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APPLICATION OF SATELLITE PICTURES TO CENSUS OPERATIONS

Bolivian Experience in Census-Taking of Population and Residences

No author given

(NASA-TM-75090) APPLICATION OF SATELLITE PICTURES TO CENSUS OPERATIONS. BOLIVIAN EXPERIENCE IN CENSUS-TAKING OF POPULATION AND RESIDENCES (National Aeronautics and Space Administration) 14 p HC A02/MF A01	N78-19581  Unclas G3/43 08644
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Translation of "Aplicaciones de las Imágenes de Satélite a Operaciones Censales, Experiencia Boliviana en el Censo de Población y Vivienda," Instituto Nacional de Estadística, Ministerio de Planeamiento y Coordinación, República of Bolivia, La Paz, Bolivia, Report, August 1977, pp 1-14



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D. C. 20546 MARCH, 1978

## STANDARD TITLE PAGE

1. Report No. NASA TM-75090	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Application of Satellite Pictures to Census Operations - Bolivian Experience in Census Taking of Population and Residences		5. Report Date March, 1978	6. Performing Organization Code
		8. Performing Organization Report No.	10. Work Unit No.
7. Author(s) None given		11. Contract or Grant No. NASW-2791	
9. Performing Organization Name and Address SCITRAN Box 5456 Santa Barbara, CA 93108		13. Type of Report and Period Covered Translation	
		14. Sponsoring Agency Code	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		15. Supplementary Notes Translation of "Aplicaciones de las Imágenes de Satélite A Operaciones Censales. Experiencia Boliviana en el censo de población y vivienda," Instituto Nacional de Estadística, Ministerio de Planeamiento Y Coordinación, Republic of Bolivia, La Paz, Bolivia, Report, August 1977 pp 1-14	
16. Abstract  The use of photographs from satellites to assist in census operations is discussed. Principles of selecting the sources of cartographic information are outlined, and the use of LANDSAT pictures in census cartography is discussed.			
17. Key Words (Selected by Author(s))		18. Distribution Statement  Unclassified - Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 14	22.

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# APPLICATIONS OF SATELLITE PICTURES TO CENSUS OPERATIONS

## Bolivian Experience in Census-Taking of Population and Residences

National Statistics Institute  
Bolivian Ministry of Planning and Coordination

### 1. CENSUS CARTOGRAPHY

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#### 1.1 Objectives

The census-taking of inhabitants and residences in Bolivia, undertaken on September 29, 1976, required the detailed preparation of a series of preliminary studies needed to assure the success of the operation. Since 1950, the country had not carried out a general program of such magnitude, and it met with a lack of statistical tradition and previous information necessary in planning the various tasks.

One of the basic requirements in the preparatory work for the census is census cartography, i.e., the set of maps and charts to be used by the census taking personnel while they are carrying out interviews.

The following are the objectives of census cartography:

a) Geographic coverage of the country to prevent the possibility of omitting regions or areas;

b) Organization of the census-taking operations from the geographical point of view, by determining correctly outlined areas containing a predetermined number of homes;

c) Rational distribution of the census documentation required in /2

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\*Numbers in margin indicate pagination in foreign text.

each of the areas, determining previously the requirements for political and administrative decisions, and the census subdivisions;

d) Supplying the census information, once it is processed, not only to the principal regions or divisions of the country, but also the smaller areas, providing the required information for specific projects of economic and social development.

## 1.2 Establishment of the Basic Maps

To draw up the final census maps, it was necessary to implement several stages of the study, which were, essentially; a: cartographic inventory, b: establishment of basic maps to be brought up to date; c: precensus of homes and cartographic revision, d: final office studies.

The cartographic inventory is intended to compile all the documentation existing in the country, both for the rural and urban areas, which might be useful for the objectives of the operation. In the case of rural areas, or areas of scattered population, the area covered by the Military Geographical Institute did not complete 50% of the territory, as may be seen by the enclosed map, even though it corresponds to the provinces containing most of the Bolivian population, and the highest densities. /3

Keeping in mind that the census should be carried out in all the political and administrative areas of the country, it was obviously necessary to find other sources of cartographic information permitting the organization of census-taking operations in the provinces not covered by the IGM maps.

The only past records obtained consisted of partial sketches of some areas and departmental maps compiled for the 1950 census, all of which was not only insufficient but deficient, both from the point of view of graphic representation, and the want of topicality in the information.

In the face of this situation, there were basically two options: launching a program of aerophotography to complete the territory without regular cartography, so as to be able to prepare photo-maps; and by organizing a program of field operations to obtain planimetric sketches, taking as reference the few existing deficient maps for these areas.

Both alternatives require very long periods of execution, incompatible with a reasonable census schedule and basically many totally disproportionate estimates, taking into consideration the objectives and limitations of an operation such as the census. /4

Setting aside these options, the use of pictures from technological satellites appeared as a more adequate and convenient alternative, once it was possible to assure they could be obtained through an agreement between the National Statistics Institute, Geobol, and the International Development Agency.

For all the areas covered by the departments of Pando and Beni, as well as the corresponding ones north of the La Paz Department (Itturralde and Franz Tamayo provinces); north of the Cochabamba department (Ayopaya and Chapare); and in the north, east, and south of the department of Santa Cruz (provinces of Nuflo de Chavez, Velasco, Sandoval, Chiguitos, and Cordillera), the satellite pictures represented the main source of information for the basic maps, required for undertaking a pre-census of homes. Once the operations in view of cartographic topicality and listing of homes were implemented in the field, the final census maps were prepared, to be used by the census personnel.

### 1.3 Office Studies

The sources of cartographic documentation for the basic maps should /5 meet several requirements, among which the correct graphic representation and the topicality of the toponymy are most important. The satellite pictures - interpreted by the technical services of the ERTS of Geobol - satisfied these requirements from the census point of view, by furnishing the graphic basis for the organization of precensus

operations. With respect to toponymy - generally unrevised - missions were provided for its revision and completion in the field. Taking into account these facts, Geobol furnished two types of maps, on the approximate scale of 1:250,000, with and without numbers of the natural and cultural sections. On the basis of these pictures, in the Cartography Department of the INE, maps were made of the provinces mentioned, and by this means it was possible to set up the pre-census of homes and the cartographic revision in this context.

#### 1.4 Field Operations

Between the months of October, 1975, and July, 1976 (with a break in the rainy months of December-January), the pre-census of homes was taken in the entire national territory. The basic maps prepared with the information coming from the ERTS pictures (for the previously indicated provinces) were revised and completed in the field, as the result of the work of the teams of supervisors and revisers who covered the different areas after a period of qualification and training. In short, this work led to revised references of the existing population centers, checking the number of accidents, establishing the limits of the districts or census areas and confirming those of Departments and Provinces, estimating the number of homes in each area, and planning census subdivisions. /6

## 2. PRINCIPLES OF SELECTING THE SOURCES OF CARTOGRAPHIC INFORMATION

One of the basic principles of census cartography is that the technical characteristics of the sources of information (basically graphic scale, references construction standards, cultural and national sections represented, dates of establishment, etc.), should be adequate for the density of the units studied in each area of the territory. In the case of Population and Home Census, the correspondence between the density of population and homes is of interest, for which one must consider the concentration and scattering of the same in each political and administrative division.

Starting from this hypothesis, it is possible to classify the scales

of the cartographic material for a census in the following way:

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A. Population distribution according to areas.	Type of Census Map
Principal cities and urban centers	Scale 1: 1,000- 1:2,000
Intermediate and small population centers	Scale 1: 2,000- 1:5,000
Densely populated areas of scattered inhabitants (rural)	Scale 1: 25,000- 1:50,000
Sparsely populated areas of scattered inhabitants (rural)	Scale 1: 100,000 -1:250,000 or more

Since the graphic scale with which the census maps were established determines the level of compiled information and the degree of details recorded, it is proper and necessary that the scales of the maps and charts used as sources of information be the same or similar to those employed to establish the census maps. A map or plane may be magnified or reduced to establish another for practical reasons, but not excessively, inasmuch as more information is not acquired with respect to the deformation.

In the special case of the population and home census in Bolivia, these factors were taken into account to select the inventoried maps, with regard to the areas of concentrated and scattered population.

For the reasons mentioned, the LANDSAT pictures could only be chosen as sources of information to establish the basic maps in the case of /8 the sparsely populated areas of scattered inhabitants (or those of low density). This determination was not only based on the scale of the latter (1:250,000) but because of many of the said areas there was no possibility of using the IGM topographic documents of greater topographic precision and higher level of geographic information. Consequently, the LANDSAT pictures were used for the departments of Pando, Beni, part of Santa Cruz, and Cochabamba, and discarded for the rest of the territory.

### 3. USE OF LANDSAT PICTURES IN CENSUS CARTOGRAPHY

In the areas of Bolivia where it was decided to use the satellite pictures, both geographic and demographic characteristics favored the use of the above-mentioned sources of information. Generally speaking, these are the basic reasons:

a) We are dealing with sparsely populated areas with low density of inhabitants, most of the regions of which are covered by virgin vegetation, or devoted to vast agricultural and cattle breeding operations and in which the sparse road development means that the rivers represent the main means of transport as well as the preferred areas of settling of the population.

b) The graphic scales (1:250,000) with which the pictures were /9 established are adequate for the regions concerned, taking into account not only their extent, but the low density of the cultural sections which guarantees an interpretation and representation consistent with the census needs.

Consequently, keeping in mind the reasons mentioned, the LANDSAT pictures have many advantages as regards scale, interpretation of accidents, and the maps to be drawn up. This cannot be generalized to other areas of the territory, with other geographic and demographic characteristics.

### 4. FUTURE POSSIBILITIES OF USE OF THE LANDSAT PICTURES IN OTHER STATISTICAL PROJECTS

Satellite pictures of the territory of Bolivia, or regions thereof, offer very promising prospects as regards the use of these sources of cartographic information for future statistical projects. The reasons are based on the following considerations:

a) The pictures may be obtained in comparatively short times, calculated from the remote perception by the satellite to the actual interpretation in the offices. The possibility of Eastern Bolivia being submitted to regular cartography (topographic scales) implies an /10

undertaking of very great magnitude, and presumably very costly, because of which such maps may not be used for many years in statistical projects.

b) The regions in which the satellite pictures were used for census purposes, as was stated, are of vast areas and low population density, justifying the use of 1:250,000 scale for rural areas. Assuming that the densities of these regions will not vary substantially within a short time, this scale would continue to be justified and therefore the pictures may continue to be the main source of cartographic information for the future.

c) For census projects, the National Statistical Institute will have to tackle the permanent revision of the selected areas (segments) for undertaking investigations by sampling for census purposes. These operations will have to include preliminary office activities in each area, sketching field missions, listing of homes and revision of the toponymy and references in the chosen census segments. Since these /11 studies will have to be carried out with a semestrial or annual periodicity, the possibility of having cartographic sources which also revise periodically the information on the changes occurring in the natural or cultural sections is very important. This will represent another positive factor for the satellite pictures for those rural areas of eastern Bolivia integrating the selection of the samples for future statistical projects.

d) Finally, to implement the National Census for Agriculture and Cattle-Breeding, census maps will have to be prepared with an outline of the geographic entity of each political and administrative subdivision. The experimental studies which are being carried out by Geobol, regarding the interpretation of the pictures for compiling maps for the utilization of Bolivian soil may be an invaluable contribution for these purposes.

## 5. CONCLUSIONS

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Considering the deficiencies mentioned in sources of cartographic

documentation for extensive areas of Bolivia, as well as the importance of furnishing revised maps and plans to census personnel for adequate organization of their work, the contribution of the satellite pictures to the population and home census was, on the whole, positive. This contribution may not only be considered as particularly valuable for census cartography in several departments, but also - with the revision and completion in the field during the pre-census and census - it enables the INE to have at its disposal the most topical planimetric maps Bolivia possesses for statistical purposes.

Taking into account the greater speed in obtaining pictures than in drawing up topographic charts for vast areas of the country, the use of the former offers promising prospects for future statistical projects.

NAME OF SATELLITE PICTURES USED AS SOURCE OF INFORMATION IN THE PREPARATION OF CENSUS MAPS

Name	Identification Code
Río Abuna	1191-14075
Río Acre	1424-14002
Guayaramerín	1045-13554
Bolpebra	1192-14140
Cobija	1191-14082
Riberalta	1045-13561
Río Heath	1191-14084
Río Madidi	1424-14012
Rosaguado	1045-13563
Magdalena	1224-13515
Versalles	1223-13461
Río Guaporé	1240-13403
Apolo	1191-14091
Rurrenabague	1424-14015
San Borja	1045-13570
Trinidad	1224-13522
Perseverancia	1223-13043
San Simón	1240-13410
Nacientes Río Verde	1005-13335
Lago Titikaka	1191-14093
Covendo	1045-13572
Río Chapare	1224-13524
Ascensión	1223-13470
Concepción	1240-13412
San Ignacio	1005-13341
Sierra Aguapel	1454-13270
San Matías	1453-13212
Norte Roboré	1454-13272
Puerto Quijarro	1453-13214
Cabezas	1240-13421
Izozog	1005-13350
Roboré	1454-13275
Tacuvaca	1453-13221
Laguna Mandiore	1038-13180
Camiri	1240-13424
Fortín Mendoza	1005-13353
Cerro San Miguel	1238-13311
Puerto Busch	1453-13223
Mutún	1038-13183

FOLEPOT FRAME 2

FOLEPOT FRAME 2

70°

69°

68°

67°

66°

65°

64°

63°

62°

61°

60°

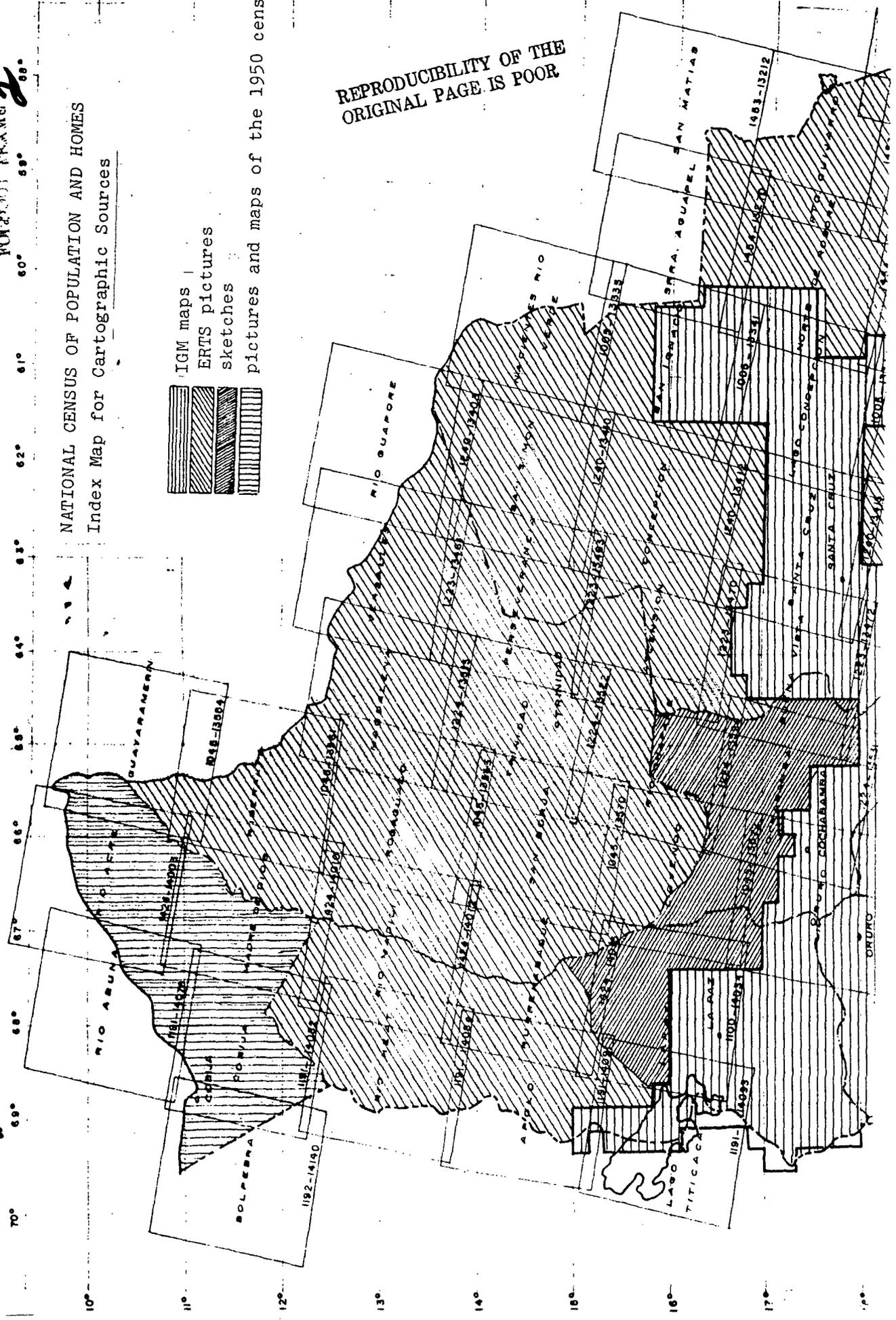
59°

58°

NATIONAL CENSUS OF POPULATION AND HOMES  
Index Map for Cartographic Sources

- IGM maps
- ERTS pictures
- sketches
- pictures and maps of the 1950 census

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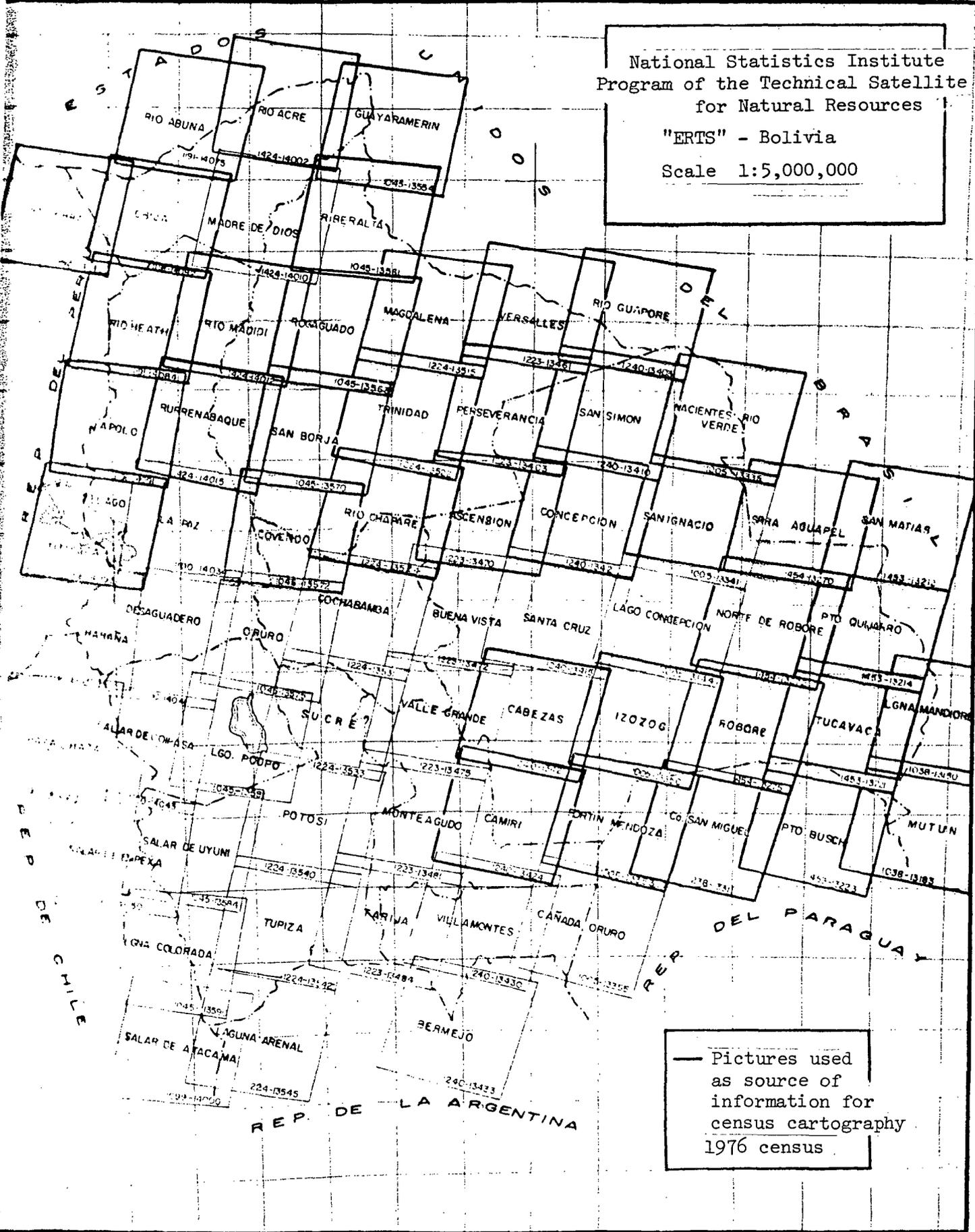




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National Statistics Institute  
Program of the Technical Satellite  
for Natural Resources  
"ERTS" - Bolivia  
Scale 1:5,000,000



— Pictures used as source of information for census cartography 1976 census

69° 68° 67° 66° 65° 64° 63° 62° 61° 60° 59° 58° 57°