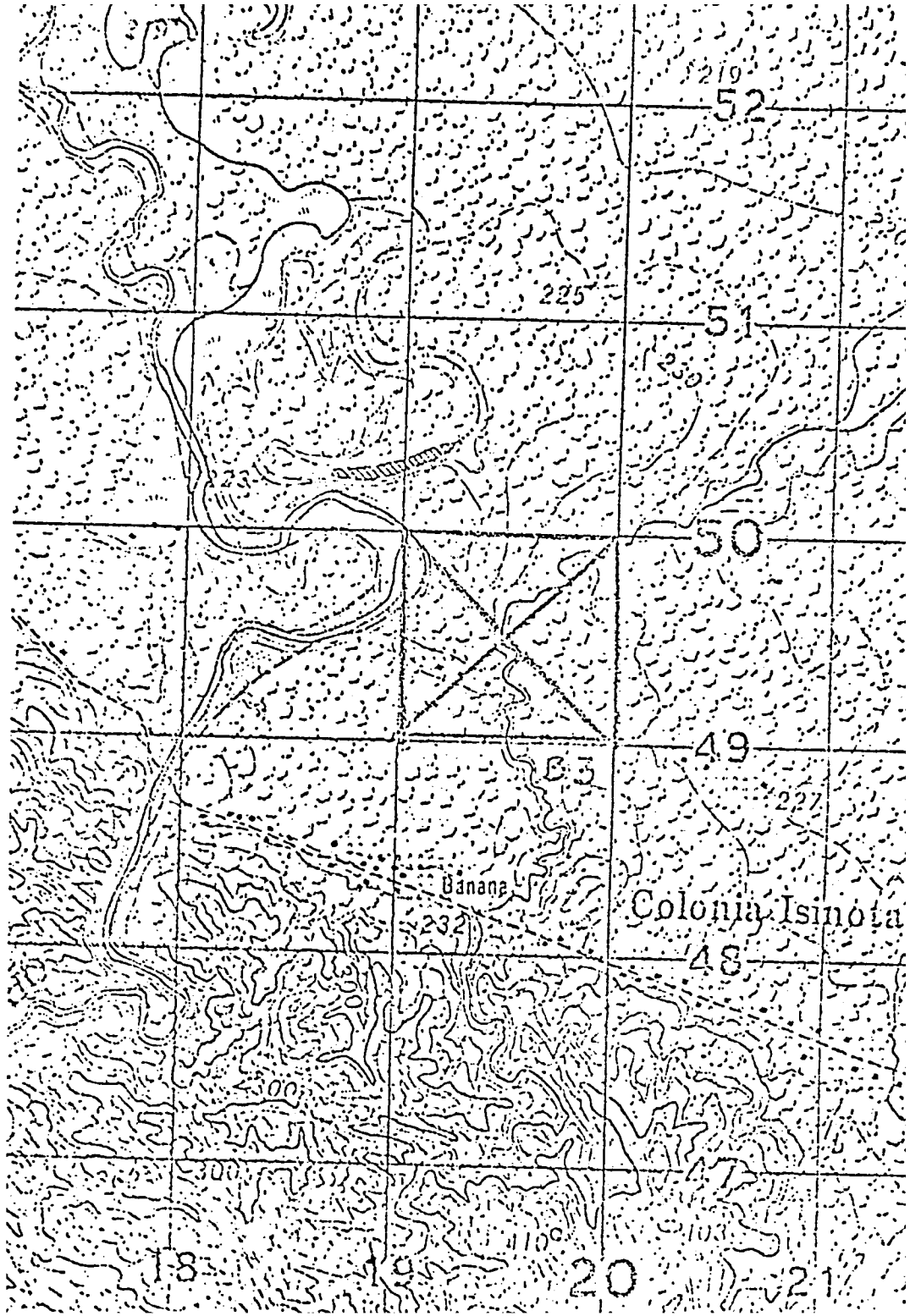
FIGURE 2: FIELD SURVEY SAMPLE FORM

234

Escala de mapa = 1:32,500
Muestra = 1 km x 1 km

Hoja de Trabajo: Estimado de poblaciones y estructuras

Estructuras Número	Tipo	Para Residencia: No. de Personas	Observaciones



24

"opportunistic" data was viewed as qualitative because it could not be integrated nor extrapolated in conjunction with the study surrogates. It should be noted that while this data is non-quantifiable within the study's methodology, significant insights can be gained as to demographic dynamics through a review of these "opportunistic" samples.

Upon completion of the field survey, the data was tabulated on a grid cell data form (see Figure 3 for an example). The field data was analyzed in conjunction with that data acquired from the aerial photography and Landsat imagery.

FIGURE 3: SURVEY TABULATION FORM FOR GRID CELL DATA

GRID CELL	MAP	REGION	STRUCURES	DW. UNITS	TOTAL PERSONS	PERSONS/DW.UNITS	CULT. 1984

CULT. 1985	PERSONS/HECTARE

5.0 ANALYSIS AND RESULTS

The following is a discussion of data analysis, the population surrogate relationships studied and extrapolated, and the subsequent estimates of land use and population. All analyses took place at three levels; sample cell, micro-region and in the aggregate.

5.1 Land Use

The total area for the Chapare population estimate study consists of 404,184 hectares of which 115,525 hectares were classified as cultivated/developed*. This represents a settled area of approximately 28.58% of the total CSA. See Table 1 for areal data by micro-region. Little change was noted between classification of cultivated/developed and unsettled land from 1984 and 1985 data sources. This factor may be attributed to two inherent characteristics of the Landsat data and its analysis.

* Based on 8 August 1985 Landsat Thematic Mapper data.

28

TABLE 1: CHAPARE MICRO-REGIONS CULTIVATED/DEVELOPED AREAS AND UNSETTLED AREAS**

	Total Land Area (Has)	Cultivated/Developed Area (Has)	% Total
Region 2	60,252	9,603	15.9
Region 3	49,446	26,131	52.8
Region 4	68,779	20,204	29.4
Region 5	32,695	4,185	12.8
Region 6	36,633	11,057	30.2
Region 7	95,764	25,399	26.5
Region 8	38,603	14,515	37.6
Region 9	22,012	4,431	20.1
TOTAL	404,184	115,525	28.58

** Based on August 8, 1985, Landsat Thematic Mapper imagery.

First there is an imprecision in discerning the differences between barbecho, floodplain/wet land and cultivation as land use classes. Second, the accuracy of the 30-meter resolution of the Landsat Thematic Mapper data is coarse compared to the finer resolution of the aerial photography. This resolution concept means that any feature (such as vegetation, impervious surface, bare soil, rock, water, etc.), covering an area smaller than 30 m x 30 m may be mistaken as some other cover type based on the size and reflectance value of the surrounding ground cover. However, upon a comparison several of randomly selected grid cells with the aerial photography this imprecision appears to be no greater than 8 to 9% for this study. Since several of the following estimates are based on relationships to cultivated/developed area these sources of introduced variation are inherent to those estimates.

29

Micro-regions 7, 4 and 2, respectively, are the largest micro-regions, having approximately 55% of the total land area of the CSA. Micro-regions 3, 7 and 4, respectively, have the greatest amounts of cultivated/developed land; approximately 62% of the total cu[illegible]d/developed land contained in the CSA. Micro-regions 3, 8 [illegible] 6, respectively, have the highest cultivated/-developed land densities within the CSA. See Table 2 for a compilation of relative land area rankings by micro-region.

TABLE 2: RELATIVE RANKINGS OF CHAPARE MICRO-REGIONS BY TOTAL AREA, TOTAL CULTIVATED/DEVELOPED AREA AND CULTIVATED/DEVELOPED DENSITY

Region	Total Area	Cultivated/Developed Area	Cultivated/Developed Density
2	3	6	7
3	4	1	1
4	2	3	4
5	7	8	8
6	6	5	3
7	1	2	5
8	5	4	2
9	8	7	6

The consideration of environmental variables that influence cultivation and settlement patterns such as access to infrastructure, steep slopes, soil types and crop suitability, were beyond the scope of this study. These variables are significant, if not primary considerations. For the individuals who have or will settle in the CSA. It is recognized that these environmental variables are keys to understanding the previously described cultivation and settlement estimates. Similarly, the micro-region densities may provide insight and serve as

a basis for future investigations. These land use estimates should not serve alone as guidelines for directing future colonization and expansion.

5.2 Field Survey

The field survey team collected data for 187 of the 234 delineated sample cells. Data for 20 sample cells were discarded because of contradictions or inconsistencies on the survey form. A total of 167 survey sample cells, representing 16,700 hectares (4.14% of the total CSA) were used to calibrate the aerial photography and Landsat data. The sample cells were not evenly distributed across the CSA micro-regions. The micro-regions with the smallest sample showed the greatest variance when extrapolated for estimations. All of the micro-regions were sampled in excess of the prerequisite 2%. Table 3 summarizes the distribution of the survey sample cells by micro-region.

TABLE 3: DISTRIBUTION OF FIELD SAMPLES BY MICRO-REGION

Region	Delineated	Collected	Field Sample % of Total Area
2	30	13	2.2
3	29	22	4.4
4	35	30	4.4
5	21	8	2.4
6	20	17	4.6
7	49	37	3.9
8	30	30	7.8
9	20	10	4.5
	234	167	4.13 Average

Many of the survey forms collected contain field notes and observations. These range from types of crops under cultivation, land tenancy and ownership agreements, age distributions, point of emigration, to opinions concerning coca production within the Chapare. The field team technical report, attached as Appendix A, provides an example of the qualitative information contained on the survey forms.

5.3 Population

The following population estimates were made by analyzing and extrapolating data for three different surrogate - population relationships. All three estimates have similar tendencies, high variance within their individual estimation ranges and low variance between their central tendencies (statistical means).

5.3.1 Dwelling Units, Persons per Dwelling Unit and Total Cultivated Area

This estimation procedure is a modification to that described in the study's scope of work. Upon review of the sample survey data it became clear that the number of structures in the CSA was a poor surrogate for population estimation. The number of structures was misleading in two respects:

a. The number counted from the 1984 aerial photography was almost half that indicated by the sample survey. This probably was caused by the inaccuracy of counting structures from the aerial photography. In the CSA many structures are obscured or hidden because of dense vegetation cover. This imprecision essentially was confirmed in discussions with members of the field survey team.

b. Field survey data indicated that several structures may of ten comprise one dwelling unit. A common observation was that a separate structure existed for the cooking/-food preparation area, another for the living/sleeping quarters, and perhaps a third for the work area.

After further discussions with field team members and review of the sample survey forms, it was noted that data on the number of Dwelling Units (DU) and Persons per Dwelling Unit (P/DU) was particularly detailed. Field team members consistently expressed a high degree of confidence in these data's accuracy. These two elements (DU and P/DU) were chosen as surrogates. The new surrogates were extrapolated in relation to Total Cultivated Area (TCA) data. This particular surrogate analysis produced a population estimate of 196,336 for the CSA. The results of this method are summarized by micro-region on Table 4.

TABLE 4: CHAPARE POPULATION ESTIMATE BY DWELLING UNIT PER CULTIVATED HECTARE (DU/CH) X PERSONS PER DWELLING UNIT (P/DU) X TOTAL CULTIVATED AREA (TCA)

	DU/CH	P/DU	TCA	Population Estimate
Region 2	.41	6.34	9,603	24,962
Region 3	.21	5.86	26,131	32,157
Region 4	.28	6.79	20,204	38,411
Region 5	.67	5.70	4,185	15,982
Region 6	.34	6.43	11,057	24,173
Region 7	.24	5.60	25,399	34,136
Region 8	.22	5.70	14,515	18,202
Region 9	.28	6.70	4,431	8,313
TOTAL				196,336

Micro-regions 4, 7 and 3 are estimated to have the highest populations (53% of estimated total), while micro-regions 9, 5 and 8 are the lowest (22% of estimated total).

Aggregating the totals for each micro-region provides an estimated total population of 234,786. This estimate is summarized on Table 5. The central tendency between the two estimates is 215,561 for the total CSA population.

TABLE 5: CHAPARE POPULATION ESTIMATE USING AGGREGATED MICRO-REGION MEANS OF DU/CH AND P/DU

Population = TCA $\bar{x}$ $\bar{y}$ where:

$$\bar{x} = \frac{xi}{N}, \text{ where } xi = \frac{Pi}{Dui} \quad i = 1,8 = 6.14$$

$$\bar{y} = \frac{yi}{N}, \text{ where } xi = \frac{Dui}{CHi} \quad i = 1,8 = .331$$

TCA = Total Cultivated Area = 115,528 hectares

therefore,

Population = 115,528 x 6.14 x .331 = 234,786

P/Du = Persons per dwelling unit
Du/Ch = Dwelling units per cultivated hectare

5.3.2 Persons per Hectare

The second relationship analyzed and extrapolated is straight forward: the number of Persons per Hectare (P/H) and Total Area (TA). The resultant population estimate is 204,265 for the entire CSA. The results of this estimation method are presented by micro-region on Table 6. Micro-regions 7, 4 and 2 are estimated to have the highest population totals (54% of estimated total for the CSA). The lowest population levels are estimated in micro-regions 9, 8 and 6 (24% of estimated total).

TABLE 6: PERSONS PER HECTARE BY MICRO-REGION

	Persons per Hectare	Total Area (Hectares)	Estimated Population
Region 2	.5226	60,252	31,488
Region 3	.5133	49,446	25,381
Region 4	.5113	68,779	35,167
Region 5	.6475	32,695	21,170
Region 6	.5675	36,633	20,789
Region 7	.4491	95,764	43,008
Region 8	.4629	38,603	17,869
Region 9	.4267	22,012	9,393
TOTAL		404,184	204,265

Aggregating the totals for each micro-region results in a population estimate of 207,185 for the CSA. Additionally, when the variance between micro-regions is considered an estimate range of 178,528 to 235,841 is derived. The central tendency is 207,185. This estimate is summarized on Table 7.

TABLE 7: CHAPARE POPULATION ESTIMATE RANGE
PERSONS PER HECTARE AGGREGATED MICRO-REGIONS

Mean = .5126 persons per hectare

Standard deviation = .0709

Total Area	Low (.4417)	Median (.5126)	High (.5835)
404,184	178,528	207,185	235,841

Comparison of the resultant estimates indicates similarities at both the micro-region and aggregate levels. Both estimates indicate the highest population levels in micro-regions 4 and 7. These two micro-regions have the largest total land areas. The change of micro-region 3 to 2 as the third highest can be attributed to surrogate selection. Micro-region 3 has a larger TCA,

while micro-region 2 has the largest TA. When comparing the lowest population estimates micro-regions 9 and 8 are indicated by both methods as two of the lowest. Both methods estimate a total population with less than a 5% variance 196,336 - 204,265. The aggregate total of the P/DU x DU x TCA estimate is 234,786, just within the aggregate P/H x TCA estimate range of 178,528 to 235,841. The central tendencies of both estimates stay within a range of 207,000 to 216,000 for total population.

5.3.3 Persons per Cultivated Hectare

The third estimation procedure applied is significantly different from the two previously discussed. Its objective was not a population estimate for the CSA but a proportional relationship or density of cultivated/developed area by micro-region. This information may prove valuable for future planning efforts. It is conceptually more complex in that it reverses the process employed by the previous two methods. Instead of extrapolating from sample cell data to obtain aggregate micro-region estimates, the previous micro-region estimates are reduce to project data for a standard sample cell. The entire process is summarized on Table 8.

a. Total population estimates, as derived from the previous two methods are entered in Column 1 by micro-region.

b. The total area of each micro-region is divided into the population range limits of Column 1. The results are tabulated in Column 2.

c. The total cultivated area for each micro-region of Column 1. The results are tabulated in Column 3.

d. Aggregating Column 3 ranges and multiplying by total cultivated area provides a population projection which has an upper limit of 270,328. This is well beyond any of the previously derived ranges.

TABLE 8: SUMMARY OF CHAPARE MICRO-REGIONS - ESTIMATES FOR TOTAL POPULATION AND POPULATION DENSITIES (PERSONS PER HECTARE - PERSONS PER CULTIVATED HECTARE)

Region	I Total Population	II Persons per Hectare	III Persons per Cultivated Hectare
2	24,962 - 31,488	.4143 - .5226	2.5994 - 3.2790
3	25,331 - 32,157	.5133 - .6503	.9713 - 1.2306
4	35,167 - 38,411	.5113 - .5585	1.7406 - 1.9012
5	15,982 - 21,170	.4888 - .6475	3.819 - 5.0585
6	20,789 - 24,173	.5675 - .6599	1.8801 - 2.1862
7	34,136 - 43,008	.3565 - .4491	1.3440 - 1.6933
8	17,869 - 18,202	.4629 - .4715	1.2311 - 1.2540
9	8,313 - 9,393	.3778 - .4267	1.8761 - 2.1198
TOTAL (1)	196,336 - 204,265	x = .4615 x = .5483	x = 1.9327 -
		x 404184	x 115525
TOTAL (2)	186,531 - 221,614	223,275 - 270,328	
	x = 203,971		

This estimation method has been included in this report despite its high variance because it focuses on several issues that need consideration. The high upper limit for aggregated population estimate is attributable to the high the smallest number of field samples (see Table 3). When designing the field survey samples strategy it was presumed that a 2% sample would be the minimum needed (Hamburg, 1983). The data indicate this is erroneous and that a minimum 3.5 - 4% field sample is the minimum required. Because of this sampling deficiency, population estimates for micro-region 2 and 5 are the least accurate.

The following information is provided by Table 8.

a. Micro-regions 2 and 5 are indicated as the most urbanized, having the highest concentration of people per cultivated/developed area. Villa Tunari, reportedly the largest urban area in the Chapare, is located in micro-region 2.

b. There are approximately two people living in the Chapare for each cultivated hectare.

c. The central tendency of the total estimates contained in Table 3 is approximately 217,000.

Before ending this discussion of methodology, two points need to be emphasized. First, there is an inherent error factor involved due to the nonuniform time frames of the data sources - 1984, 1985 and 1987. This could not be avoided because of the availability and cost constraints previously discussed. Regardless of the methodological suppositions, the effect on the resultant estimates is unknown and should be kept in mind when reviewing the following analysis and results. Second, data was clustered into the CUMAT ecological micro-regions. The micro-regions was the best sub-region strategy available. It was adapted to meet Objective a. - "Stratify the region... to provide a framework for field sampling...." Theoretically, clusters tend to be more homogeneous than the population as a whole, in other words, elements within them tend to exhibit high intra-cluster correlations. The clustering design chosen for this study, ecological micro-regions, is not related to agriculture nor settlement practices. It is likely, but unproven, that the ecologic variables of each micro-region would have a homogenizing effect on its agriculture and settlement. This effect is related directly to the diversity of variables between

micro-regions. Are the micro-regions so ecologically diverse from one another that these practices are altered? At present this aspect is unknown.

6.0 RECOMMENDATIONS

1) A methodological premise was that expansion of cultivated and settled land would have been held to a minimum because of the coca control program implemented in 1986. That is the August 1985 Landsat data was acquired after most new land clearing for the 1985-86 year and hence would represent 1986 agricultural area. Enforcement and coca control that were implemented minimized new land clearing for the 1987 crop year. Agricultural activity would not have significantly changed in terms of land area from August 1985 to July 1987.

This premise may be invalid due to the uncertainty of coca control program effectiveness into mid-1987. New satellite data of the study area should be acquired and processed as close to the field survey time frame as possible. Intergrating 1987 satellite data with the field survey data will provide a much higher degree of accuracy for both land use and population estimates. This can be achieved for less than one half the present study costs.

Both Landsat and SPOT imagery should be considered as future data sources. SPOT imagery would provide a greater resolution than Landsat. However, the primary consideration for data acquisition should be the close correlation between date of imagery and date of field survey.

2) Field survey data obtained for micro-regions 2 and 5 were under-sampled. Both micro-regions exhibit population and settlement characteristics that make them particularly noteworthy. Indications are that they have high urban populations. If these indications are correct, this may have significantly skewed the estimation results.

More field samples should be collected for micro-regions 2 and 5. At least a 4% sample of total area should be obtained. Upon collection the survey data should be integrated with available satellite data.

3) The estimations that have been made do not address the many environmental variables that influence cultivation/settlement decisions. Thus, the estimates' planning value is accordingly limited.

The land use and population estimates should be integrated with existing land capability data. This would create a better understanding of the cultivation/settlement decisions made in the Chapare and provide an invaluable planning tool. Understanding the relationships among population densities, environmental variables and land available for development would allow future programs to focus on those areas of the Chapare that are viable candidates for expansion.

4) It was beyond the scope of the methodology to provide quantitative information regarding point of origin and other demographic data. However, while conducting the field survey, information was collected that provides valuable insight into many demographic issues, particularly, point of origin. This qualitative data has been georeferenced to 1:50,000 scale topographic maps and identified as to micro-region.

All of the field survey forms collected for this study should be reviewed by Chapare development participants. While this demographic data would be difficult to quantify it can provide planners with a strong sense of demographic characteristics of the Chapare.

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APPENDIX A

Field Team Technical Report

APPENDIX A

ESTUDIO ESTRUCTURA DE POBLACION DEL CHAPARE TROPICAL

INFORME TECNICO

A objeto de realizar la encuesta de Estructura Poblacional en el Chapare se conformaron tres equipos de trabajo; cada equipo con su respectiva movilidad, movilidades alquiladas de Renta Car. La constitución de estos grupos de trabajo fué de acuerdo al siguiente detalle:

- Primer Equipo. Dr. Hector Mogrovejo
  Rosario Omonte
  Conductor Edmundo Sanchez
- Segundo equipo. Egr. Alfredo Lima
  Susy Claure
  Conductor Fernando Tejada
- Tercer Equipo. Agr. Aulio Deza
  Remberto Trigo
  Conductor Paulino Peña.
- Como Supervisor, el suscrito Ing. Oscar Omonte M.

Los tres equipos se trasladaron el día 15 de junio/87 a hrs. 13.00 p.m. hacia el chapare tropical, llegando a Villa Tunari a hrs. 19.15 p.m.

Martes 16 jun/87.

La iniciación del trabajo de campo se ha realizado con cierta cautela y pendientes de cualquier reacción contraria de parte de los campesinos en la zona de Chimoré, a la altura de la senda F. En principio, la información recopilada, fué en base a observaciones solamente.

MIERCOLES 17 DE JUNIO

Se continúo el trabajo en la zona de Chimoré. Pero, habiendo establecido, la modalidad de enfoque de la entrevista, por supuesto sin crear suceptibilidad en el campesino, se decidió incursionar incluso a lugares accesibles solamente por sendas; en razón a que necesariamente se tenía que hacer un esfuerzo, tratando en lo posible de abarcar mayor cantidad de muestras en mérito a realizar un trabajo eficiente. Así, como primera experiencia, en la muestra J-11 el primer equipo juntamente con el guía que fué un colono del lugar se extraviaron increiblemente. Luego de una caminata de 25 minutos, perdidos en el monte, lograron ubicar una senda.

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JUEVES 18 DE JUNIO.

Con más confianza, conociendo como evitar la susceptibilidad del campesino, se decidió el traslado del personal hacia Puerto Villarroel; partiendo a hrs 5 a.m. de Villa Tunari.

La zona comprendida entre Chasqui y Puerto Villarroel, es una zona suceptible a inundaciones, considerandola más apto para la explotación ganadera que para la agricultura.

VIERNES 19 DE JUNIO.

En Valle Ivirza, se tiene la primera impresión de que los colonos estaban llegando a lugares tan inaccesibles como es la ubicación de la muestra O-8, que queda saliendo de la colonia Simón Bolivar hacia el Sud-este cerca al rio Sajta. En la muestra mencionada se obtuvo información de que existían más sindicatos hacia adentro.

En la zona se cultiva mayormente coca, en cambio la producción de plátano, papaya y yuca es para consumo familiar. Las partes no son aptas para el cultivo de cítricos, en cambio las partes bajas, son las más apropiadas.

SABADO 20 DE JUNIO.

La muestra N-20 se encuentra ubidada en una zona estratégica, cuya accecibilidad es dificultada por la poca visibilidad de la senda de acceso a la muestra. La superficie de cultivo de coca es mayor que en otras zonas observadas, cuyo promedio es de 6 a 7 Has. por colono. El ingreso hacia la muestra es atravez de una senda dificilmente observable por personas que no son del lugar.

Es en este recorrido, que se tuvo la impresión de que algunos estaban pizando coca a unos 30 metros aproximadamente de la senda; impresión causada por el penetrante olor, por lo que se apresuró el paso para evitar un posible encuentro innecesario.

DOMINGO 21 DE JUNIO.

Con el objeto de dar oportunidad al personal, para la revisión respectiva de las boletas de la semana pasada. Se decidió realizar el trabajo en muestras cercanas a Villa Tunari.

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45

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DE LUNES 22 A DOMINGO 28 DE JUNIO.

En el transcurso de la segunda semana de trabajo ; sin confrontar mayores problemas, como ocasionales precipitaciones fluviales, que no interrumpieron en el trabajo, por el esfuerzo desplegado por el personal. Se continuó normalmente en las zonas de: Colonia El Paraiso, Ibuelo, San Isidro, San Carlos, Santa Fé, Colónia La Estrella, Agrigento y Mariposas. De esta forma se logró completar todas las muestras ubicadas desVilla Tunari hasta Ivirgarzama.

LUNES 29 DE JUNIO.

Con la satisfacción de haber concluido un 55% de las muestras, se decidió incursionar hacía la zona más conflictiva del Chapare, como es Santisima Trinidad e Isinuta.

En esta oportunidad el primer equipo partió a Hrs. 3.30 A.M hacía Sasasama, en cuyo recorrido fué interceptado por efectivos de UMOPAR, quienes en forma grosera y temerariamente violentarón al personal. Luego de arduas explicaciones los dejaron continuar.

En esta fecha se conformarón 4 equipos, a fin de dinamizar el trabajo en el área en cuestión.

MARTES 30 DE JUNIO.

Replegado el primer equipo, de la zona más alejada, se continuó con los 3 equipos originales de trabajo.

Se completó el trabajo en la zona de Colonia Mariscal Sucre dependiente de la Central de Isinuta.

MIERCOLES 1 DE JULIO.

Los tres equipos se encuentran próximos a Eterazama. Este es uno de los centros de acopio de droga.

Algunos campesinos al comentar sobre el control que realizan los efectivos de UMOPAR, mencionan de kilos decomisados a campesinos y también de toneladas "no decomisadas" a narcotraficantes que gozan de cierta influencia.

Al finalizar el día, se nota el agotamiento de todo el personal por el trajín continuo.

JUEVES 2 DE JULIO.

En Eterazama se recogierón interesantes comentarios. Mencionan "Cobertura" que dán los de UMOPAR osea un tiempo determinado que pagan los narcotraficantes a UMOPAR, para que en ese tiempo se realize el acopio ilícito de sulfato base de cocaina, pasado el tiempo de cobertura, en cualquier momento salen en batida, apresando a todo sospechoso, y colonos en posesión de droga e insumos. Pasado el tiempo de cobertura puede ser apresado hasta el mismo narcotraficante por encontrarse fuera de hora.

El precio de la masa húmeda es de Bs 400.- y de masa seca es de Bs 500.- en cambio "base" se cotiza u 700.

Existen también los "piratas" osea sin haber pagado "cobertura" a UMOPAR realizan el acopio de droga; por supuesto que en muchas ocaciones son cogidos con las manos en la masa.

El centro de acopio de droga se encuentra principalmente en el lado nor-este de Eteramazama; a unos 80 metros de la carretera troncal, donde se observa el manejo de polvo y/o masa en bolzas de plástico de los encargados de la recolección sin ningún temor.

VIERNES 3 JULIO.

La falta de una brújula, una vez más se ha hecho sentir, al ubicar la muestra E-5, en cuyo acceso se tuvo dificultades, en razón a que las sendas indicadas en la carta geográfica del IGM difieren de las existentes. Sin embargo luego de prolongadas entrevistas con campesinos del lugar, se ubicó la muestra deseada.

SABADO 4 JULIO.

Se ingresó hacia Puerto San Francisco, con la finalidad de realizar el trabajo en las zonas más representativas y cercanas a la carretera. Puesto que ya no se disponía de mayor tiempo para abarcar muestras alejadas.

DOMINGO 5 JULIO.

Teniendo instrucciones de retorno en el día, se decidió aprovechar el trayecto de regreso, para continuar con el trabajo. Con el objeto de no dejar un vacio en algunas zonas; concluyendo de esta forma el trabajo de campo a hrs 16.oo p.m. Iniciando el retorno a hrs 17.30 p.m. de Cristal Mayo, para llegar a Hrs. 21:15 a la ciudad de Cochabamba.

47

CONCLUCIONES.

- De acuerdo a las muestras observadas, todos los campesinos cultivan coca.

- En algunas zonas, la existencia de otros cultivos es solamente como camuflaje para el cultivo de la coca.

- Con motivo de la reducción de la coca; son los lotes los que tienden mas a reducirse, osea, lotes de 20 has. son divididos entre los hijos, con la finalidad de que no les afecte el control de la reducción de la coca, que impone la existencia de 2 has. solamente para cada lote.

- Toda información obtenida en la presente encuesta es estimada, por ser esta, producto de preguntas directas al campesino y también de observaciones en las proximidades de las viviendas; Sin embargo cultivos que se encuentran en medio de los lotes y por lo tanto no observables, probablemente en algunos casos se han obviado.

- De una forma general, a todo el personal, se ha exigido un trabajo esforzado, incluso en dias lluviosos y a lugares poco accecibles, mediante caminatas de hasta 14 km por día. Sin embargo merecen especial mención Dr Hector Mogrovejo, Alfredo Lima y Rosario Omonte por el esfuerzo realizado y también por la voluntad demostrada en el trabajo.

Ing. Oscar Omonte M.
SUPERVISOR DE ENCUESTA