12-1970

A Utilization of Topographic Maps to Verify Selected Aspects of Pre-Collected Data Accuracy

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A UTILIZATION OF TOPOGRAPHIC MAPS TO VERIFY SELECTED ASPECTS OF PRE-COLLECTED DATA ACCURACY

by

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A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan
December 1970

ACKNOWLEDGEMENTS

The author now joins the ranks of those graduate students who have become indebted to the professional guidance and stimulation received from a Graduate Advisor. I wish to express my sincere appreciation to Dr. Oscar H. Horst for his ever-present concern with my progress as a graduate student and, specifically, for the constructive recommendations directed toward this paper. Dr. David G. Dickason is also to be recognized for his assistance in the writing of those statistically oriented portions of this paper. His supervision produced a clarity of thought otherwise unattainable by the author. This paper's technical format and final typing are the results of efforts undertaken by Mrs. Connie L. Applegate, who is to be acknowledged for this service.

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INTRODUCTION

It is essential to a more complete understanding of this thesis that the "Introduction" be expanded beyond the traditional bounds of describing the motives (background and scope) of the study. Therefore, included is a brief discussion of the assumptions underlying the writing of this paper. Consideration of these is most important, for the reader must be in rather complete agreement with these suppositions before benefit can be derived from the text that follows. The author submits full responsibility for the nature of these assumptions and stands prepared to accept any conclusive evidence contrary to his beliefs. These assumptions are that:

(1) studies of "macro" areal proportions are becoming increasingly important in the field of Geography as a result of the growing interest in developing a "unified theoretical structure"[1] for the many facets of the discipline. There currently exists a trend away from the

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[1]Robert B. McNee, "The Changing Relationship of Economics and Economic Geography," in Introduction to Geography: Selected Readings, ed. by Fred Dohrs and Lawrence Sommers (New York: Thomas Y. Crowell Company, 1967), p. 312.

traditional "classificatory" approach used by some geographers--this being replaced by a "classificatory-theoretical"[2] approach that minimizes the unique and emphasizes those general conditions that appear in various places around the world. Resultingly, large-scale systematic studies will become the effective means of rendering these desired theories.

(2) sources of secondary data[3] are continuing to gain importance as these theoretical structures are sought and developed. That is, the geographer who attempts to "broadly conceive and balance"[4] his discipline by approaching given phenomena from a macro-systematic viewpoint must rationally forego any attempt to

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[2]William Bunge, "Theoretical Geography," in Introduction to Geography: Selected Readings, ed. by Fred Dohrs and Lawrence Sommers (New York: Thomas Y. Crowell Company, 1967), p. 356.

[3]Henceforth, secondary data are ". . . information collected by some agency other than the firm [or person] desiring the information and secured from that agency by purchase or otherwise . . . data that have already been published, whether printed, mimeographed, or reproduced in some other manner," from Howard L. Balsey, Introduction of Statistical Method (Totowa, New Jersey: Littlefield, Adams & Co., 1964), pp. 17-19.

[4]McNee, "Relationship of Economics," p. 312.

personally collect great masses of primary data[5] and, instead, must become quite dependent upon information gathered by organizations which have the means and funds to properly survey existing conditions. The author is by no means inferring that geographers are to cease the collection of data in the field; any statement of this nature would be academically naive. It is only implied that pre-collected sources of data are becoming increasingly important as a supplement to data personally gathered by the researcher.

(3) adequate concern and attention are frequently not given to the verification of the absolute accuracy of supplementary data, particularly that originating in the developing world. Traditional verification of statistical data has consisted of reviewing the data-accumulation technique or of substantiating the method used in sampling the entire population of a given phenomenon. To date, validation of

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[5]Defined as ". . . data secured by one's own efforts for one's own purposes. Primary data will consist of the first collection of information and usually also the first publication of the collected information." Balsey, Statistical Method, pp. 17-19.

pre-collected data has been limited to checks on the procedural aspects of the data-collecting techniques. The fact remains that data can be utilized with assurance only when both absolute and procedural verifications have been appraised.

The last of these assumptions is especially critical to the writing of this thesis. Regarding this concern for proper verification of statistical data, the author places special emphasis upon data coming from the developing world, for data accuracy tends to be directly proportional to the level of development attained by the country in which the data were collected.[6] The gathering of reliable mass data is a highly sophisticated process that requires tremendous amounts of time, energy, financial backing, and technical ability. It is, likewise, a process that partially reflects the very character of national conditions, in that political harmony, economic stability, and a concern for the proper

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[6]It is recognized that certain developing countries which have, at one time or another, been under the dominant control of a more highly developed country (such as British influence in India) cannot be included within the confines of this statement. The author also wishes to establish the fact that most inferences made in this paper pertain directly to the Latin American sector of the developing world.

administration of internal affairs are all necessary conditions for the successful compilation of data. Most developing countries of the world are lacking in certain aspects of these elements. Thus, the validity of data collected in these areas needs to be viewed in a precautionary manner, even though proper data-collecting procedures have often been made available by the more advanced nations. In terms of the above required conditions, it is conceivable that much of the developing world's data may fall outside an accepted range of error and is not truly representative of existing conditions and trends.

If the possibility exists that developing nations tend to accumulate and publish less accurate statistical materials (at least relative to developed nations) then it must be recognized that the researcher who proposes to conduct research within these nations must place special emphasis upon verifying the reliability of data before initiating a proposed study. But upon what premise is a decision made as to whether or not available data are worthy of incorporation into a research effort? To date, the only means of determining reliability is to enter the area of study and to verify, through rough sampling, selected figures included within the available data. However, limited accessibility,

prohibitive financial costs, or unreasonable amounts of time and energy are all factors that may tend to discourage one from actually carrying through with this most important aspect of data verification. It is submitted that these limitations are dominant reasons why checks on absolute accuracy of data are discouragingly infrequent. What is needed are techniques whereby this type of accuracy can be more easily verified and which can function in conjunction with the more traditional procedural checks on data.

The subject matter of this thesis is concerned with the development of a technique that utilizes topographic maps to verify this absolute factor of data accuracy. The procedures involved in this technique are constructed such that the verification process can be accomplished within the confines of one's own office and can be attained within a relatively short period of time. As a substitute for field verification, this technique may permit the researcher to better evaluate the absolute accuracy of certain data types and, thereby, enhance the validity of a study being largely derived from pre-collected sources.

The topographic map has great potential in this area of data verification because of its precise nature and because of the array of information contained.

These maps are increasingly available due to the activities of various geodetic services which have successfully extended medium- and large-scale map coverage to those areas of the world where information has previously been scant or completely lacking. Accompanying this increase in areal coverage has been a simultaneous refinement in the process of constructing topographic maps. As compared to the outdated procedure whereby surveying teams empirically checked various elements of an area's landscape, today's maps are symbolized reproductions of aerial photographs. Air photos are taken at a sufficiently low altitude to insure the inclusion of a wide range of physical and cultural features. These are then utilized to accurately establish the location, quantity, and quality of surficial features on topographic maps. Included within these maps is information on road and railroad characteristics, features related to communications, precise elevations, vegetation types, land surface slope, and toponyms of both cultural and physical derivation.

Another information type that may exist within a topographic map is the location of political and administrative lines of demarcation.[7] Such features are a

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[7] This type of information is not always available (as in the case of southwestern Guatemala).

primary means of verifying numerical data and, as such, will be emphasized in this paper. These delineations lend themselves to this task since statistical data are normally collected by political units.[8] All data have traditionally been collected on the basis of either local units, such as villages, hamlets, cities, townships, or Standard Metropolitan Statistical Areas (S.M.S.A.); or by national units, such as states or departments. Regardless of political administrative titles, all statistical enumeration units are defined by established boundaries that can be located on a topographic map.

Since all data are areally defined by some definite boundary, it is essential that two conditions be present if data are to be accurately collected. First, the boundary of the enumeration unit must be properly drawn and, secondly, the data collector must be aware of this location and constantly adhere to it when accumulating the data information. Regardless of either the accumulation technique or method of sampling (collection procedures), data must be considered

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[8]The relationship between data enumeration units and political boundaries is discussed in, Preston E. James and Clarence F. Jones, American Geography: Inventory and Prospect (Syracuse: Syracuse University Press, 1954), p. 107.

acceptable only when this adherence to unit boundaries can be verified. Verification of this adherence serves to enhance the character of any data considered. Problems related to the spatial distribution of phenomenon, to enumeration unit boundaries, and the resolution of these problems through the application of various techniques related to topographic maps, are the substance of this paper.

Thus, the interrelatedness of those components used in this study--the collection of numerical data, political boundaries that function to delimit enumeration units, and topographic maps--becomes evident. The data collected within any enumeration unit and the subsequent distribution of phenomena are only as accurate as the location of those political boundaries that delimit such areas. Topographic maps may function to indicate whether these boundaries are, in reality, properly conceived by the data collector and, subsequently, may serve to verify secondary data gathered on the basis of such boundaries.

CHAPTER I

THE SOUTHWESTERN GUATEMALAN HIGHLANDS: A HISTORICAL PERSPECTIVE

When considering the nature of political boundaries in various parts of the world, it becomes apparent that a wide range of circumstances exists regarding their orderly location. Within the United States, for example, the adoption of a cadastral land survey system in various parts of the country has resulted in a precise location of administrative boundaries. The impact of this orderliness is reflected directly in the accurate location of political boundaries on topographic maps and indirectly in the accumulation of statistical data. Since transport routes are often patterned upon this system, they serve to delimit local political units (specifically, the township and county) and are readily identifiable on aerial photographs; consequently, the establishment of political boundaries on maps is greatly facilitated. In addition, a boundary system of this type allows the collector of statistical data to properly adhere to enumeration unit limits when collecting material. This logically permits the scientist who utilizes this information to infer, within reasonable limits, the absolute accuracy of the

data gathered within these boundaries. If other standards for acceptable data are met (procedural standards), the researcher may generally use these source materials with confidence.

In contrast to the United States are numerous countries, mostly located within the developing world, which have not experienced any orderly system of delimiting internal boundaries. Such nations have historically failed to incorporate any semblance of regularity in defining political units and have been content to delimit these units by elements such as stream courses, mountain ridges, or features of the landscape sometimes vaguely defined. Administrative boundaries of enumeration units may not only be obscure but also extremely sinuous, and political entities may be grotesquely shaped and differ significantly in size. Tactics directed toward data accumulation are most assuredly frustrated under these haphazard conditions. The absence of well-defined demarcation lines inhibits accumulation and also tends to produce some doubt as to the absolute accuracy of compiled materials. It is within this perspective that the technique for verifying or discrediting mass data by the analysis of unit boundaries meets its greatest challenge.

To exemplify conditions within the developing world,

a portion of the Central American country of Guatemala was selected as the setting in which to demonstrate procedures by which enumeration unit boundary locations can be verified. Chosen were thirty-six contiguous municipios[1] located in a portion of the southwestern highlands of the country (see Fig. 1 for the location of the study area, and Fig. 2 for title and location of each municipio within the study area). Quezaltenango, the second largest city in Guatemala, serves as a point of reference in locating the area of study. From this urban center, and also from the municipio of the same name, the remaining municipios extend in a fan-shape manner to the west, north, and east. Directly south of Quezaltenango is located a chain of volcanoes that serves not only as the southern boundary of the study area but also as the delimiting edge of the entire highland region. The western portion of the study area is marked by the municipios of San Marcos and San Rafael Pié de la Cuesta (Fig. 2, units #32 and #31, respectively), each located approximately thirty-five kilometers from the Guatemalan-Mexican border. The

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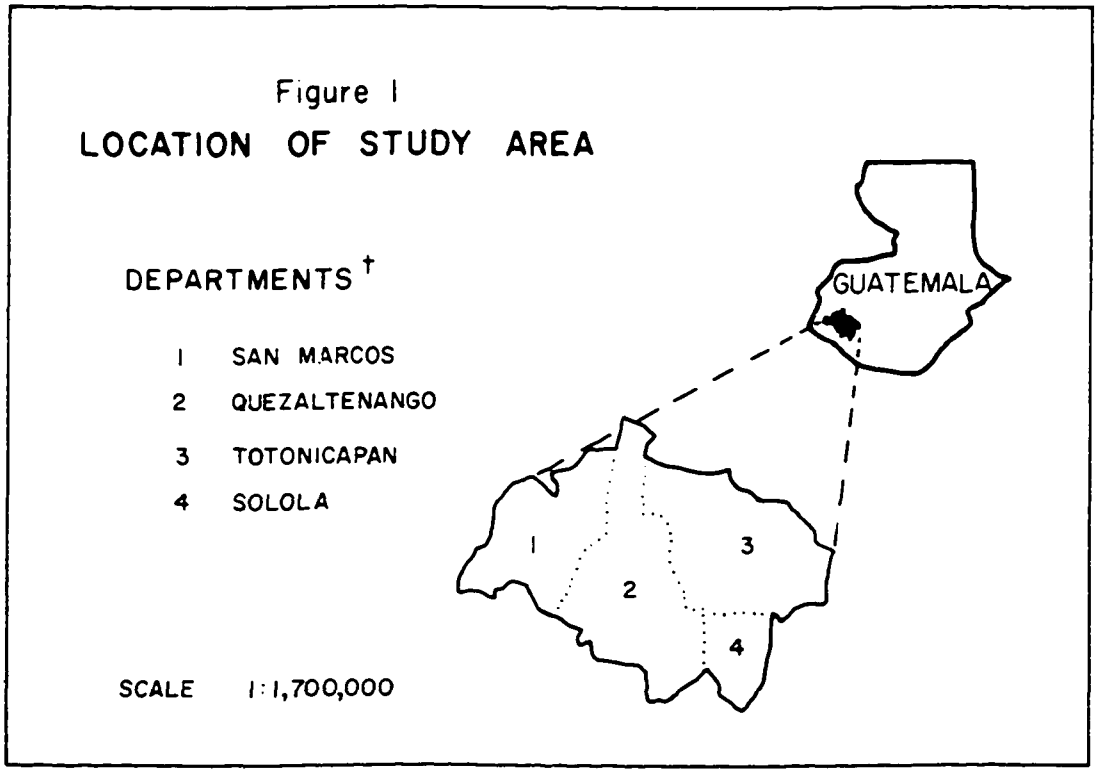
[1]A municipio is a Guatemalan political unit containing a cabecera (principal village or town with locally oriented political authority) and a number of outlying aldeas (smaller villages) or rural settlements.

Figure 1

LOCATION OF STUDY AREA



† The depicted boundaries are derived from official Guatemalan sources.

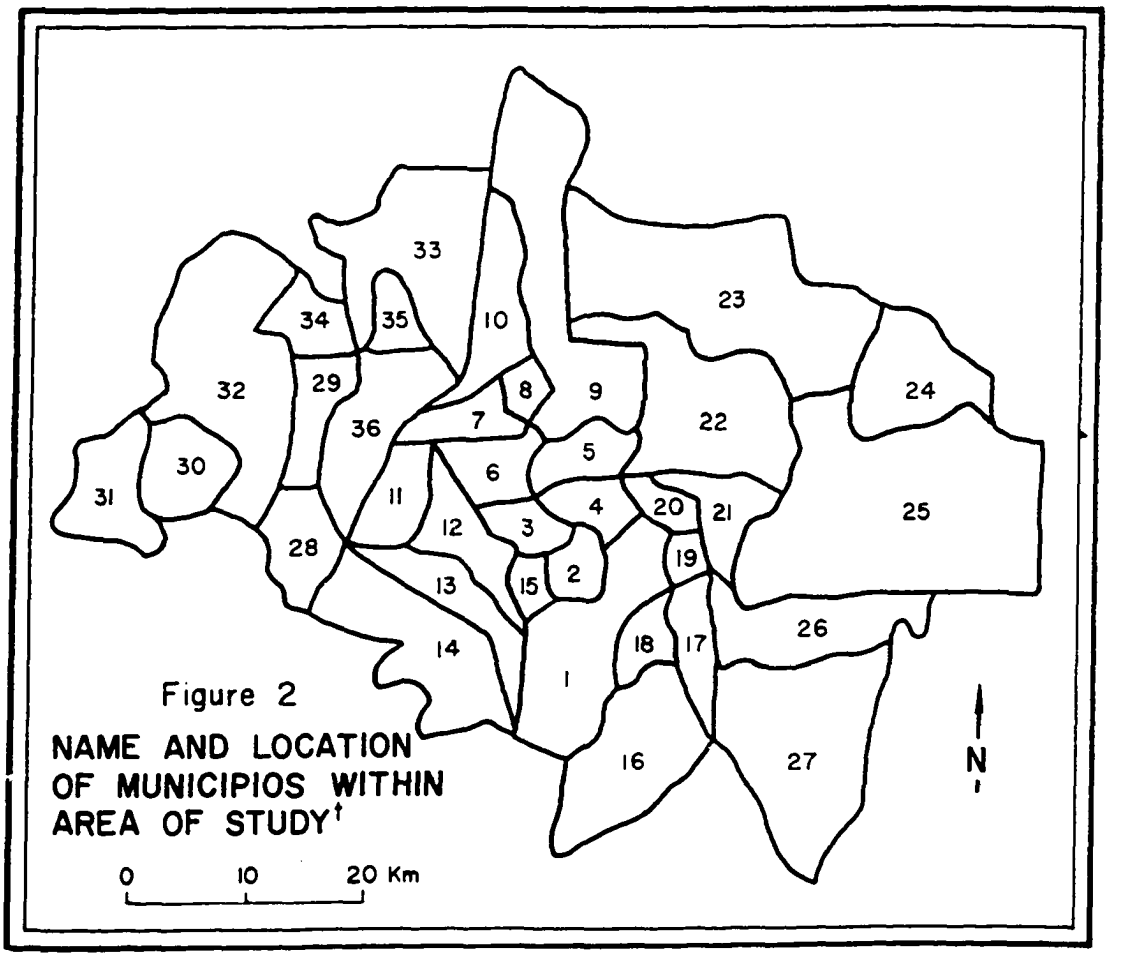


Figure 2

NAME AND LOCATION OF MUNICIPIOS WITHIN AREA OF STUDY†

1. Quezaltenango
2. La Esperanza
3. San Miguel Siguilá
4. Olintepeque
5. San Francisco la Unión
6. Cajolá
7. Sibilia
8. Huitán
9. San Carlos Sija
10. Rio Blanco
11. Palestina de los Altos
12. Ostuncalco
13. Concepcion Chiquirichapa
14. San Martín Sacatepéquez
15. San Mateo
16. Zunil
17. Cantél
18. Almolonga
19. Salcajá
20. San Andres Xécul
21. San Cristobal Totonicapán
22. San Francisco el Alto
23. Momostenango
24. Santa María Chiquimula
25. Totonicapán
26. Nahualá
27. Santa Catarina Ixtahuacán
28. San Cristóbal Cucho
29. San Pedro Sacatepéquez
30. Esquipulas Palo Gordo
31. San Rafael Pié de la Cuesta
32. San Marcos
33. Cabricán
34. Comitancillo
35. San Lorenzo
36. San António Sacatepéquez

†Boundaries derived from Direccion General de Estadistica.

municipios of Cabricán, San Carlos Sija, and Momostenango (Fig. 2, units #33, #9, and #23, respectively) delimit the northern boundary of the area and are located nearly twenty-eight kilometers from Quezaltenango. The eastern portion of the area terminates with the municipio of Nahualá (Fig. 2, unit #26), situated proximally to Lake Atitlán. The entire area measures slightly over 2,500 square kilometers and is located within a predominantly Indian setting, quite isolated from other regions of Guatemala.[2]

The viewpoint that special attention should be directed toward the problem of boundary delimitation in southwestern Guatemala may be strengthened if consideration is given to selected components of the country's national character and to various conditions prevailing within the area of study. An attempt is made here to causally relate these conditions to the process of locating internal administrative boundaries. This discussion should be placed within the context of all Latin

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[2]The required topographic maps of this area were obtained from the Instituto Geográfico Nacional in Guatemala. These sheets were compiled in 1964 (although air photos were taken in 1954) and constructed on the scale of 1:50,000. The following maps were utilized (listed by name and reference code): Tajumulco (1861 III); Comitancillo (1861 II); Momostenango (1961 III); San Marcos (1860 IV); Quezaltenango (1860 I); Totonicapán (1960 IV); Coatepeque (1860 III); Colomba (1860 II); and Santa Catarina Ixtahuacán (1960 III).

America, for it is suspected that Guatemala is not unique in this respect.

National Factors of Influence

To the many conquistadores, settlement of Guatemala and other areas of the New World was defined in terms of economic exploitation. The nature of the monarchy of Spain demanded that the rapid accumulation of wealth be the primary concern of those who entered this newly found land. As a result, irrational utilization of both natural and human resources became widespread. The early Spaniards were primarily concerned with those areas that contained valuable minerals and/or large populations to serve as sources of labor and tribute.

The consequences of this early colonial attitude were far reaching and had a tremendous impact upon later socio-cultural growth within Guatemala. Of primary significance to the theme of this paper is the fact that a well-ordered land tenure system was prohibited from developing. In their haste to acquire wealth, the Spaniards failed to establish a political system that adequately encompassed the needs of the New World people. A semi-feudalistic system emerged in which Indian rights were basically forfeited, and through which local

exploitation of these people was accomplished. Tremendous tracts of vaguely-defined land (including Indian villages) were allocated to select military personnel, to ecclesiastical orders, and to persons of aristocratic means. A landed elite emerged which held little regard for the ancestral property rights of local inhabitants.

Central authorities neglected their responsibilities to the indigenous Indians and readily permitted individual landowners to procure and control as much land as possible. Landholdings were frequently large enough to include portions of several adjacent municipios. Land was not taxed by these authorities and precise data on each holding were not required. Thus, it is understandable that boundaries of many properties and political units are currently ill-defined or only vaguely represented on existing topographic maps.

Directly related to this lack of attention to the delimitation of private and public land units is the influence exerted by a "frontier" in the historical development of a country. Within the United States, for example, as population densities increased along the eastern seaboard there occurred a simultaneous decrease in the productivity of land. People then turned to the free lands that lay west of the Appalachian Mountains in hopes of bettering their economic position in life. The

contemporary national leaders possessed sufficient foresight to realize that problems of land tenure would arise if vast numbers of people entered these available western lands without proper land titles to well-defined tracts of land. Surveying teams were sent into the area with instructions to develop the land tenure system noted previously. The township and range system was chosen and often developed on the basis of mile-square sections that were later delimited by easily recognized roadways. Had this decision by the federal government not been forthcoming, it may reasonably be assumed that the existing orderliness of our tenure system would never have materialized.

Within Guatemala there never existed a frontier to beckon the pioneer, for the early Spaniards, in their search for quick wealth, sought, explored, and quickly appropriated for themselves those areas of the country that gave promise of merit. Within a relatively short period after discovery in 1524, all of Guatemala's land resources were controlled by this group of individuals. Settlers did not consist of enterprising, small, private landholders, but rather of non-productive landowners who amassed great expanses of land for purposes of social and political prestige. It was impossible for adherable boundaries to develop under the extensive land use/land

tenure system that developed.

It would be misleading to generalize that the accuracy of location of internal administrative boundaries is directly related to the level of political and economic development attained by a particular country; yet, somewhat paradoxically, the unstable political and economic conditions that have prevailed within Guatemala must assume a significant role when analysing the character of political boundaries within the country.

From its inception as an independent political state in 1825, most Guatemalan governments have been occupied with various full-time administrative tasks that far exceed the importance of pursuing such services as precisely surveying and locating internal political and enumeration unit boundaries. The poorly directed political factions in power from 1885 to 1920 were forced to totally concern themselves with continuous revolts, assassinations, military juntas, and general disorder. Not until 1946 and 1952, with the respective rise to power of Juan José Arévelo and Jacobo Arbenz Guzman, did a type of social reform develop within Guatemala that might have been concerned with the ajudication of problems of land tenure (and indirectly with the adequate delimitation of properties). Until recently, indoctrined lack of peace and order among

various political groups has been detrimental to the lower priority activity of properly delimiting political unit boundaries.

Political instability has not been the only impediment to the proper delimitation of land units. Of equal significance are economic constraints which prohibit the Guatemalan government from accumulating adequate national wealth. An uncertain export economy, complemented by widespread subsistence agriculture, is hardly conducive to generating the funds required for an adequate land survey.

Another dimension concerns the socio-political framework of the economy. Notwithstanding the difficulty of acquiring national wealth, it must be assumed that limited funds could be made available for such projects as a land cadastral survey. However, political affiliations at various governmental levels with those groups opposed to such a survey (i.e., the large landowner) have made efforts along this line impossible in the past.

Local Factors of Influence

The most direct influence in choosing the specific area of study was the realization that errors had been committed on the part of Guatemalan personnel when

mapping the boundary for the Ostuncalco municipio (Fig. 2, unit #12), located within the study area approximately twelve kilometers west of Quezaltenango. In 1962, field checks of this municipio's boundary location prompted construction of a demarcation line that differed markedly from an officially recognized map.[3] Comparison of these boundary lines in Fig. 3 indicates discrepancies in both area and location. It is not known definitely whether all census data have been collected for the Ostuncalco enumeration unit on the basis of this officially recognized boundary; regardless, it is apparent that this particular boundary location, as conceived by the national government, is inaccurately mapped.[4]

Another direct insight into the boundary situation in the southwestern highlands may be drawn from the fact that topographic maps available for this area contain little information regarding the limits of municipios

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[3]Oscar H. Horst, "The Specter of Death in a Guatemalan Highland Community," The Geographic Review, LVII (October, 1967), p. 151. The "officially" recognized map referred to here has been taken from a small-scale map of Guatemala, constructed by the Dirección General de Estadística.

[4]The individual census map for this unit made available by the Dirección General de Estadística is much more similar to the boundary constructed by field work, implying that data, at least in the 1964 census, were possibly being properly collected within this specific unit.

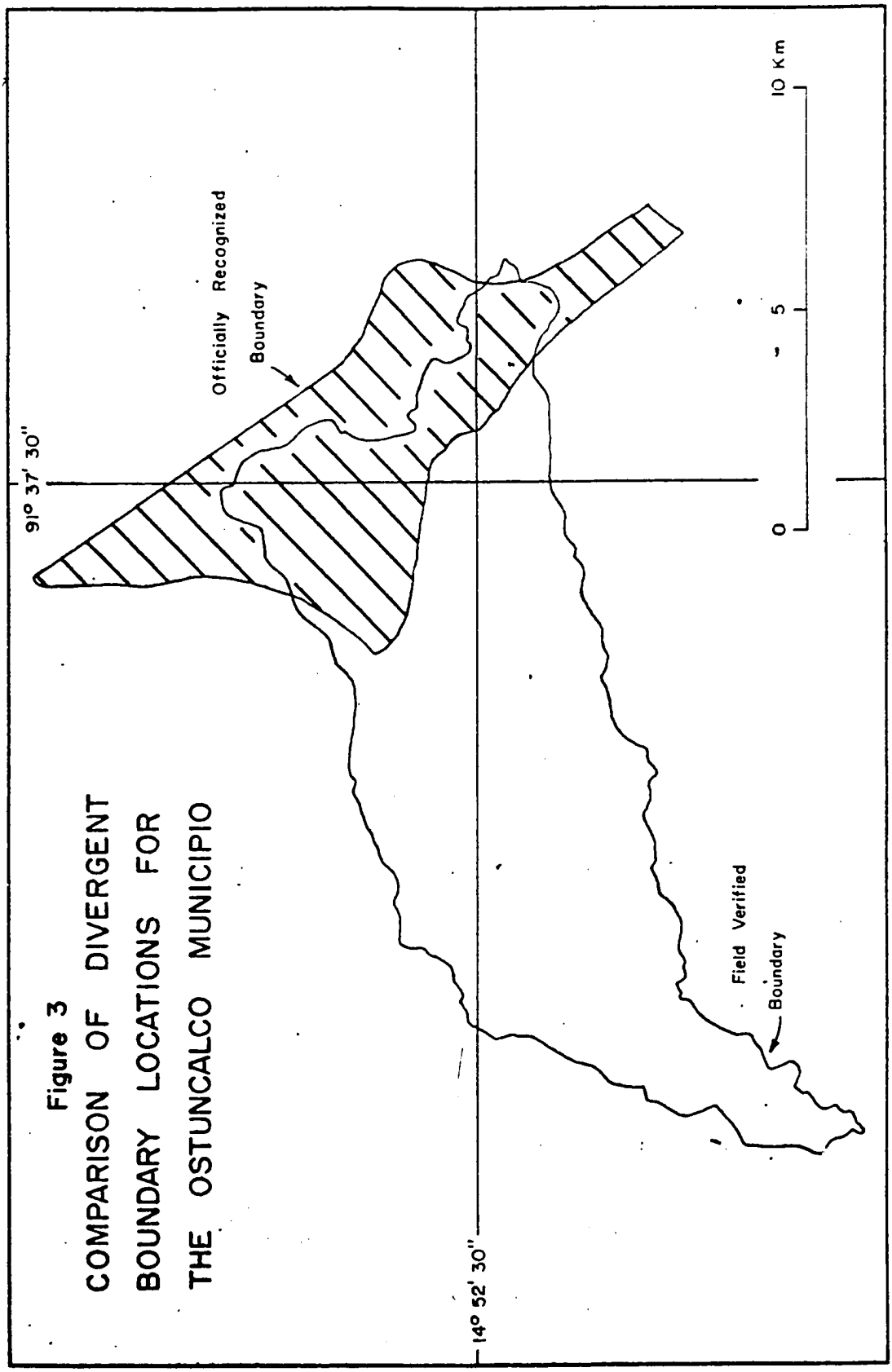

Figure 3
COMPARISON OF DIVERGENT BOUNDARY LOCATIONS FOR THE OSTUNCALCO MUNICIPIO

located there. It may be inferred that boundary line locations are sufficiently vague in the highlands to preclude their incorporation on topographic maps.[5]

The failure to convey these demarcation lines appears to result from a complex array of features which, within a relatively small area, produce a highly inaccessible landscape. Steep ridges, sharp divides, and deeply entrenched canyons cut from the easily eroded volcanic ash produce a landscape that greatly increases travelling distance and renders east-west movement extremely difficult.[6] These physical conditions detract from precisely locating political unit boundaries, both on the ground and on topographic maps.

Regarding the Spanish purpose for settlement, it is understandable that a relatively small degree of concern was directed toward remote highland areas on the part of the conquistadores. Following traditional procedure, the region was royally bequeathed to select landowners, but physical conditions were such that

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[5]This is in contrast to coastal areas south of the study area, where rather complete information does exist regarding the limits of political units.

[6]Felix W. McBryde, Cultural and Historical Geography of Southwest Guatemala (Washington, D. C.: U. S. Government Printing Office, 1945), p. 16.

Spanish interest remained quite marginal. Factors of inaccessibility and restricted areas of highly productive land dissuaded the Spaniard from firmly implanting his mark upon the southwestern upland area. Robert Naylor alludes to this point when he states that ". . . the rugged terrain . . . left the Indians regionally isolated, [and] concentrated in the colder altitudes on marginal lands that were beyond the mainstream of Spanish settlement and interest."[7] The Spaniards tended to limit their occupation to upland basins where wheat production was found to be profitable; the remaining areas were willingly left to the Indian and his traditionally communal way of life. Other than the tribute extracted from the local inhabitants, there was little inducement on the part of private landlords to encroach upon most of the Indian lands. This lack of intervention obviated the construction of municipio limits in large sectors of the highland landscape.

A peculiarity of cultural dimensions, emerging after the start of this century, has apparently existed in the highland region which must necessarily add to the confusion of municipio boundary locations. In the

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[7]Robert A. Naylor, "Guatemala: Indian Attitudes Toward Land Tenure," Journal of Inter-American Studies, IX (October, 1967), p. 625.

past, various national regimes have somewhat haphazardly created new municipios at the expense of portions of older units, or have annexed individual municipios to adjacent units. Significantly, these newly created units have not always persisted in a permanent form but have been periodically dissolved and re-established as independent units. In certain instances, the areal extent of selected municipios cannot be determined because of this historical shifting of areas from one unit to another. One sixth of the municipios located within the study area have, at one time or another, been affected by this situation. The circumstances pertaining to these specific units are listed below.[8]

Esquipulas Palo Gordo (Fig. 2, unit #30):

> By government disposition of March 5, 1936, the municipio was annexed to San Marcos and was re-established as an independent unit on March 29, 1948.

Momostenango (Fig. 2, unit #23):

> Since the municipio of San Bartolo was annexed to Momostenango by government dispostion on September 19, 1935 and then re-established on January 9, 1951, the territorial extension cannot be indicated . . . .

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[8]Francis Gall, Diccionario Geográfico de Guatemala, (Guatemala: Dirección General de Cartográfia, 1961), Tomos I y II.

Rio Blanco (Fig. 2, unit #10):

Being annexed to the municipio of San António Sacatepéquez, Department of San Marcos, and upon applying the Sixth General Population Census of 1950, the approximate extension cannot be determined. The municipio was annexed on March 5, 1936 to San António Sacatepéquez, Department of San Marcos, and re-established by government disposition on March 14, 1951.

San Lorenzo (Fig. 2, unit #35):

Being annexed to the municipio of San Marcos, upon applying the Sixth General Population Census of 1950 the extension cannot be indicated. The municipio of San Lorenzo was created by soliciture of neighbors on November 27, 1813 and installed in 1814. Abolished by government disposition on March 5, 1936 and annexed to San Marcos, it was re-established on October 10, 1951.

San Marcos (Fig. 2, unit #32):

On February 9, 1942 the municipios of San Marcos and San Pedro Sacatepéquez were fused to form a new municipio called San Marcos la Unión, whose municipio cabecera would be the city of La Unión. This disposition was left without effect July 20, 1945, upon re-establishing the municipio.

Santa Maria Chiquimula (Fig. 2, unit #24):

The municipio was created by government disposition on August 12, 1872. The disposition of September 19, 1935 annexed Santa Maria Chiquimula to the municipio of Santa Lucia La Reforma, government disposition left without effect June 25, 1936.

A final explanation for the lack of adequately defined boundary locations within the study area is related to a local facet of the pattern of land tenure. Extremely small, irregularly shaped landholdings constitute all agricultural units in the highland area except in the larger basins controlled by powerful landowners. A

project directed toward the delimitation of boundaries in this upland region would necessarily reckon with the cost of providing titles to these numerous minifundia. Exorbitant court fees, arising from disputed titles to these individual holdings, would require financial resources far in excess of those potentially available, and, consequently, detracts from any interest toward the determination of local boundary locations. Indeed, if national authorities were to undertake a project of specifying the location of political unit boundaries (which must include the designation of private holdings), the highland area would rank low on the list of regions to be initially surveyed.

Conclusions

An implicit condition emerges from these statements that may directly relate to the absence of well-defined boundaries within this highland region, this being a traditional lack of national interest in civic affairs pertaining to most inhabitants of the southwestern highland region. This is equally pertinent whether it relates to accurately defining boundaries or to other acts of service. National authorities may lack interest for economic reasons; local authorities, of whom many are landowners, may prefer to maintain the status quo.

Thus completes a brief description of those factors, both national and local, which may explain conditions related to administrative boundary locations and enumeration units in the highland country of Guatemala. Recognition of a major mapping error in the Ostuncalco municipio; colonial and present day deterrents to the development of an integrated society; a lack of national, political, and economic security; physical and historical circumstances within the highland region itself; and a significant lack of interest in administering proper internal services are a few of the suggested factors that tend to explain the absence of political boundary lines on topographic sheets covering the highland area.

Chapter II deals with the central theme of this thesis--the description of a procedure that may be used to properly locate municipio boundaries where they are missing or believed to be in error.

CHAPTER II

APPLICATION OF THE BOUNDARY-LOCATING TECHNIQUE

A consistent property of numerical data is that they are representations of phenomena as they exist within a well-defined and pre-established areal unit. Depending upon the service required of data, the areal unit may be of utmost importance. If degrees of concentration (i.e., density or intensity) of phenomena are sought, the precise area of these units becomes critical to a meaningful interpretation of the data. Furthermore, the spatial limits of selected elements can be accurately determined only on the basis of those units used in the data collecting process.

A brief review of numerical data readily reflects this near axiomatic significance of enumeration units. Individual data figures provide, in their published form, information concerning a specific topic or phenomenon. But in aggregate form these same data exhibit spatial overtones and furnish information pertaining to those units that contain the data-related phenomenon.

Due to the importance of this numerical data/enumeration unit relationship, organizations throughout the world use consistent procedures for gathering and

presenting data. These data are most commonly listed within the context of a hierarchy of political units, each unit being legally defined and possessing definite boundaries. This use of a political unit hierarchy as a means of categorizing data provides a convenient system for locating the agglomeration of chosen phenomena.

Thus, theoretically defining each level of this hierarchy as:

n = the first order, consisting of toponyms of cultural and physical features of the landscape

N = the second order, in which a given number of (n) factors are located

N' = the third order, in which a given number of (N) factors are located

etc.,

it is easily concluded that $(n_1 + n_2 + \cdots n_n) = N$, that $(N_1 + N_2 + \cdots N_n) = N'$, that $(N'_1 + N'_2 + \cdots N'_n) = N''$, etc. If a sufficient number of levels were incorporated into any given mass of data, it would eventually be possible to derive the total quantity of any phenomena for the highest level in the hierarchy, that being the surface of the earth.

Successful completion of the boundary-locating technique presented here is dependent upon the accumulation of various source materials that utilize a data presentation method somewhat similar to that described above.

Specifically, what is needed is a type of reference that contains the first order of this hierarchy; this is fundamental to the success of the technique. Such references to urban places and physical features form the means by which the boundaries considered in this paper are to be best approximated.

The author was able to obtain a number of the required source types which pertain to the country of Guatemala. The source most heavily relied upon was authored by Francis Gall.[1] In this publication, Gall chooses a system of cross-classification in which each of Guatemala's municipios (the second order unit for this study) is listed alphabetically and discussed in terms of internally located toponyms (first order units). All toponyms are also listed and described independently in the dictionary. By utilizing this reference, it is possible to determine all significant toponyms within any municipio and to also ascertain the municipio within which any selected toponym is located. An example of the type of information provided by Gall may be seen in Fig. 4. Using Gall's work and supplementary information gained from other sources[2] it was possible to determine

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[1]Gall, Diccionario Geográfico de Guatemala.

[2]Mateo Morales Urrútia, La División Política y Administrativa de la República de Guatemala (Guatemala:

Figure 4

Example of Information Contained within the Diccionario Geográfico de Guatemala

EL RODEO, municipio del departamento de San Marcos; municipalidad de 3ª categoria. Extensión aprox.: 81 km^2.

Colinda al Norte con San Pablo; al Este con San Rafael Pie de la Cuesta y El Tumbador, así como con Pajapita; al Oeste con Catarina y Malacatán (todos del mismo departamento).

El banco de marca establecido por la D. G. de C. en el parque de la cabecera, está a 700.10 mts. SNM. Latitud 14°54'50", longitud 91°58'33".

Sobre la Ruta Nacional No. 1 que de la capital conduce a Talismán, en la frontera con México, El Rodeo está aprox. a 8 km. de la cab. mun., San Pablo y aprox. 9 km. a San Rafael Pie de la Cuesta. Por la Ruta Deptal. 5, de El Rodeo hay aprox. 9 km. a la unión de los ríos La Puerta, Ixcaná y Cabuz, donde se une a la Ruta Nacional 8, que a su vez entronca con la Nacional No. 1, aprox. 1 km. al Este de Malacatán. Por la Ruta Nacional No. 13, llamada también Justo Rufino Barrios, de El Rodeo a El Tumbador, hay aprox. 17 km. El municipio cuenta con una red de carreteras municipales y vecinales, que unen a la cabecera con sus poblados y valiosas fincas de café.

El municipio es esencialmente agrícola, dedicándose la mayoría de sus habitantes al cultivo del café y, en menor escala, al de caña de azúcar.

La lengua indígena predominante es la Mam.

La fiesta titular, San José, se celebra del 14 al 20 de marzo.

Según los datos del Censo General de Población de 1950, el municipio tenia un total de 6,211 habitantes (2,899 ladinos y 3,312 indígenas), correspondiendo a la cabecera 519 y el resto al área rural.

Nombre antiguo del municipio: San José El Rodeo. Su Nombre geográfico normalizado, es El Rodeo.

El municipio cuenta con 1 pueblo, 5 aldeas y 3 caseríos.

EL RODEO, aldea del mun. Morazán, Pro. 396 hab. con los caseríos

Agua Blanca	El Piñal
Bramaderos	La Toma
Guapinol	Achiotes

all significant place name locations within the entire study area.

As evidenced from Fig. 4, the place names associated with each municipio (in this instance, El Rodeo) are categorized on the basis of a political hierarchy. The cabecera of each municipio, due to its physical size and administrative importance, is consistently the first urban place to be listed. Considered next are the aldeas found within the same municipio. The final category of administrative units consists of the caserio. These subdivisions of the municipio are, in turn, followed by a rather detailed list of prominent physical features found within the municipal limits. Such toponyms are necessarily first order members of the enumeration unit hierarchy and should not be confused with higher order members.

Adherence to Gall's method of listing place names greatly facilitated the process of locating municipio boundaries. By simultaneously approaching all thirty-six municipios of the study area from a level of extreme generality to one of detailed refinement (that is,

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Ministerio de Gobernación, 1960), Tomo II. Clemente Castillo Cordero and Juan Alfredo Garcia, Atlas Político Administrativo de la República de Guatemala (Guatemala: Ministerio de Educación Pública), 1953.

from the cabecera level down to and including the physical features found within each municipio), it was possible to eliminate much confusion as to proper boundary locations. Furthermore, the element of boundary location error was greatly reduced by concentrating on a particular toponym category rather than attempting to place boundaries by haphazardly moving from one locational type to another.

To aid the reader in better understanding how municipio boundaries were derived, Figs. 5 and 6 are provided to visually demonstrate the approach used. These maps depict a small area about the village centers of San Antonio Sacatepéquez and Palestina de los Altos, both located in the northern portion of the study area (Fig. 2, units #36 and #11, respectively). Within this area are examples of all constituents and surficial conditions utilized in the process of determining municipio boundary locations. Constant reference to these maps should be made during the following procedural discussion.[3]

The initial phase of locating the demarcation line for a municipio may appear, in writing, to be rather

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[3]These maps are derived from topographic maps. However, only those features of the area that aided in the location of boundaries are included.

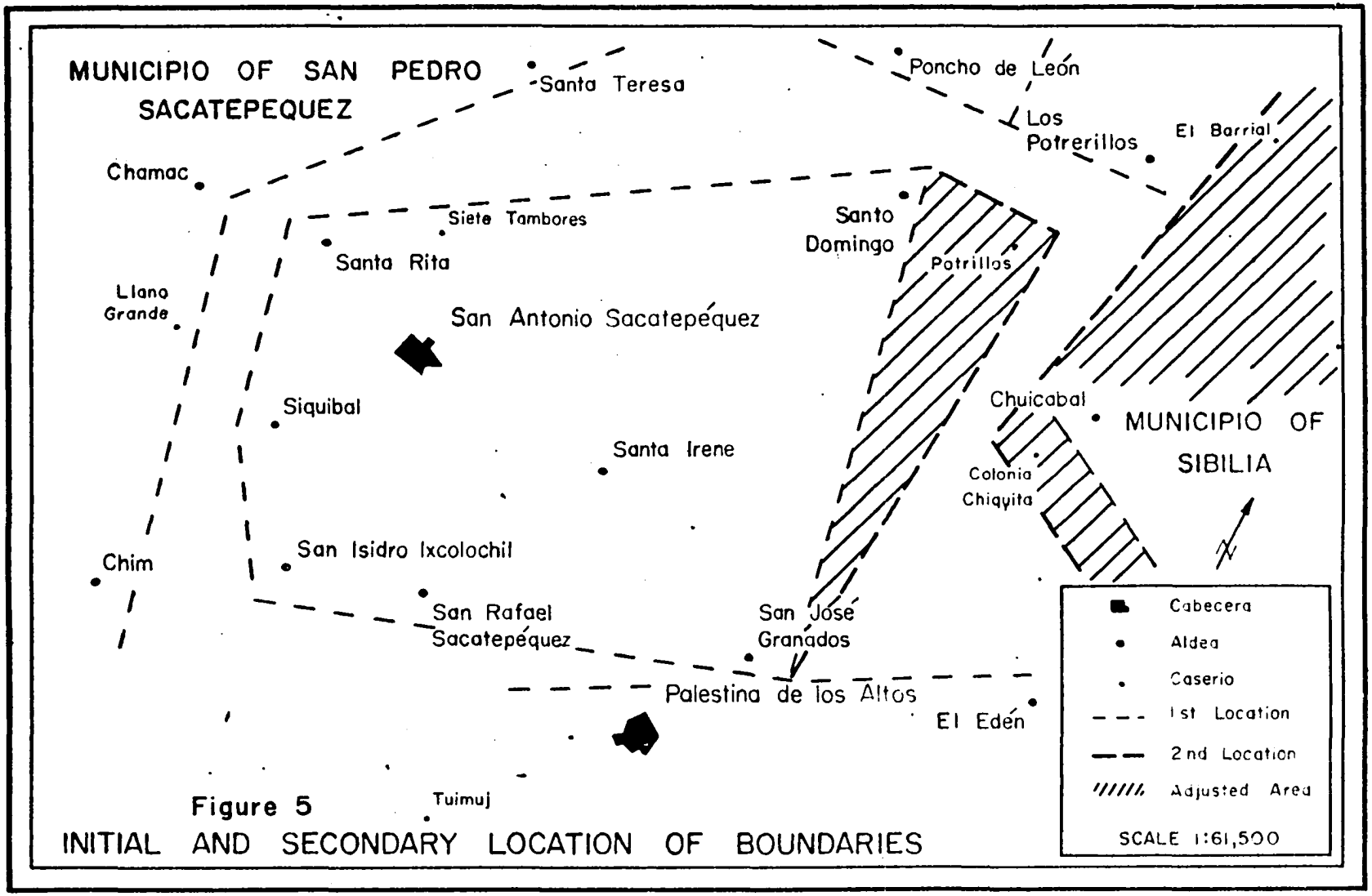

Figure 5
INITIAL AND SECONDARY LOCATION OF BOUNDARIES

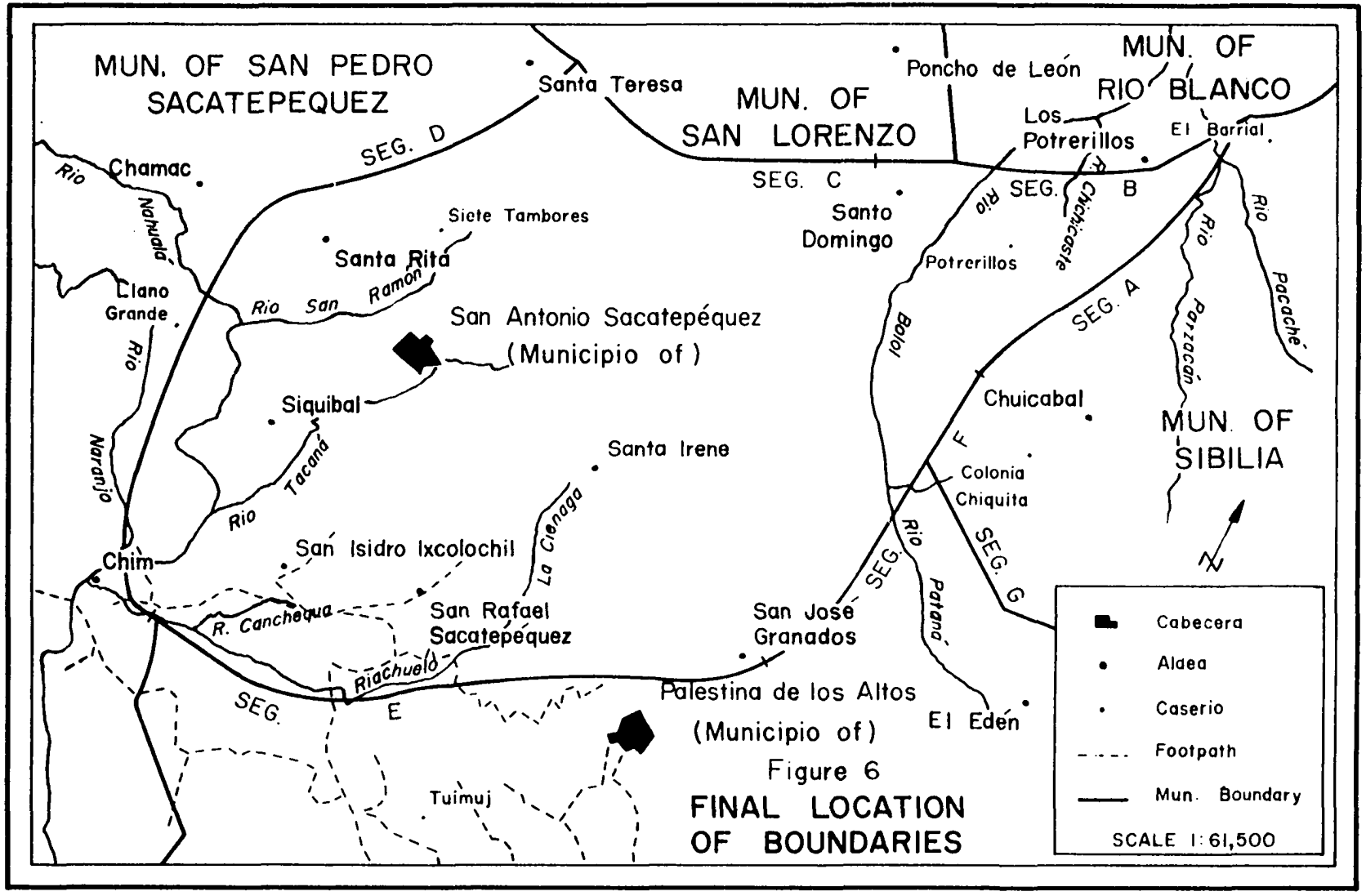

Figure 6
FINAL LOCATION OF BOUNDARIES

redundant, since each municipio and its cabecera share identical names; the cabecera of the San Pedro Sacatepéquez municipio is San Pedro Sacatepéquez, the municipio of Sibilia contains the cabecera of Sibilia, etc. However, so as to maintain a consistent procedural pattern throughout this process, the initial phase appears as:

Municipio: San Pedro Sacatepéquez
Cabecera: San Pedro Sacatepéquez

Municipio: Palestina de los Altos
Cabecera: Palestina de los Altos

Municipio: San Antonio Sacatepéquez
Cabecera: San Antonio Sacatepéquez

Municipio: Sibilia
Cabecera: Sibilia

The significance of this most general initial step lies in the resulting recognition of both a "core area" within each municipio and a political boundary location lying between any two adjacent cabecera locations. This is the extent of the usefulness of this first phase but, nonetheless, it is a vital step in the initiation of the boundary locating process. Two of the four cabeceras considered are located in Fig. 5.

Also included in Fig. 5 are the locations of aldeas. Upon classifying these locations according to their respective political units, the following spatial pattern may be observed:

Municipio: San Pedro Sacatepéquez
Aldea: Santa Teresa
Chamác
Chim

Municipio: Palestina de los Altos
Aldea: El Edén

Municipio: San Antonio Sacatepéquez
Aldea: Santa Irene
San Isidro Ixcolochil
San José Granados
San Rafael Sacatepéquez
Santo Domingo
Santa Rita
Siquibal

Municipio: Sibilia
Aldea: Chuicabal

By including each aldea within its appropriate administrative unit, highly tentative boundaries can be constructed around each cabecera.[4]

The high degree of generality produced by using only cabecera and aldea locations is reflected in the large amount of undefined terrain found between the tentative boundaries. What remains unknown is the extent to which each boundary line should be outwardly extended (relative to cabecera location) so as to ultimately eliminate these non-possessed areas.

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[4]The linear distance of the aldeas from their respective cabeceras accounts for their relative importance in determining these boundary locations, for the aldeas situated furthest from their cabecera are the ones lying closest to a municipio boundary.

One determining factor in further expansion of boundaries concerns the political affiliations of the caserios found in the area. Each caserio has political identity with a specified municipio or aldea and can, therefore, be utilized as the basis for extending the limits of a selected municipio. Source materials assign the caserios as follows:

Municipio: San Pedro Sacatepéquez
Caserio: Llano Grande

Municipio: Palestina de los Altos
Caserio: Tuimuj

Municipio: San Antonio Sacatepéquez
Caserio: Siete Tambores
Potrerillos

Municipio: Sibilia
Caserio: Colonia Chiquita
El Barriál

The shaded area in Fig. 5 depicts municipio boundaries after adjusting for the location of the caserios--determined, again, by use of topographic maps. Portions of the previously assigned area have been appreciably eliminated by incorporating these locations into the appropriate municipios.

A final step in the use of place name references is to include physical features of the area within their appropriate political unit. The inclusion of volcanic peaks and mountain ranges furthers the outward expansion of boundaries, but of greatest significance are the many

areally-defined streams included within the reference materials--specifically, those located entirely within the limits of a single municipio. By ranging over more terrain than urban or other physical features, the streams are of special aid in further refining municipio boundaries.

Proper areal distribution of the features provides for a further confirmation of boundaries represented in Fig. 5:

Municipio: San Pedro Sacatepéquez
Physical Features: Río Naranjo

Municipio: Palestina de los Altos
Physical Features: Río Pataná

Municipio: San Antonio Sacatepéquez
Physical Features: Río Chichicaste
Río Tacaná
Río Canchequa
Río Ramón
Riachuelo la Ciénaga

Municipio: Sibilia
Physical Features: Río Patzacán

The incorporation of physical features in Fig. 6 provides for a further readjustment of boundaries approximated by utilization of only cultural toponyms. At this point, all cultural and physical place name locations (first order units) are found within the correct municipio (second order units).

It may well be argued that the precise placement of these boundary lines in Fig. 6 is not possible when

utilizing only place name locations. There are, however, additional steps that may be taken to further increase the accuracy of this boundary-locating technique. By making use of information supplied implicitly by a topographic map, it is possible to subjectively improve the location of boundaries, once they have been positioned by toponyms. Route patterns of transportation may serve as a prime means of determining the location of boundaries in areas where population is rather sparse, or where place name locations are infrequent. A lack of route orientation to a specified center may indicate a minimal amount of economic and political affiliation in that direction; likewise, strong route orientation should imply an opposite situation. Thus, on the basis of route design alone, it may be possible to include a questionable area within its proper political unit.

Only a small sector of the boundary of the Municipio San Antonio Sacatepéquez is utilized to demonstrate the effectiveness of this subjective reasoning since a more extensive consideration would simply belabor the point. In the lower left portion of Fig. 6 may be found the secondary route system that exists immediately south of the cabecera of San Antonio Sacatepéquez. In this instance, route structure is such that footpaths crossing the Riachuelo la Ciénaga are minimal, indicating a lack

of interaction between the residents on either side of the stream. Since the sited source materials place this Riachuelo only in the municipio of San Antonio Sacatepéquez, the boundary line between San Antonio Sacatepéquez and Palestina de los Altos definitely lies south of this stream and has been subjectively situated so as to bisect the sole route which crossed it. This presumption influenced the final boundary location in this particular part of the study area.

A complimentary aspect of the subjective location of boundaries is related to the presence of streams and mountain ranges not mentioned in the references used earlier. It is suspected that such features of the landscape often serve as rather vague, but still accepted, municipio boundaries within the highland area of Guatemala.[5] These features, when located in places of questionable political affiliation, may be utilized as the limits to municipio jurisdiction.

Thus, the lines of demarcation were specifically located on Fig. 6 by objectively utilizing the location and political unit identity of toponyms and subjectively

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[5]This situation became apparent while attempting to locate the true boundary to the Ostuncalco municipio in 1967 (see Footnote 4, Chapter I, p. 21).

reviewing landscape patterns of selected phenomena. These procedures were applied in like manner to all portions of the study area so as to obtain similar results. These boundary lines and their locations are not, however, presented as absolutely accurate limits to the political units found in the study area. They are presented solely as best estimates of lines of actual demarcation and function only to verify the location of areal limits used previously to collect statistical data.

For purposes of brief review and verification, the boundaries located in Fig. 6 are discussed below by segments. Instead of locating the boundary lines by considering the place name locations on either side, the boundary line is examined so as to insure the correct grouping of toponyms within their proper municipio. The boundary of the municipio San Antonio Sacatepéquez has been verified in this manner. This boundary has been divided into segments, running counter-clockwise from A to F (see Fig. 6) to facilitate the discussion. The boundary between the municipios of Sibilia and Palestina de los Altos (Segment G) is also examined.

Segment A: Utilized references indicate that Sibilia municipio contains the cultural and physical toponyms of El Barriál and Río Patzacán, respectively. This segment, properly positioned west of these locations, conforms to this distribution.

Segment B: By constructing this segment so that it passes to the south of Los Potrerillo (an aldea of the Río Blanco municipio) and across a portion of the Río Chichicaste, all political affiliations are correct. This segment must intersect Segment A near the caserio of El Barriál.

Segment C: A description of the aldea of Santo Domingo in the Diccionario places its political ties with the San Antonio Sacatepéquez municipio. The aldea of Pancho de León is associated administratively with the San Lorenzo municipio. This segment's location is conducive to this spatial differentiation.

Segment D: From cited sources, politically defined toponyms for the San Antonio Sacatepéquez municipio are Siete Tambores, Santa Rita, Siquibal, San Isidro Ixcolochil, Río Tacaná, Río Canchiqua, and Río Ramón. Those place names found within the municipio of San Pedro Sacatepéquez include Santa Teresa, Chamac, Llano Grande, Las Guayabas, Chim, and Río Naranjo. All toponyms are contained within their respective units as a result of this segment's derived location.

Segment E and F: The present location of Segment E was subjectively determined in view of the configuration of footpaths in the area and an abrupt termination of dwelling units south of the line. In support of this location, the Riachuelo la Ciénaga is found in its proper unit. The sites of Tuimuj and the cabecera of Palestina de los Altos are correctly confined within the municipio of Palestina de los Altos and the place names of Santa Irene and Potrerillos are defined as members of the San Antonio Sacatepéquez municipio. References comply with this distribution and further indicate that Chuicabal is an aldea of Sibilia. This latter information is corroborated by the location of Segment F.

Segment G: The Río Pataná is described in the reference materials as of the Palestina de los Altos municipio but not the Sibilia municipio. Colonia Chiquita is a caserio of Sibilia, so this segment has been located between the Río Pataná and this caserio. The aldea El Edén is associated with the Palestina de los Altos municipio so must be west of this segment.

This segmental approach to the verification of boundary locations demonstrates that political lines of demarcation can be reasonably located even in areas where boundaries are highly irregular. However, certain situations may arise that tend to limit the utility of this technique; a limited number of such circumstances were encountered during this study and, subsequently, created various problems in defining approximate boundary locations.

One such situation concerns the repetitious use of place names. David Sopher in discussing this touches lightly on this subject by concluding that:

> Where the Spanish, Portuguese, and French, directed by or conscious of the Church, settled in New World lands that had been sparsely occupied by primitive peoples, saints' names and other religious terms are likely to be numerous as place names . . . . The greatest density of Hagiotoponyms [places named for saints] and the highest proportion of them to all kinds of place names, occurs where the New World Catholic population has been a conservative, dispersed, rural one of European origin.[6]

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[6]David E. Sopher, "Geography of Religions," Foundations of Cultural Geography Series (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1967), p. 34.

Identical place names, religious as well as others, are found not only in widely scattered parts of the country but also within extremely short distances of each other. Under these latter conditions, it may be most difficult to identify properly the correct place name location with the proper political unit. Indicative of this is the presence of three caserios named "Río Hondo" located in separate but contiguous municipios approximately two kilometers east of San Lorenzo. It was most difficult to place these caserios within their appropriate political units; in fact, the ultimate positioning of unit boundaries around these caserios was again due to the type of subjective reasoning discussed previously. Admittedly, the boundaries within this specified area may misrepresent existing conditions.

A problem of greater magnitude, frequently involving larger areas, is that in which place names, for purposes of identification, are completely lacking. Since this technique is based primarily upon the existence of toponyms, it is logical that this problem should appear. Within the region covered by this study, many areas exist that contain no inhabitants and few dominant physical features (usually isolated areas of higher elevation). In these instances, boundaries were arbitrarily drawn with respect to contour lines that indicated either

ridge lines or well-defined valleys. Rather than attempt to defend the boundaries located under these conditions, it is considered most profitable to admit the marginal utility of this technique in regions largely unoccupied by man.

By adhering to the procedures outlined above, boundaries were ultimately established for the thirty-six municipios found within the study area. The location and configuration of these demarcation lines are given in Fig. 7. Since the sinuous and most irregular character of internal boundaries is indisputable in the highland area of Guatemala, this map would appear to be quite agreeable with expected results. But is this actually so?

When officially recognized boundaries for the same municipics (taken not from topographic maps but from a map published by the Dirección General de Estadística) are superimposed upon the derived boundaries resulting from this study, large discrepancies in boundary location and areal extent of municipios are noted (see Fig. 8).[7] It is the purpose of Chapter III to provide adequate proof that the boundaries

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[7]Lines of latitude and longitude were utilized to insure proper superimposing of these map sources.

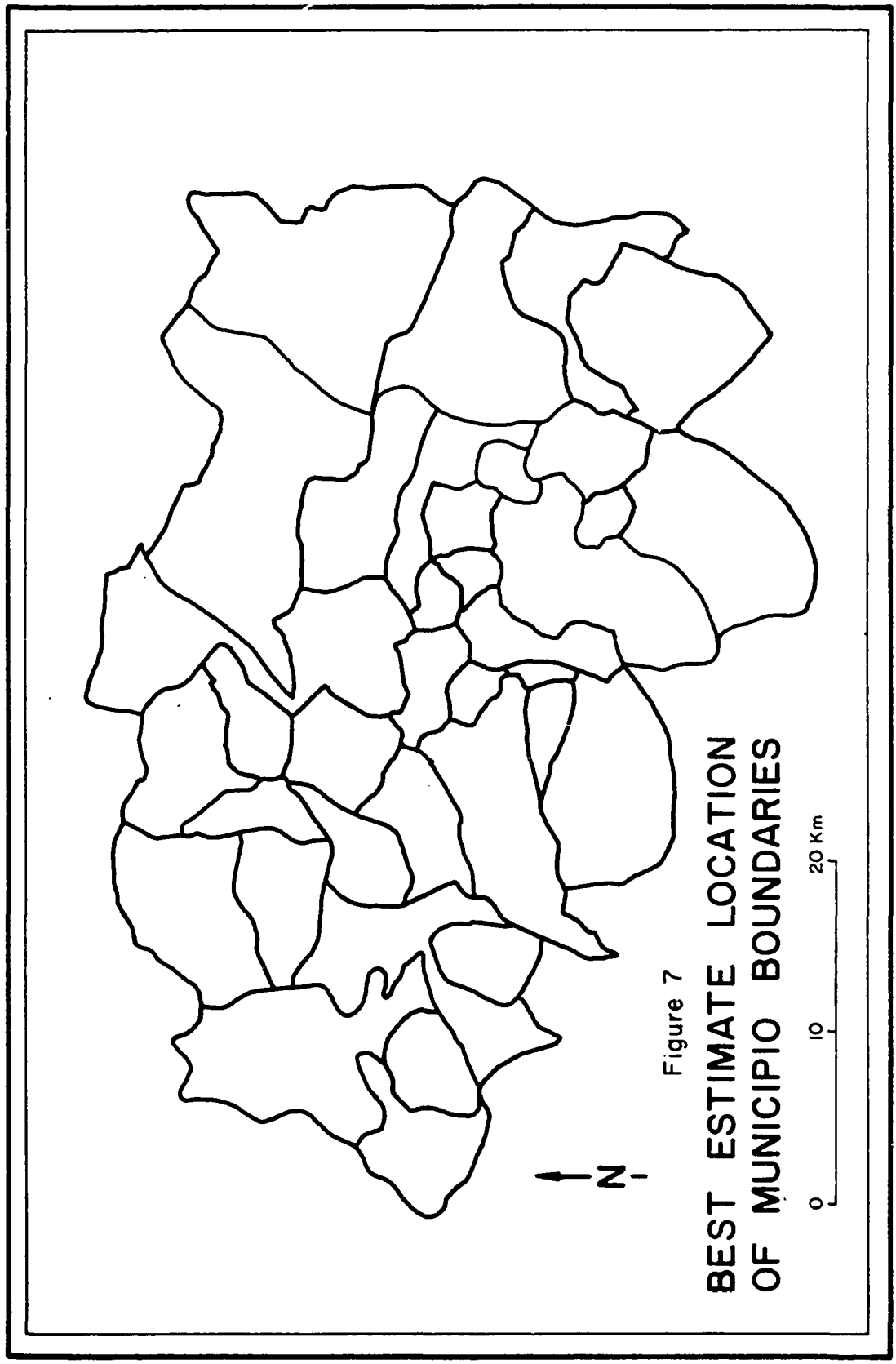
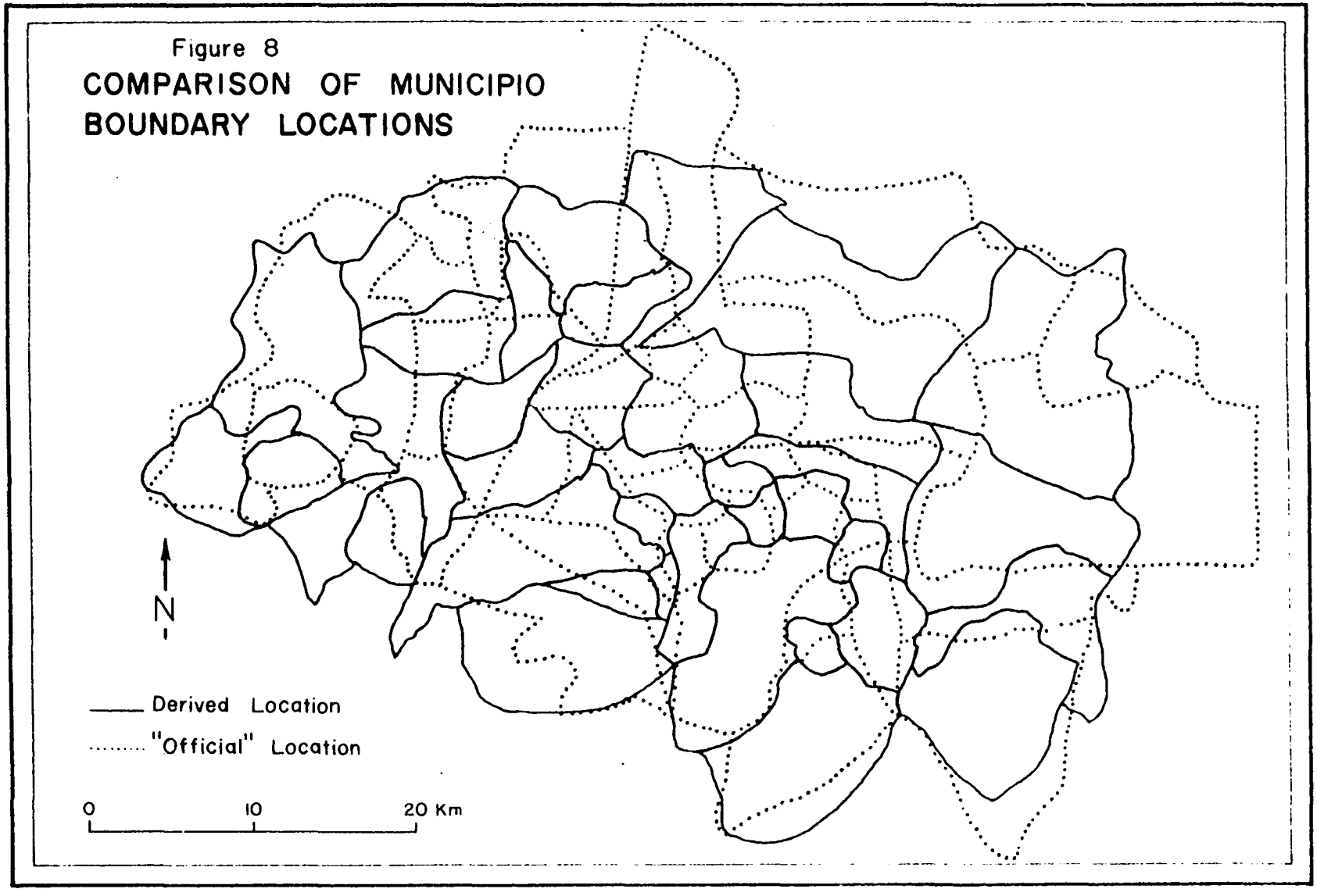


Figure 7

Figure 8

COMPARISON OF MUNICIPIO BOUNDARY LOCATIONS



designated through this thesis are more nearly correct than those boundaries presently adhered to by the Guatemalan government.

CHAPTER III

VERIFICATION OF THE BOUNDARY-LOCATING TECHNIQUE

The contents of the preceding chapter demonstrate that administrative lines of demarcation can be constructed for Guatemalan municipios by utilizing spatially and politically defined cultural and physical locations. These boundary lines represent only best-approximations of actual boundary locations and are not proported to depict absolute correctness. However, even when allowing for this best-approximation factor of accuracy, gross discrepancies in location are found to exist between these administrative lines and those boundaries currently recognized by Guatemalan officials. The question arises as to which set of boundary locations is more representative of existing conditions--those formulated by this paper or those being accepted by official authorities?

The present chapter is committed to clarifying this question through verification of those boundary lines derived through this study. Initial emphasis is placed upon a statistical verification of boundary locations by linear correlation, this being succeeded by a more traditional description of field work disclosures

accumulated while working in the Guatemalan highlands during the summer of 1968. Though complementary in nature, these separate verifications provide adequate insight into the boundary location dilemma.

Statistical Verification

When source materials were being collected, a reference entitled Guía Kilométrica de la República de Guatemala was obtained which provided information that differed considerably from place-name oriented sources utilized in Chapter II. This publication was produced for the purpose of providing route distance values from selected points of origin on Guatemalan transport routes to other locations along these routes.[1] The points considered vary widely in nature, ranging from cabeceras, aldeas, and caserios, to bridges, locally prominent fincas, grinding mills, and route junctions.

Of particular significance to this paper is the inclusion within the Guía Kilométrica of route distances from arbitrarily selected points of origin (usually from the plaza of a cabecera) to those sites where municipio boundaries transverse the route being considered. The

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[1]Dirección General de Caminos, Guía Kilométrica de la República de Guatemala (Guatemala: 1949), Tomos I y II.

availability of this information would have greatly enhanced the process of establishing boundary line locations; however, because of the Guía Kilométrica's unique nature (i.e., possession of a type of information not usually made available for regions) and because the entire process described in Chapter II is predicated upon toponyms, it was decided that this course should function as a determinant of technique feasibility rather than as a direct aid in the location of boundaries.

A detailed consideration of the Guía Kilométrica produced thirty-five distance values which are found on routes located within the study area (these routes are both primary [Volume I] and secondary [Volume II] road types). The selected point of origin, the associated municipio boundary, and the route distance between them given in Table 1 has the location of each distance coded (column 2) and can be located by referring to Fig. 9.

After compiling, arranging, and coding the distance values derived from the Guía Kilométrica, it was necessary for purposes of applying linear correlation to determine from the topographic maps used in this study the identical type of information being offered. For those thirty-five distance values obtained in the Guía Kilométrica, equivalent figures were gathered, representing distances from the identical points of origin to the

TABLE 1

ROUTE DISTANCE VALUES FROM THE GUÍA KILOMÉTRICA

Route No.	Location Code	National Routes from	to	Listed Distance (Kms.)
1	N1	Center of Totonicapán	Totonicapán-San Cristóbal Totonicapán Boundary	8.80
	N2	Center of San Cristóbal Totonicapán	Quezaltenango-Totonicapán Department Boundary	2.82
	N3	Salcajá	Quezaltenango-Salcajá Boundary	6.88
	N4	Quezaltenango	Quezaltenango-La Esperanza Boundary	6.35
	N5	Quezaltenango-La Esperanza Boundary	La Esperanza-San Mateo Boundary	4.30
	N6	San Mateo	San Mateo-Ostuncalco Boundary	.28
	N7	Ostuncalco	Ostuncalco-Palestina de los Altos Boundary	13.64
	N8	Palestina de los Altos	Quezaltenango-San Marcos Department Boundary	.97
	N9	San Antonio Sacatepéquez	San Antonio Sacatepéquez-San Pedro Sacatepéquez Boundary	3.65
	N10	San Rafael Pié de la Cuesta	San Rafael Pié de la Cuesta-El Rodeo Boundary	5.63
9S	N11	Intersection of Routes 9S and 1	Quezaltenango-Almolonga Boundary	4.28

TABLE 1 (continued)

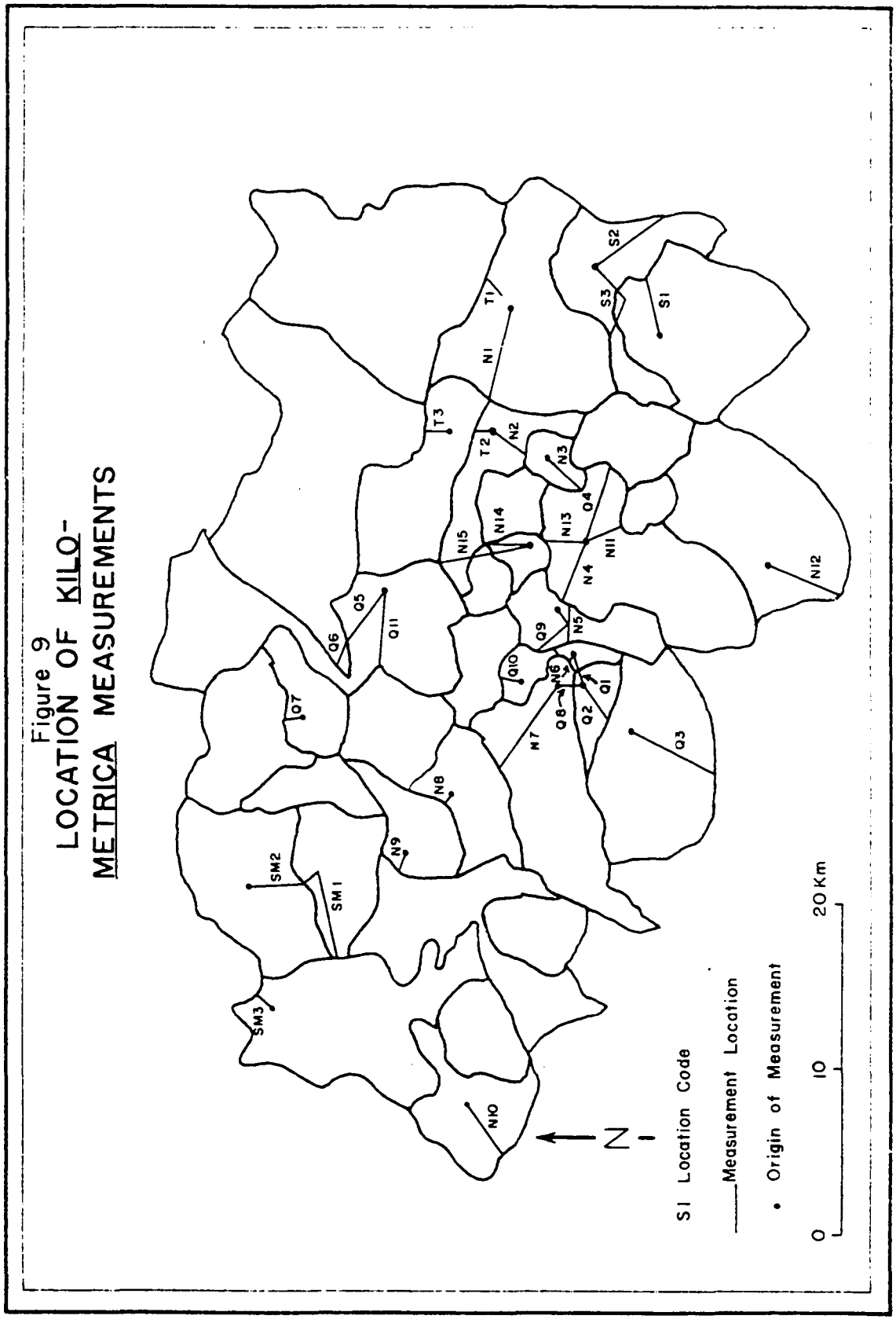
Route No.	Location Code	from	to	Listed Distance (Kms.)
		National Routes		
9S	N12	Santa María de Jesús	Quezaltenango-Retalhuleu Boundary	11.10
9N	N13	Intersection of Routes 9N and 1	Quezaltenango-Olintepeque Boundary	6.48
	N14	Olintepeque	Olintepeque-San Cristóbal Totonicapán Boundary	8.68
	N15	Olintepeque	San Carlos Sija-San Cristóbal Totonicapán Boundary	16.18
		Department Routes		
		Quezaltenango Department		
3	Q1	San Mateo (via Concepción Chiquirichapa)	San Mateo-Ostuncalco Boundary	2.69
	Q2	Concepción Chiquirichapa	Concepción Chiquirichapa-San Martín Sacatepéquez Boundary	2.69
	Q3	San Martín Sacatepéquez	San Martín Sacatepéquez-Colomba Boundary	15.00
7	Q4	Quezaltenango	Quezaltenango-Cantél Boundary	4.15
13	Q5	San Carlos Sija	San Carlos Sija-Totonicapán Boundary	6.69
	Q6	San Carlos Sija-Totonicapán Boundary	Quezaltenango-Totonicapán Department Boundary	1.62

TABLE 1 (continued)

Route No.	Location Code	Department Routes from	to	Listed Distance (Kms.)
13	Q7	Huitán	Huitán-Cabricán Boundary	1.83
14	Q8	Concepción Chiquirichapa	Concepción Chiquirichapa-Ostuncalco Boundary	.58
15	Q9	La Esperanza	La Esperanza-San Miguel Sigüilá Boundary	3.48
	Q10	San Miguel Sigüilá	San Miguel Sigüilá-Cajolá Boundary	2.15
17	Q11	San Carlos Sija	San Carlos Sija-Sibilia Boundary	6.35
		San Marcos Department		
1	SM1	Intersection of Routes 12 and 1	San Lorenzo-Comitancillo Boundary	11.62
	SM2	San Lorenzo-Comitancillo Boundary	Center of Comitancillo	9.68
2	SM3	Center of San Sebástian	San Marcos-Tejutla Boundary	9.09
		Totonicapán Department		
1	T1	Intersection of National Route 1 & Department Route 1	Totonicapán-Santa María Chiquimula Boundary	5.05
2	T2	San Cristóbal Totonicapán	San Cristóbal Totonicapán-San Francisco El Alto Boundary	3.80

TABLE 1 (continued)

Route No.	Location Code	Department Routes from	to	Listed Distance (Kms.)
2	T3	San Francisco El Alto	San Francisco El Alto-Momostenango Boundary	5.39
		Sololá Department		
2	S1	Santa Catarina Ixtahuacán	Santa Catarina Ixtahuacán-Nahualá Boundary	10.54
3	S2	Nahualá	Nahualá-Santa Lucia Utatlán Boundary	10.25
	S3	Nahualá	Sololá-Totonicapán Department Boundary	10.82



same municipio boundary/route intersection on the same routes. These values were determined by use of a calibrated map measurer.[2] Subsequently, for each individual Guía Kilométrica value, there was derived a corresponding distance value representing the results of this study. Both sets of values are given in Table 2.

Since there is no conceivable cause and effect relationship between the series of figures obtained from the Guía Kilométrica and that gained from the topographic maps, the correlation coefficient was utilized to gain knowledge of the association between relative values of each factor; that is, it was desirable to determine the extent to which individual figures in one series approximate the figures of the other series.[3] The Guía Kilométrica series of distance values was selected as the independent (x) variable and the series obtained from

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[2]Various conversions were required of the initial values obtained from the map measurer since it was calibrated in miles and because of the necessary conversion of figures to represent maps of 1:50,000 scale. Several readings were taken for each value, after which an average value was determined.

[3]When utilizing linear correlation, the variables used are normally related such that (1) one variable acts upon the other, (2) both variables act upon each other, (3) both variables are acted upon by an outside force, or (4) the coincidence or covariation of two variables, which are independent of each other, are logically related. Essentially, what is being sought is merely the degree of association between the series.

TABLE 2

A COMPARISON OF ROUTE DISTANCE VALUES

Location Code	Listed Distance from Guía Kilométrica (Kilometers)	Derived Distance from Topographic Maps (Kilometers)
N1	8.80	9.66
N2	2.82	2.55
N3	6.88	2.03
N4	6.35	5.33
N5	4.30	3.04
N6	.28	.39
N7	13.64	13.21
N8	.97	.76
N9	3.65	2.41
N10	5.63	4.70
N11	4.28	2.54
N12	11.10	1.27
N13	6.48	4.31
N14	8.68	6.47
N15	16.18	10.93
Q1	2.69	.51
Q2	2.69	3.94
Q3	15.00	11.68
Q4	4.15	5.84
Q5	6.69	5.46
Q6	1.62	2.91
Q7	1.83	1.53
Q8	.58	.37
Q9	3.48	3.17
Q10	2.15	2.03
Q11	6.35	5.97
SM1	11.62	9.90
SM2	9.68	8.64
SM3	9.09	2.54
T1	5.05	6.23
T2	3.80	1.77
T3	5.39	3.04
S1	10.54	5.71
S2	10.25	11.43
S3	10.82	7.37

this study as the dependent (y) variable. Employing linear correlation analysis, an (r) value of .8141 was obtained from the series being considered. This definitive mathematical value of the degree of association between the (x) and (y) series indicates that the relationship is acceptable by statistical standards, being significant at the .01 level. Furthermore, the coefficient of determination (r^2) equals 66.3 per cent, that percentage of variation in the (y) series that may be associated with the (x) series. If percentages of any phenomenon can be perceived as conforming to a normal distribution, this (r^2) value indicates a potentially useable boundary-locating technique which approximates ± 1 standard deviation from the normal range. The highly favorable correlation between those distance values obtained from the Guía Kilométrica and those derived from this project enhances the viewpoint that those boundaries determined by this project are, in general, more accurately located than the presently utilized lines of demarcation.

Moreover, this correlation coefficient implies the accurate location of boundaries in a region composed of heavily populated areas versus areas completely void of habitation, and that contains flat, arable land as opposed to land that is hostile to man's living requirements.

Although it is a most acceptable value, this coefficient may well represent a significantly large degree of error, for it has been demonstrated that a significant portion of the study area is composed of places largely devoid of toponyms.

So as to illustrate a greater potential for this technique if utilized in a more conducive area of study, additional comparison of the derived route distances was pursued. The (x) and (y) values were plotted to form a scattergram (Fig. 10) on which a regression line was imposed. The relative residual for each coordinate was calculated to determine the standard deviation from the regression line (see Table 3). All points of greater deviation than ± 1 standard error from this line were selected so as to ascertain which members of each route distance series were most dissimilar. Reference should be made to Fig. 9 for the location of these distance values within the study area.

Upon resolving the location of these values on the topographic maps, explanations were sought as to why the (y) variable was minimally associated with the (x) variable at these coordinates. These explanations are presented below.

Figure 10

SCATTERGRAM OF NON-DELETED VARIABLES

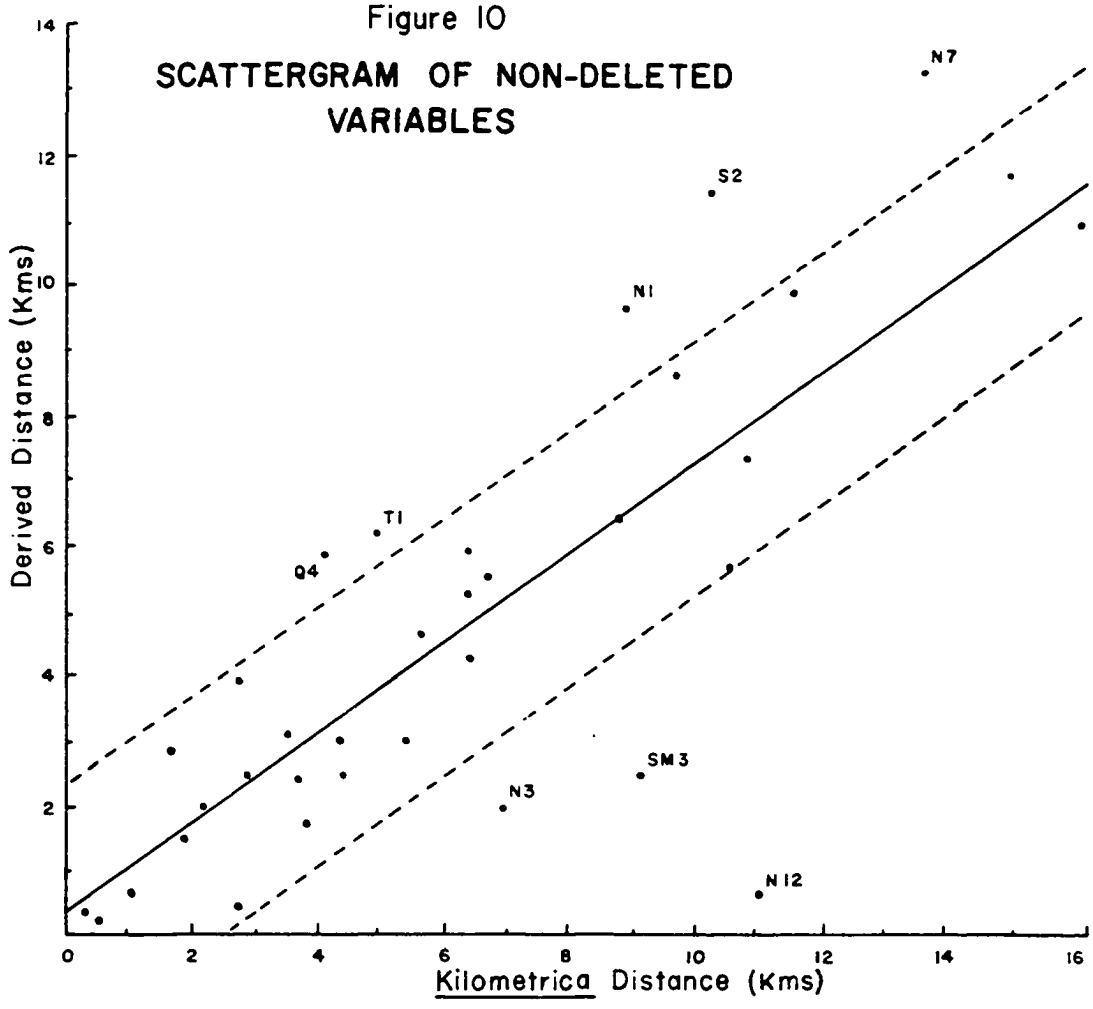


TABLE 3

RELATIVE RESIDUALS FOR NON-DELETED LOCATION VALUES

X	Y	Y_c	$Y_c - Y$	$(Y_c - Y)/S_{y \cdot x}$
8.80	9.66	6.47	- 3.49	1.69
2.82	2.55	2.34	- .21	.10
6.88	2.03	5.14	3.11	1.50
6.35	5.33	4.78	- .55	.27
4.30	3.04	3.36	.32	.15
.28	.39	.59	.20	.10
13.64	13.21	9.81	- 3.40	1.64
.97	.76	1.07	.31	.15
3.65	2.41	2.91	.50	.24
5.63	4.70	4.28	- .42	.20
4.28	2.54	3.35	.81	.39
11.10	1.27	8.05	6.78	3.28
6.48	4.31	4.87	.56	.27
8.68	6.47	6.38	- .09	.04
16.18	10.93	11.56	.63	.30
2.69	.51	2.25	1.74	.84
2.69	3.94	2.25	- 1.69	.82
15.00	11.68	10.75	- .93	.45
4.15	5.84	3.26	- 2.58	1.25
6.69	5.46	5.01	- .45	.22
1.62	2.91	1.51	- 1.40	.68
1.83	1.53	1.66	.13	.06
.58	.37	.80	.43	.21
3.48	3.17	2.80	- .37	.18
2.15	2.03	1.88	- .15	.07
6.35	5.97	4.78	- 1.19	.57
11.62	9.90	8.41	- 1.49	.72
9.68	8.64	7.07	- 1.57	.76
9.09	2.54	6.67	4.13	2.00
5.05	6.23	3.88	- 2.35	1.14
3.80	1.77	3.02	1.25	.60
5.39	3.04	4.12	1.08	.52
10.54	5.71	7.67	1.96	.95
10.25	11.43	7.47	- 3.96	1.91
10.82	7.37	7.86	.49	.24

Location	Explanation for Extreme Deviation
T1	This extended site is completely devoid of place-name locations, making it impossible to determine enumeration unit boundary locations by utilizing this technique.
N3	Topography, plus the factor of non-existing place-name locations, are responsible for the large degree of error. The N3 distance value is found in the eastern portion of the Quezaltenango Basin where fertile soils and flat terrain enhance intensive crop production and detract from concentrated village sites. Physical and cultural toponyms are completely lacking.
N12	Those references utilized in Chapter II to determine boundary locations indicate that the aldea of Santa María de Jesús, located on Route 9S, is situated in the Quezaltenango municipio. This implies that the boundary between the Quezaltenango municipio and the adjacent unit of Retalhulen must be found south of Santa María de Jesús. However, it will be noted from the topographic map that no additional points of reference are found along Route 9S in this direction until quite removed from the highland area. Again, due to a limited number of place names, the author's original placement of the southern boundary to Quezaltenango was grossly incorrect.
N1, S2, & N7	It will be noted from Table 2 that the (x) and (y) values for these particular distance locations approximate each other quite closely. The high standard deviation values for these figures are the result of influences exerted upon the slope of the regression line by other highly deviant points, specifically, N3, SM3, and N12.

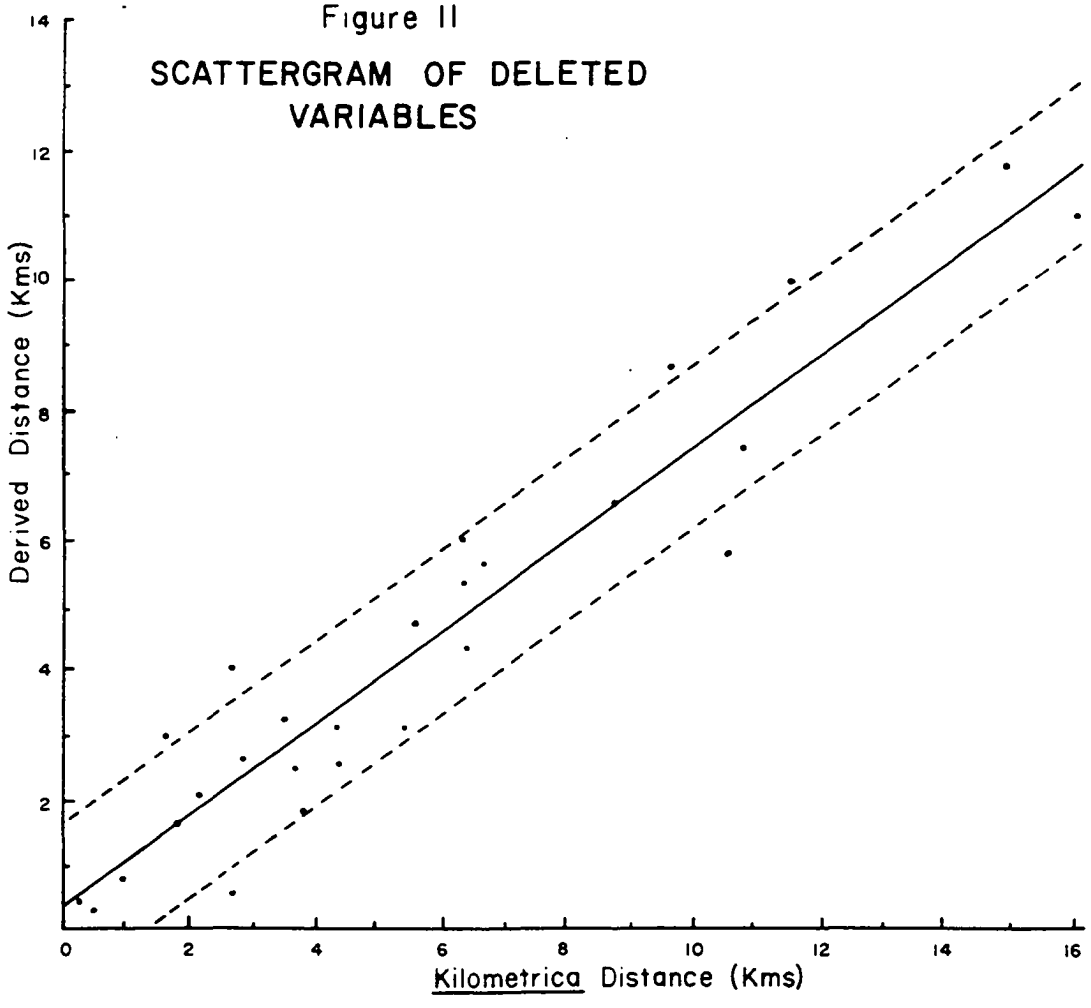
Q4 This site is located outside the accepted error range because of a possible error on the part of Guía Kilométrica. The caserio of Chichihuitan is situated in the Quezaltenango municipio. The distance from this site along Route 7 to the city of Quezaltenango is 5.84 kilometers, indicating that the Quezaltenango-Cantel municipio boundary is located at least this far from Quezaltenango. The Guía Kilométrica defines this distance value at only 4.15 kilometers. (Had the 5.84 value been utilized as the (x) variable, the Q4 location would fall within the range of accepted error.)

SM3 The Guía Kilométrica may be in error at this point also. It indicates that the Tejutla-San Marcos boundary is 9.9 kilometers from San Sebastian. Based on the Diccionário, the closest it can possibly be is 4.67 kilometers due to the listing of Esquipulas within the San Marcos municipio. Again, had the 4.67 distance value been used in the (x) series, this coordinate would have been included within the accepted range of error.

These eight most deviant observations were deleted from the original (x) and (y) series. The remaining twenty-seven observations represent only route distance values found in areas more conducive to the boundary-locating process. A second coefficient of correlation was sought utilizing the deleted (x) and (y) values. Both the standard deviation value and the number of observations falling outside ± 1 standard deviation have decreased (see Fig. 11). As expected, the coefficient of this correlation has increased to .9530 and the

Figure II

SCATTERGRAM OF DELETED VARIABLES



coefficient of determination equals 89.8 per cent, explaining an extremely strong covariation between the (x) and (y) series. This (r) value is significant at the .01 level. Acknowledging that the (r) value of this second computation must increase in mathematical certainty after deleting the most deviant variables of the original computation, it is nonetheless evident that the degree of success obtained when determining boundary locations by the technique presented here is directly proportional to place-name availability. Utilization of this technique in highly populated areas possessing significant numbers of these toponyms produces most adequate results.

The eight most deviant observations found in the (y) series were eventually corrected by implementing the information contained within the Guía Kilométrica. The boundary line/route intersections were shifted along the appropriate route in a direction so as to finally coincide with the distance values made available by this source. Entire boundary segments were affected by this shifting which resulted in the construction of units that differed considerably in original shapes and area involved.

Field Verification

During the summer of 1968 a field check was conducted on selected aspects of the boundary situation as discussed in this paper. First-hand verification of suspected conditions was necessary before precise statements and ultimate conclusions could be made. Among the desired confirmations, there existed a significant need for irrefutably establishing the boundary locations to sampled municipios. A firm basis for evaluating both the government recognized boundaries and those derived from this study was non-existant without this corroboration. Only by more specifically locating boundaries in the field would it be possible to conclude which boundary source was most accurate.

To facilitate this procedure the author concentrated on that political boundary containing the San Mateo municipio (Fig. 2, unit #15) located approximately eight kilometers west of Quezaltenango. Surrounding this municipio and sharing portions of its boundary are the political units of Concepción Chiquirichapa, Ostuncalco, San Miguel Sigüilá, and La Esperanza. By focusing field efforts on this single demarcation line, it was possible to consider the limits to all or portions of five municipios.

The method utilized in this search for a valid boundary was wholly dependent upon information gathered from the local inhabitants. Although largely illiterate, these persons contributed immensely to the accumulation of desired data; pre-occupation with the land has resulted in a thorough awareness of local boundary locations, both political and personal in nature. The control exerted upon these people by local taxing agencies has also created a definite awareness of political affiliation. By questioning these rural inhabitants as to which political unit they identified with and then inquiring about their knowledge of political boundary locations, the exact placement of demarcation lines was made possible. By tediously walking along and through fields surrounding the San Mateo cabecera, criss-crossing the sought-after boundary line, and always searching for that point where local inhabitants indicated their alliance to a municipio other than San Mateo, it was possible to accurately derive the precise location of the San Mateo municipio boundary.

The ultimate location and configuration of this field verified boundary is presented in Fig. 12 and is superimposed upon a boundary derived through this study (by utilizing toponyms) and also upon a boundary obtained from the Dirección General de Estadística. Emphasizing

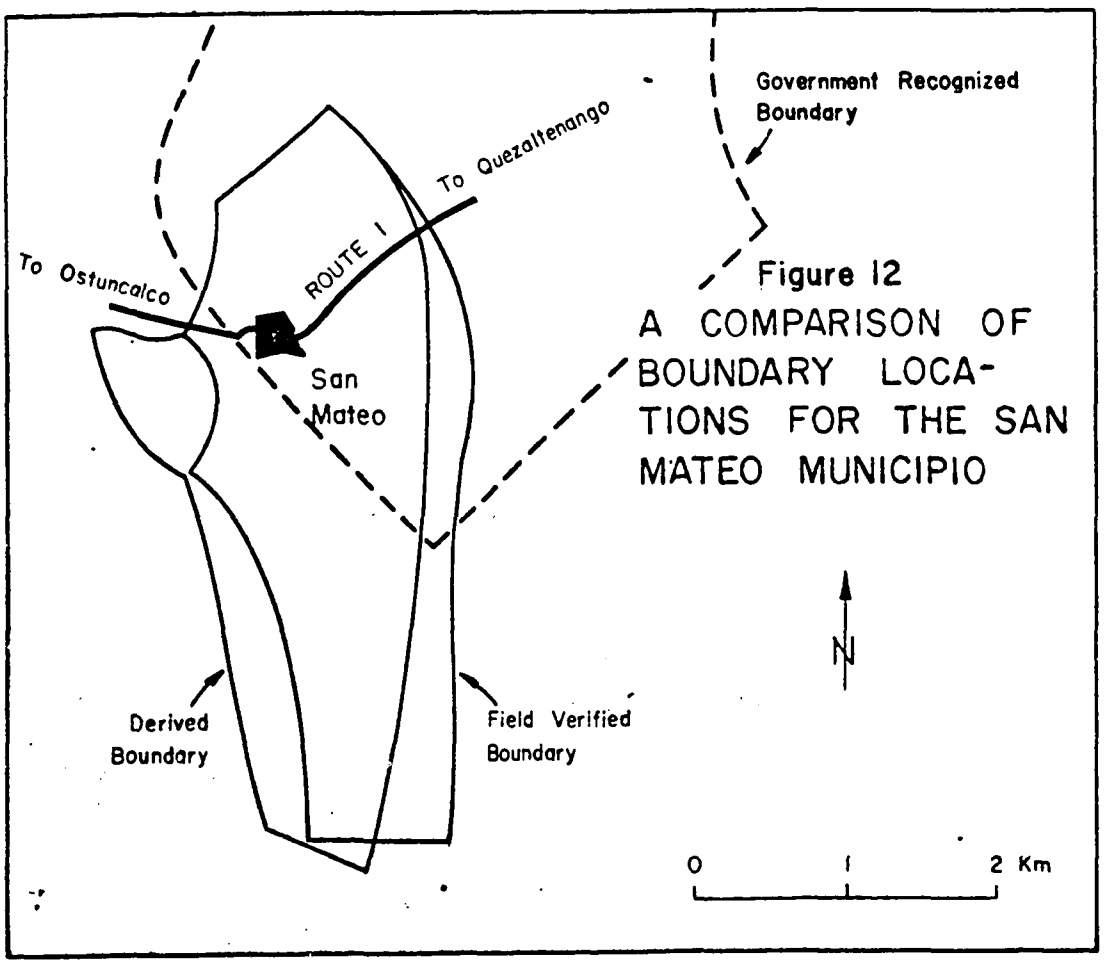


Figure 12
A COMPARISON OF BOUNDARY LOCATIONS FOR THE SAN MATEO MUNICIPIO

the "best approximate" nature of the study-derived demarcation line, locational discrepancies with the field verified boundary are minimal. This compares to gross disparities existing between the officially recognized boundary and the field verified line of demarcation. A comparison of these boundaries further substantiates the proposed condition of municipio limits in the highlands of Guatemala and also verifies the utility of toponyms for construction of adequate boundaries to enumeration units.

The location of political lines of demarcation is, in itself, relatively unimportant. Furthermore, disputing the location of boundary lines currently accepted by Guatemalan authorities contributes only marginal insight into a region's enigma. The true significance of this ability to approximate boundary lines is manifested only when the quantities of data gathered on the basis of enumeration unit boundaries are critiqued. These data, and not the actual demarcation lines used for their collection, are of primary concern to the social scientist.

Chapter IV is devoted to an evaluation of selected types of data originating in the area of study. By means of this evaluation, it is hoped that the significance of this thesis is positively revealed.

CHAPTER IV

IMPLICATIONS OF THE BOUNDARY-LOCATING TECHNIQUE

The comparison of divergent boundary line locations and the subsequent verification of the boundaries contrived through this study have contributed only initial aspects toward a meaningful interpretation of existing conditions within the highland area of Guatemala. Of greater significance is the fact that past efforts of accumulating data have possibly been based on an official, yet incorrectly positioned, set of demarcation lines. It is readily apparent that spatially-oriented data can be miscalculated if unit limitations are not precisely known or are incorrectly mapped. In an effort to fully demonstrate the importance of properly locating political boundaries which serve as enumeration unit limits, an attempt has been made to compare area values and the spatial distribution of rural populations as provided for by a set of "officially recognized" and a set of derived political boundaries.

For these comparisons to be meaningful, the approximate location of boundaries derived through this thesis must be accepted as more accurately placed than those depicted on official Guatemalan map sources. In

addition, the precise nature of topographic maps must be appreciated. As symbolized reproductions of aerial photographs, this research "tool" must be distinguished as a product of scientific achievement. As such, the accurate portrayal of location, quantity, and quality of surficial features must be accepted. This recognition of topographic maps, in conjunction with acceptance of boundaries located through this study, enhances the significance of the following data comparisons.

Comparison of Area Data

The inclusion within statistical publications of area values for enumeration units is quite common and can be considered one of the more easily obtained types of information. If boundary lines are well delimited and accurately placed, accumulation of area data should present few problems to the data collector. Furthermore, it might also be concluded that any discrepancies found in such data would, because of its readily obtainable nature, most definitely reflect upon other more sophisticated types of information. The verification of area values for enumeration units may well function to verify or discredit other data types.

The areas of the political units derived through

this project were determined by means of a planimeter[1] and subsequently compared with five independent and officially recognized sources. The results are presented in Table 4.[2] It will be noted that only the slightest degree of similarity exists between these derived values and those obtained from the various governmental sources. None of the consulted publications, as a whole, conform to the values gathered by this project and only approximately 35 per cent of the individual values are in close proximity. It is immediately evident that great caution should be exercised when utilizing area data as presented in any of the sources cited in Table 4.

Comparison of Rural Population Data

Rural population figures for an enumeration unit may be somewhat more difficult to obtain than area values, but, nonetheless, can be utilized to further

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[1] An instrument for measuring the area of any plane figure by passing a tracer clockwise around the bounding plane.

[2] The inconsistent nature of values derived from the Guatemalan sources is of no direct concern to the present discussion. This factor of spatial irregularity does, however, contribute significantly to the initial supposition of this thesis that municipio limits are, at best, only vaguely comprehended.

TABLE 4

A COMPARISON OF MUNICIPIO AREA VALUES

Municipio	Area Values (Kms^2)					
	A	B	C	D	E	F
Comitancillo	98	113	113	113	151	63
Esquipulas Palo Gordo	40	21	21	21	50	25
Río Blanco	29	-	-	-	-	-
San Antonio Sacatepéquez	54	100	100	100	107	49
San Cristóbal Cucho	36	56	56	56	63	19
San Lorenzo	56	-	-	-	-	-
San Marcos	187	146	146	-	175	82
San Pedro Sacatepéquez	98	253	253	253	37	62
San Rafael Pié de la Cuesta	60	60	60	60	56	40
Momostenango	221	332	332	-	199	53
San Andrés Xecul	25	17	17	17	17	8
San Cristóbal Totonicapán	46	36	36	36	32	21
San Francisco el Alto	80	132	132	132	105	28
Santa María Chiquimula	209	80	80	80	65	15
Totonicapán	145	328	328	328	316	45
Nahualá	76	218	218	218	75	39
Santa Catarina Ixtahuacán	125	-	-	218	174	27
Amolonga	12	20	20	20	17	5
Cabricán	67	12	60	60	58	31
Cajolá	31	36	36	36	38	8
Cantel	30	28	28	28	32	16
Concepción Chiquirichapa	19	48	48	48	54	18
Huitán	36	16	16	16	17	15
La Esperanza	43	32	32	32	20	11

TABLE 4 (continued)

Municipio	Area Values (Kms^2) A	B	C	D	E	F
Olintepeque	12	36	36	36	33	11
Ostuncalco	114	44	44	2,502*	46	51
Palestina de los Altos	44	48	48	48	52	21
Quezaltenango	126	120	120	120	91	33
Salcajá	19	12	12	12	16	9
San Carlos Sija	152	142	142	142	231	82
San Francisco la Unión	14	32	32	32	30	5
San Martín Sacatepéquez	124	100	100	100	130	53
San Mateo	6	20	20	20	20	3
San Miguel Sigüilá	13	28	28	28	22	4
Sibilia	47	28	28	28	29	42
Zunil	125	92	92	92	86	14

*This figure has been changed in the 1968 supplement of the Diccionário Geográfico de Guatemala to read 44 kms^2.

A = Area values obtained by means of derived boundaries as established by the author.
B - Urrútia, La División Política y Administrativa de la República de Guatemala.
C - Cordero and Garcia, Atlas Político Administrativo de la República de Guatemala.
D - Gall, Diccionário Geográfico de Guatemala.
E = Area values derived from the Dirección General de Estadística maps, published in 1951 by the Departamento de Mapas y Cartográfia. The grid dot method of determining area values was utilized.
F - Dirección General de Estadística, Censo Agropecuario 1950 (Guatemala: Integrantes de la Comisión Nacional del Censo, 1954), Tomos I, II, y III.

display the significance of this boundary-locating endeavor. Table 5 contains population data listed in both the 1950 and 1964 Population Census of Guatemala for the political units appropriate to this study. Accompanying these figures is a set of population values derived, as were the area values of Table 4, from adherence to the set of derived boundaries placed on topographic maps used in this study. The procedure utilized in acquiring these derived values for population consisted of totalling the number of dwelling unit symbols (shaded squares on the topographic map) for each municipio, then multiplying these totals by the average number of persons per dwelling unit within each municipio.[3] Reiterating, contemporary techniques of topographic map construction permit this method of estimating rural population to be utilized.

Total values from Table 5 indicate that everything is in reasonable order; all municipios except Salcajá, San Mateo, and La Esperanza (located within close proximity of one another) have increased in rural population during the fourteen year interval between census dates, and total values for each column indicate an average

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[3]These average figures were derived from the 1964 Population Census.

TABLE 5

A COMPARISON OF MUNICIPIO RURAL POPULATION VALUES

Municipio	Project Derived Data[a]	Data Derived from 1950 Census[b]	Data Derived from 1964 Census[c]
Comitancillo	(1832)(5.4)= 9,893[d]	10,608	13,863
Esquipulas Palo Gordo	(256)(5.6)= 1,434	1,452	1,979
Río Blanco & San Antonio Sacatepéquez (combined)	(1340)(5.5)= 7,370	4,438	5,932
San Cristóbal Cucho	(382)(5.6)= 2,139	2,892	4,708
San Lorenzo & San Marcos (combined)	(1537)(6.2)= 9,529	7,453	9,798
San Pedro Sacatepéquez	(1705)(5.1)= 8,696	11,468	15,906
San Rafael Pié de la Cuesta	(542)(5.5)= 2,981	5,468	6,485
Momostenango	(5234)(5.7)= 29,834	21,064	29,906
San Andrés Xecul	(547)(5.1)= 2,790	3,844	5,529
San Cristóbal Totonicapán	(1306)(5.2)= 6,791	7,279	11,631
San Francisco el Alto	(1792)(5.2)= 9,318	9,533	14,515
Santa María Chiquimula	(1597)(5.4)= 8,624	8,609	14,281
Totonicapán	(2883)(5.3)= 15,280	26,261	35,268
Nahualá	(401)(5.2)= 2,085	17,512	20,782
Santa Catarina Ixtahuacán	(245)(5.2)= 1,274	8,588	11,712
Amolonga	(63)(4.5)= 284	666	810
Cabricán	(532)(5.8)= 3,086	3,207	4,842
Cajolá	(1037)(5.6)= 5,807	3,174	3,834
Cantel	(585)(5.3)= 31,005	6,678	8,577
Concepción Chiquirichapa	(478)(5.6)= 2,677	2,064	3,158
Huitán	(500)(5.2)= 2,600	1,364	2,487
La Esperanza	(680)(4.8)= 3,264	2,060	1,532
Olintepeque	(386)(5.2)= 2,007	4,513	6,013
Ostuncalco	(2312)(5.4)= 12,485	8,397	11,016

TABLE 5 (continued)

Municipio	Project Derived Data[a]	Data Derived from 1950 Census[b]	Data Derived from 1964 Census[c]
Palestina de los Altos	(1353)(5.0)= 6,765[d]	2,817	4,238
Quezaltenango	(2609)(5.4)= 14,087	8,329	12,858
Salcajá	(434)(5.3)= 2,300	1,472	1,432
San Carlos Sija	(2297)(5.8)= 13,323	8,147	11,654
San Francisco la Unión	(297)(5.9)= 1,752	1,762	2,269
San Martín Sacatepéquez	(909)(5.0)= 4,545	4,506	6,104
San Mateo	(186)(5.3)= 986	86	63
San Miguel Sigüilá	(446)(5.2)= 2,319	792	1,469
Sibilia	(759)(6.0)= 4,554	1,800	2,618
Zunil	(252)(4.9)= 1,235	1,388	1,824
Totals:	233,119	191,909	289,093

[a]The topographic maps utilized in this study were produced from aerial photographs taken of the study area in 1954. These rural population values, thus, represent conditions existing at that time.

[b]Dirección General de Estadística, Sexto Censo de Población (Guatemala: Departamento de Estudios y Análisis, 1957).

[c]Dirección General de Estadística, Censos 1964 Población (Guatemala: Departamento de Censos y Encuestas, 1966).

[d]First column represents number of dwelling units; second column represents average members per dwelling unit for each municipio; final column represents derived rural population for 1954.

growth rate of 2.4 per cent--not unrealistic for the southern highland area. Interpolating this 2.4 per cent growth rate produces a range of error for the three total figures of only 6.15 per cent.

Major discrepancies occur only when individual figures are compared. Although questionable increases become evident when merely considering growth figures obtained from each census, more significant disparities are realized when both census figures are compared in an absolute sense to those values derived from this study. Immediate indications are that certain municipios have been grossly over-enumerated by census-taking personnel, this complemented by an under-enumeration of other units. Some of the more apparent census inaccuracies are:

(1) The four municipios comprising the eastern sector of the study area are Santa María Chiquimula, Totonicapán, Nahualá, and Santa Catarina Ixtahuacán. Respectively, the 1964 Population Census lists each rural population as 14,281; 35,268; 20,782; and 11,712--totalling 82,043 inhabitants. This compares to a total of 28,706 inhabitants derived from utilizing topographic map information, a value approximating one-third of the published totals. Even when allowing for the physical conditions under which many highland

Indians live, it is inconceivable that an elevated topography of extreme local relief, such as exists throughout these fringe municipios, could support a rural population in excess of 80,000 inhabitants (the total area of these four units barely exceeds 800 kms.^{2} by official figures). Southern portions of this eastern sector are dominated by dissected cinder cones, and the entire area is characterized by heavily eroded lands of relatively high elevation. Only limited portions of the Totonicapán municipio are available for any form of intense human habitation.

(2) Cantel, a municipio located immediately east of Quezaltenango, is depicted in most Guatemalan sources as possessing an areal extent of 28 kms.^{2}. The 1964 Population Census lists 8,577 rural inhabitants for this political unit, indicating over 300 inhabitants per km.^{2}. This absolute figure is, in itself, difficult to comprehend, but in view of the inhabitable extent of Cerros Jolom, Chonajtajuyub, and Chuicham, which occupy nearly one-half of the municipio, the figure becomes absurd. The rural population value of 3,276, as derived from this project, is much more rational.

(3) Census figures are not always in excess of those derived from topographic maps. The Census of 1964 indicates a rural population of only 63 inhabitants for the entire municipio of San Mateo. Additional studies might indicate that local inhabitants are, in fact, urban oriented and migrate daily to their fields, thus, explaining this low rural figure. Yet, the presence of a national route across the northern sector of this unit, optimal accessibility to larger cities such as Quezaltenango or even Guatemala City, and the presence of rather large areas of productive agricultural lands afford the assumption that far more than 63 persons rurally inhabit this enumeration unit.

Other discrepancies and probable inaccuracies may be determined from the comparison of census figures to those values derived from this study; those mentioned above are only the more obvious. The composite results of such comparisons indicate that total values of rural population, though apparently correct in published form, are insufficient as a means of determining actual conditions within a selected area. For a more accurate analysis of these conditions, evidence indicates the importance of considering the quantity and quality of phenomena

as they exist within individual enumeration units. It is obvious that such criteria, as published in secondary data form, are presently being incorrectly estimated in the highland region of Guatemala.

Comparison of Rural Population Densities

The final attempt to associate the boundary-locating procedure presented in this paper with the ability to verify or discredit certain types of secondary data involves the consideration of rural density patterns within the study area. Density maps may be utilized in a number of ways, one being that of implying certain characteristics about the data consulted for actual map construction. If the distribution of a phenomena, as illustrated on a density map, is rational in appearance, the sources (of which one must be area) utilized to construct the density map may be considered reasonably accurate. In the case of population distribution and density, if the known influences of such factors as economic activity, local topography, proximity to transportation routes, and even cultural peculiarities do not conflict with the cartographically presented distribution of peoples, those sources consulted for actual construction of the population density

map may be considered reasonably accurate.[4]

Figs. 13 and 14 represent population distribution and density derived solely from Guatemalan sources, the municipios being constructed on the basis of official maps. The areas and population figures for these maps were taken from Tables 4 and 5. Map 13 depicts a somewhat logical distribution of inhabitants since high concentrations are shown to exist in parts of the Quezaltenango Basin where intensive agriculture prevails and where primary routes are available to supply the populous with an efficient means of transportation. Similarly, the southern fringe of the study area is depicted as very low in population numbers, coinciding with the chain of volcanoes located in this sector. However, within the context of the previous discussion of conditions within the eastern fringe area, Fig. 13 connotes a much higher population density than could exist in this sector. Fig. 14 sufficiently indicates a relatively dense population within limited sections of the Quezaltenango Basin, but does not convey the fact

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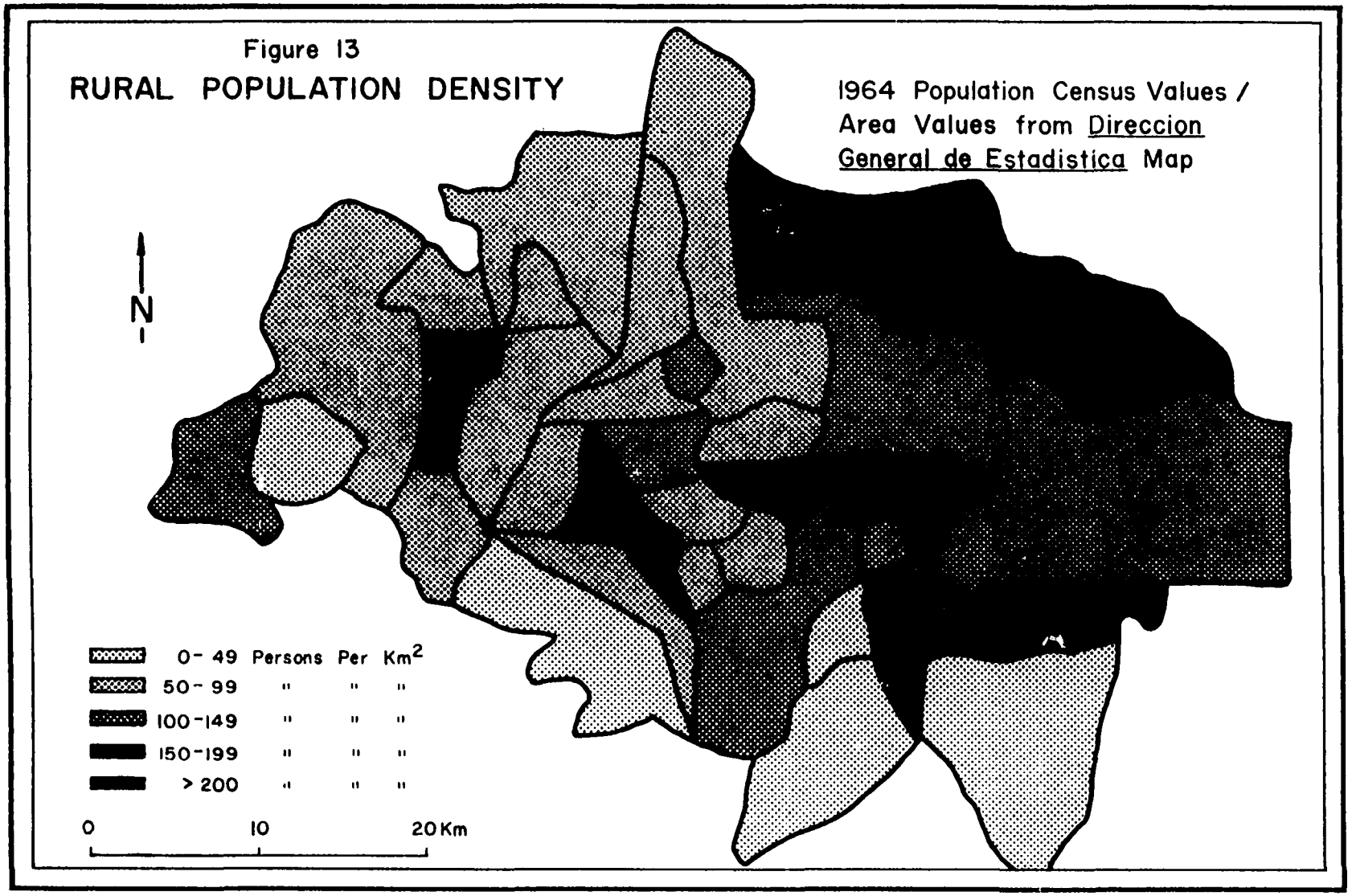
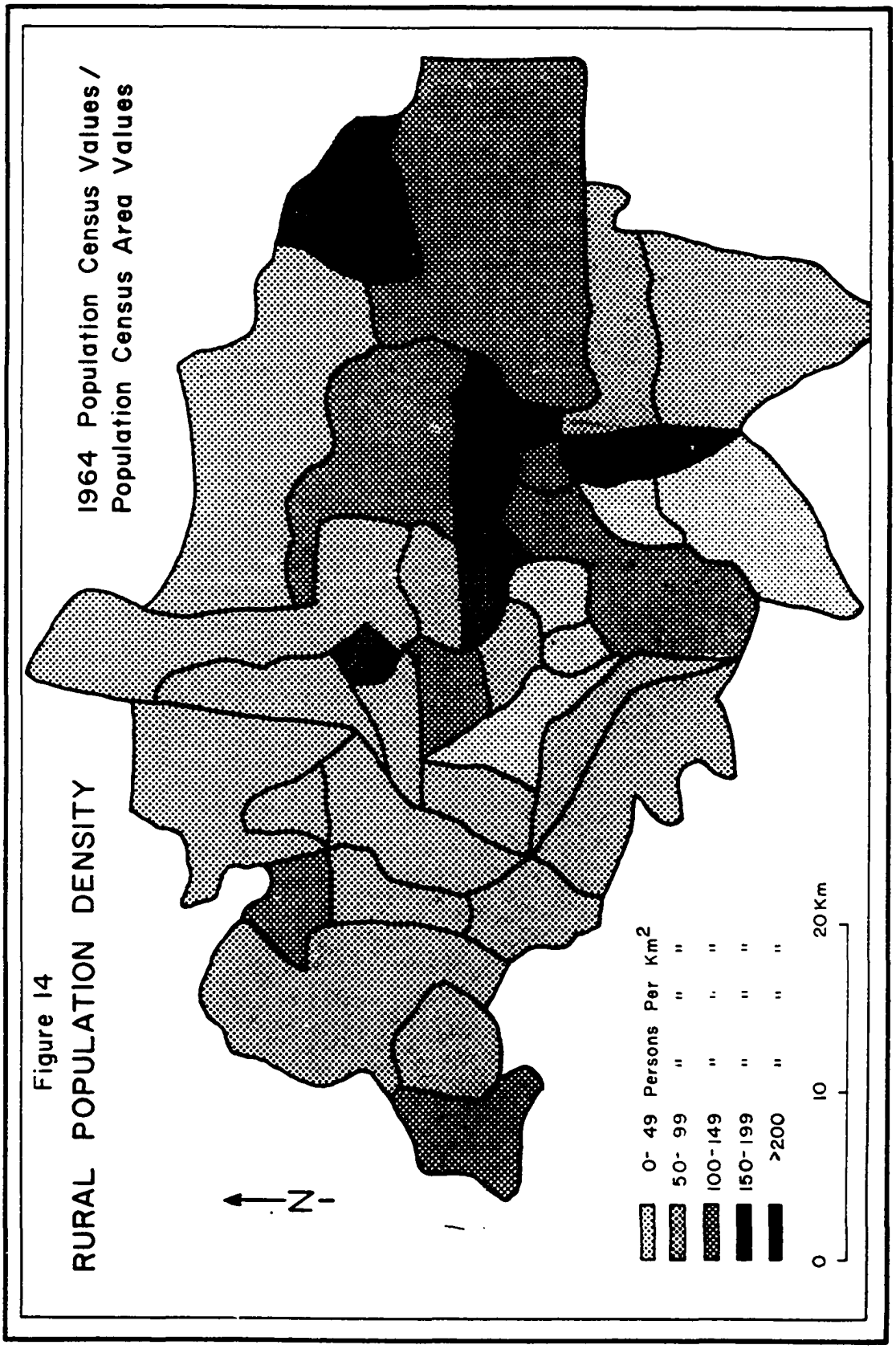
[4]It is neither the intent nor purpose of this paper to specifically relate features of the cultural and physical landscape to the distribution and density of peoples in the Guatemalan highlands. A proper context for the following discussion should be that of only determining which compared density map conforms most closely to conditions known to exist within the study area.

Figure 13

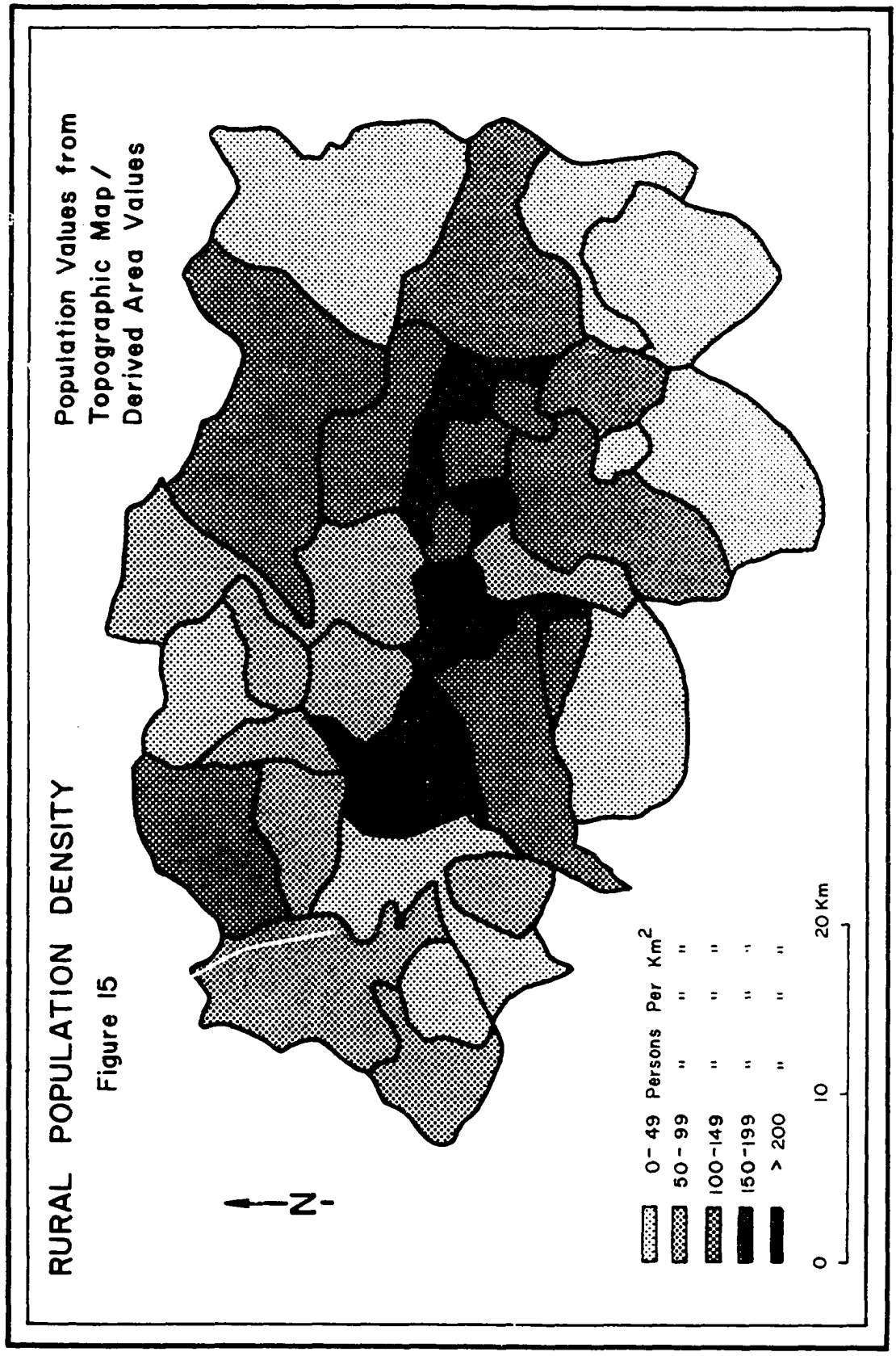
RURAL POPULATION DENSITY





that few people inhabit the slopes of the southern fringe volcanoes.

The final map of this rural population density comparison, Fig. 15, represents a population density derived entirely from efforts made through this project. Again, Tables 4 and 5 were consulted for construction of the map. Considering general determinants of population distribution within the study area, this map presents a most logical pattern of population density. Relatively large numbers of people can be associated with the major intermontane basins found within the area, as with the major arteries of transportation that traverse the various municipios. Areas of volcanic prevalence are depicted as being sparsely inhabited; and those municipios in the northern, more elevated, portions of the study area, where isolated Indian dwellings dot the countryside, are presented in the intermediate range of population density. The only concern over the pattern of this map regards the extreme drop in population numbers between the municipio of San Pedro Sacatepéquez (Fig. 2, unit #29) and the adjacent municipios of San Antonio Sacatepéquez and Palestina de los Altos (Fig. 2, units #36 and #11, respectively). This is due in large part to the scarcity of dwelling units found in the southern half of San Pedro Sacatepéquez (in proximity to volcanic



cones), which influences the density value for the entire unit. Density transitions in all other parts of the study area are quite logical. As such, this density map provides a more rational distribution of rural population than those population maps derived from published Guatemalan sources. The absolute accuracy of data utilized in the construction of this density map is manifested in the conformity of population density to basic determinants of population distribution.

The series of data comparisons presented in this chapter explicitly afford proof that discrepancies exist between published sources of area/population data and similar data types derived from topographic maps. The decision as to which data source is more accurate in absolute terms is solely dependent upon acceptance or rejection of the boundary-locating procedure presented earlier. If the use of politically-defined toponyms as a means of approximating enumeration unit boundaries is accepted in conjunction with the verification techniques of Chapter III, it must be concluded that official sources of pre-collected area/population data pertaining to Guatemala's highland region are erroneous in absolute value. If basic data on area and total rural population are incorrectly published for international use, it must be logically assumed that more sophisticated data types

are also incorrect. This assumption permits the utilization of area and total population figures as indices of other data accuracy and accords more validity for this boundary-locating endeavor.

If application of this technique produces area and population values which coincide with published materials, it may be conjectured that absolute data accuracy is available through pre-collected sources. If this application produces discrepancies, as demonstrated in the highlands of Guatemala, it must be hypothesized that available data are of questionable value for academic research. With the aid of topographic maps, verification of both enumeration unit boundary locations and adherence to these locations when collecting data is one means of appraising these pre-collected source materials.

CHAPTER V

SUMMARY

The interrelatedness of pre-collected statistical data, political boundaries that serve to delimit statistical enumeration units, and topographic maps constitute the central theme of this thesis. Being interdependent upon one another, an enumeration unit becomes functional only when its boundaries are accurately located and adhered to by the data collector. Without proper adherence to accurate location, accumulated data may be highly misleading. Concurrently, statistical enumeration units most often coincide with a politically defined unit whose boundaries may be observed or at least generally located on topographic maps. These maps readily serve to verify the location of boundaries upon which data have been gathered and may be utilized to confirm the accuracy of a variety of data.

The fact that political entities function as statistical enumeration units bears directly upon the ability to collect mass data accurately. When systematically derived, as in many portions of the United States, these units facilitate the delimitation of boundaries and adherence to them during the process of

data collection. Opposed to this situation are large portions of the earth's surface wherein the land tenure system has failed to provide for an orderly delimitation of land units. Within such areas, ill-defined enumeration units create near-insurmountable problems when collecting data of the numerical type.

Exemplifying this latter situation is the Central American Republic of Guatemala and, specifically, a portion of its southwestern highland region. Here, the impact of historical trends, both national and regional, has tended to preclude any type of systematic construction of political units for use as statistical enumeration units. Colonial motives for New World settlement, the lack of a frontier region, economic dependence upon a monoculture, and political instability have contributed immensely to the haphazard construction of municipio limits within the country. Regionally, the predominance of Indian inhabitants within the southwestern highlands, physical features of the landscape not conducive to Spanish economic interest, and periodic shifting of existing unit boundaries to form new or different political units have further contributed to the lack of well-defined enumeration units. The need to verify the absolute accuracy of pre-collected data by means of confirming enumeration unit limits is directly proportional

to the degree of haphazardness exhibited by countries in their attempt to delimit internal political units.

The technique devised for this confirmation of utilized enumeration unit boundaries consisted of initially grouping all place-name locations (both physical and cultural) within their respective political units so as to derive approximate boundary locations, and then subjectively determining the final location by reliance on transportation network patterns, mountain ridges, valley floors, or other features of the landscape. Consistent use of this procedure produced "best approximation" locations for the thirty-six municipios found in the study area.

The emergence of sufficiently large discrepancies between these derived boundary locations and those recognized by current agencies within the Guatemalan government demanded some type of verifiable proof as to which boundary set was, in fact, more accurate. To accomplish this, coefficient correlation analysis was applied to the derived boundaries using distance values from points of origin within a unit to the site where a boundary segment intercepted an identified route. Independent distance variables were obtained from the Guía Kilométrica de la República de Guatemala and dependent variables were obtained from topographic maps used in

the study. The degrees of association exhibited by first utilizing all available distance variables and then only those found initially within ± 1 standard error from the regression line demonstrated correlation values significant at the .01 level. These degrees of association statistically verified the proximity of derived boundary locations to those formerly considered within the Guía Kilométrica.

Additional field verification of the entire single municipio boundary and further substantiated both the utility of this boundary-locating technique and the positive results made possible by its application. Minimum discrepancies in location appeared between the derived locations and those determined in the field. Such verification, in conjunction with the statistical confirmation, provided positive proof that boundaries depicted through this project were accurately located.

Acceptance of these "best approximate" boundary locations necessitated the acknowledgement of other types of measurements concerning the units of the study area. Applying the utilization of a planimeter to the boundaries derived through this project produced area values for each municipio which must be considered to be as accurate as the boundary locations. Procurement of these enumeration unit area values provided an

initial means of verifying the accuracy of certain data made available from official Guatemalan sources. Comparison of the derived area values with five independent Guatemalan sources of similar data afforded substantial proof that inaccuracies exist within the official publications with regards to this specific data type.

Given the approximate location of enumeration unit boundaries on topographic maps, it was also possible to accurately determine rural population values for each municipio within the study area. Initial totalling of illustrated dwelling units within the confines of any derived boundary and subsequent multiplying of this total by the average number of inhabitants per dwelling unit produced a rural population value for each enumeration unit. A second type of published data, thus, became available for verification.

The comparison of derived rural population values was at considerable variance with figures produced by the 1950 and 1964 Population Census. Total values from each census for the entire study area were remarkably consistent and apparently accurate. For the fourteen year interim, a range in error of only slightly more than 6 per cent was determined for the three total population figures. However, a comparison of individual municipio rural values produced significant discrepancies.

Observations indicated the possibility that numerous units had been over and under enumerated in the official census counts. This would appear to indicate that while total population values for the study area, as presented in published form, may be acceptable this may not be the case for single units within the region.

A final means of ascertaining the accuracy of data samples made available by Guatemalan authorities consisted of combining enumeration unit area values with total rural population figures to produce rural population density patterns. A general familiarity with the study area's cultural and physical landscape suggests the reliability of resulting distributions of people. Two density maps, derived entirely from Guatemalan sources, depicted a somewhat irrational distribution of rural inhabitants. Associations of people with extremely rugged volcanic areas was excessive, as opposed to minimal associations with proximity to transport routes and intermontane basins. A third map presented a distribution of rural inhabitants as determined from values derived entirely from this project. This density map complied more uniformly with conditions known to exist within the study area. Intermontane basins (notably, the Quezaltenango Basin) were densely populated, high-elevation fringe areas of rugged terrain were depicted

as nearly devoid of population, and proximity to transportation routes coincided decidedly with high density values. This density map provided a more realistic distribution pattern than the maps derived from official data, thus enhancing the character of data accumulated through this paper.

A conclusion of major import emerged from these comparisons of municipio areal extent and rural population values which reflects significantly upon all types of data being gathered and published by Guatemalan officials. Enumeration unit values of area and total rural population are two of the easier types of data made available to the data collector. Given proper enumeration unit limits, neither phenomenon is complicated in structure. If these more easily derived components of the landscape are miscalculated and published in erroneous form, it must be assumed that more sophisticated types of data are being amassed and published in similar form. The predominant utility of this project becomes explicit. By verifying or discrediting pre-collected area values and total rural population figures for selected enumeration units, verification or discreditation of more sophisticated phenomena is assumed. The accuracy of published area and total rural population values adequately serves as criterion for other data types.

Available pre-collected data, as published by Guatemalan authorities, give evidence of representing inaccurate conditions within the highland area of the country. This fact has been established upon application of the enumeration unit boundary location technique presented in this paper. Had results from this project been more conducive to these published data, the opposing conclusion could have been derived. Through a step-by-step utilization of this technique it is now proposed that adequate consideration of quality be directed towards all types of data originating in this particular country before incorporating these figures into proposed research projects. Extention of this proposition encompasses a plea for concentrated efforts toward confirming data accuracy originating in all areas of the world. By utilizing available topographic maps in the manner prescribed here, this all-important phase of research activity could be accomplished.

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