

Agrarian Cadaster
Comparison among three different methods
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1.0 - Introduction

We have chosen this theme to be presented at the XVth International Congress of Photogrammetry and Remote Sensing because we have the conviction of the high importance of finding solutions for the agrarian problems, above all in the developing countries. In Brazil, for example, the problem of distribution and regularization of properties attains an area of about 1,800,000 square kms. located mainly in the North and Northeast of Brazil. This is around 1/4 of our territory and where occupation of the soil is many times done disorderly, irrationally and even illegally, since the government does not have sufficient information to establish a more convenient agrarian policy for the region.

Considering that the Brazilian rural population is approximately 40,000,000, it can be inferred the social importance for legalization of rural estate ownership in Brazil. The problems related to the agrarian topics could be discussed under innumerous aspects:

- The level of development of the country, its occurrence and the tradition in the treatment of these problems.
- The value of the land and the frequency of alterations in its utilization.
- The existence of official documentation and clearly defined boundaries of the land.
- The existence of a specific policy for agrarian problems.
- The technical and financial means available for the project, etc.

In this report we are not intending to discuss all of this gamut of aspects connected with the theme, but we could not fail to at least cite them, since what we will put in relief in our report is just one of the aspects connected with the agrarian question, i.e; the comparison among three different methods of land registration for the purpose of legalization of rural estate ownership.

As is implicit by the very title, our investigation is directed to the case of seeking to realize a gathering of information for the execution of an agrarian policy most convenient for Brazil.

We believe that, Brazil being a country of many characteristics similar to other countries of the third world, the research we are realizing and presenting may represent some contribution to other parts of the world, where they plan to implant methodologies for the survey and regularization of rural properties.

2.0 - Objective

Through data collected in all phases of a complete project of land registration and legalization of rural estate ownership, the objective of our work was to establish comparisons among three different methods of registration of rural properties, that is: by graphic restitution, orthophotomaps, and conventional topography. These comparisons refer to productivity, execution time and some considerations on accuracy.

3.0 - Methodology

The methodology of the work consisted in:

- a. Restitution: Compilation of data obtained in the routine operation in all phases of registration.
- b. Orthophotomap: Utilization of data obtained in the production of Orthophotomap plus, field tests of operations corresponding to unfiled experimental data, as for example, the survey of unidentified points in the aerophotos.
- c. Topography: Survey of properties in the field by conventional topography with instruments usually utilized in the ground control work such as Tellurometer Teodolithe, Sights, etc.

4.0 - The Test

4.1 - Graphic Restitution

TerraFoto was contracted by INCRA - Instituto Nacional de Colonização e Reforma Agrária - to perform, the survey of 50,000 hectares by photogrammetric restitution for the purpose of legalization of rural estate ownership in Paraíba, northeast of Brazil. The objective of this survey was to provide the contractor with the individual property plans which together with a descriptive memorial becomes part of the property title that INCRA provides each owner.

The work methodology, as requisitioned by INCRA, consists of the following:

Photo scale - 1:25,000

Camera WILD RC10, focal 152 mm

Lateral overlap 30% and longitudinal - 60%

Semi-analytical aerialtriangulation, adjusted by the PAT-M43 Program.

Map scale: 1:5,000

In this phase, the operator works with enlarged photos in the scale of the plan, where the corners of the properties not identified by natural details, were punched in a previous stage of field photo annotation.

Once the limits of the properties are characterized, they are digitized in the stereoplotter through the points that define them.

From the coordinates of these points, each property is drafted individually, containing between one landmark and another the azimuths and distances which together with

other information relative to the properties will compose the descriptive memorial of each parcel that accompanies the property title to be provided to the owner of the land.

Among the methods of accurated registration survey, we have chosen two other equally precognizable for determination and registration of rural properties in order to establish some comparisons, among the three: Aerial survey through orthophoto and land survey by means of conventional topography.

4.2 - Orthophotomap

For the same finality the same project was executed utilizing orthophotomaps.

By this process all the stages prior to the preparation of the etereoscopic model are the same as the graphical restitution.

Following that, we substituted the operation of photo-interpretation and selection of the details to be represented, by scanning the whole image that is subsequently reprocessed, generating the orthophotomap.

From this phase we start differing the restitution of the orthophoto and we characterize its utilization to arrive at the final product which is the registration of the property.

With this orthophotomap the operator goes to the field to execute the identification of the limits of the properties, giving distinct detail to their limits and pricking the places where the marks should be positioned.

Using the same image with the points that were indicated in the field, the boundary marks of the properties, by this process, are digitized directly over the orthophotomap.

4.3 - The Topographic Process

To establish the comparison of advantages and disadvantages of the three processes, we also made the terrestrial survey of the area where the measurements of the properties were made by restitution and orthophoto.

Not to take advantage of the fact that there already exists a survey of this area done with the aid of photographs, we chose a field team that had not participated in the registration of the area under study.

A croquis was made available of the area which already contained the official geodetic network utilized for determination.

Having to occupu the point for the measurement of the property marks, it was necessary to establish one more phase of exploration in the field where the conditions of intervisibility between the marks were analyzed, directing the sights in function of the conditions of the relief and a trail was made where vegetation impeded execution of the work.

5.0 - List of Activities

For the purpose of establishing a discussion in sequential order of how the various activities involved in the process of providing property titles, we present below a list of these activities in three different versions.

RESTITUTION	ORTHOPHOTOMAP	TOPOGRAPHY
a.Planning	Planning	Planning
b.Photogrammetric Flight	Photogrammetric Flight	-----
c.Ground Control	Ground Control	Ground Control
d.Property Identification	Property Identification	Property Identification
e.Boundary Monumentation	Boundary Monumentation	Boundary Monumentation
f.Restitution	Orthophoto	Exploration
g.Digitizing	Digitizing	Measurement of points
h.Survey of unidentified points	-----	Calculations
i.Individual Maps	Individual Maps	Individual Maps
j.Calculations and Memorials	Calculations and Memorials	Calculations and Memorials
k.General Map	General Map	General Map
l.Land use Map	Land use Map	-----

a. Planning

This phase may be considered to be the same for the three methods, since if in the photogrammetric processes the planning could be included beginning with the flight, in the topographic method, the topographic planning of field services consumes much more time for not being able to count on the help of aerial photos.

b. Photogrammetric Flight

This is a common phase to the photogrammetric process of which technical specifications are more rigid when orthophotomaps are going to be produced since the final product is the photographic image itself. On the other hand, this rigidity impedes the inconveniences, in subsequent phases of a flight not realized under ideal conditions.

c. Ground Control

This is a phase absolutely equal in flight for restitution and for orthophotomap as long as the flight has been realized with the same technical regidness. For the topographic survey this step corresponds to the network that has to be implanted for the inter-connection with the property marks.

d. Identification of the Properties

The greater or lesser rapidity in which this phase can be developed depends on various factors.

- Accessibility to the area.
- Size of property.
- Knowledge that the owner has of his property.

- Type of boundary that limits the property.
- Legal structure and laws of the registry of properties.

These are common factors to any of the above three methods.

We should stress, however, that this task is much more difficult when identification of the properties has to be done without the use of aerial photos, as in the case of purely terrestrial survey method.

e. Boundary Monumentation

Also in this phase the utilization of photographs is of great help in the planning of the routes and means that will be utilized to transport the monuments up to the specific points where they will be placed.

f. Restitution

This is the phase that most characterizes the differentiation among the three methods.

In the graphic restitution, where the model is photo-interpreted in the stereo plotter, the significant details are graphically represented producing the line map.

In the orthophotomap the same methodology is used in the case of restitution up to the phase of absolute orientation, from where the process of photo-interpretation in the stereoplotter is substituted by an operation of scanning of the model for the transformation of the normal photographic image in the orthophotographic image.

By topography, obviously this activity does not exist.

In topographic survey there is a necessity of an extra phase of field exploration before the start of the measurement.

Only then comes the measurement of the property landmarks from a geodesic network previously established for this purpose.

Whereas in photogrammetry the activities that most characterize the process are restitution and orthophoto, in Topography it is undeniable that the most characteristic task is the topographic survey itself.

g. Digitizing

In this activity common to the photogrammetric process, we noted a great gain in productivity when the orthophotomap is used.

It could be said that the digitizing made in the stereoplotter is more accurate because the image in relief can be observed. On the other hand this advantage loses its effect when it is verified that the error in the identification of the mark in the photograph is normally superior to the one that can be gained by stereoscopic observation.

h. Survey of Unidentified Points

Under this item there are:

In restitution: the survey of unidentified points in the photographs obliges a return to the field for them to be localized by topographic process.

In orthophoto, this stage does not appear in as much as (and there is a great advantage over the graphic restitution) - in the field completion and punching, when the detail cannot be sharply located, it is possible, with the use of lining of identifiable references in the photos and of instruments of simple and direct measurement to realize the exact location of these points.

i. Individual Maps

This activity appears in three comparison columns.

The individual map of each property is one of the documents that accompany the property title. In the three alternatives the execution time is the same.

j. Calculations and Memorials

This is a typical office activity and in any process the degree of difficulty is practically the same.

k. General Map

By Aerophotogrammetry this activity appears very simplified, because whether in the restitution or in the orthophoto, the job consists only in emphasizing the boundaries of the properties of the map from which the landmarks of the properties were digitized.

By Topography the operation becomes more exhaustive since the maps have to be enriched with the boundaries of the properties, and other topographic details such as rivers and roads that will serve as important references to the properties.

Even then, a plant of multipurposes cannot be obtained as in the case of the aerophotogrammetric process.

l. Land use Map

In the project of Legalization of Rural Estate Ownership under study, the defined objective was the registry survey of the properties, including only sufficient information to serve this end.

Even if all the means of aerophotogrammetry are not explored immediately, the great potential of the stereoscopic model for the confection of maps of multiple thematic uses of the soil cannot be denied, and with no doubt, the great extra advantage that aerophotogrammetry offers is unquestionably the enormous quantity of information of the soil that can be obtained

with the use of aerial photographs.

On the other hand unquestionably there is the benefit of the simple use of the aerial photograph in the agilization of the various activities along all of the process of legalization of rural estate ownership from the identification of properties up to the final document, which is the title of possession.

6.0 - Productivity

On the basis of data collected in our research, we have arrived at the table below, which shows the man/hour productive capacity for each of the activities by the three different processes:

ACTIVITY	RESTITUTION	ORTHOPHOTOMAP	TOPOGRAPHY
Planning	402 ha	402 ha	402 ha
Photogrammetric Flight	138 ha	138 ha	-
Ground Control	21 ha	21 ha	21 ha
Identification of Properties	12 ha	15 ha	5 ha
Boundary Monumentation	8 ha	8 ha	5 ha
Restitution	23 ha	63 ha	-
Digitizing	42 ha	747 ha	-
Survey of unidentified points	8 ha	16 ha	5 ha
Individual Maps	37 ha	37 ha	37 ha
Calculations and Memorials	19 ha	19 ha	19 ha
General Map	22 ha	38 ha	5 ha

7.0 - Execution Time

As a consequence of the productivity numbers above we arrived at table 2, which shows the corresponding time in workdays to accomplish all the stages of legalization of rural estate ownership of 50,000 hectares corresponding to 4,200 properties.

8.0 - TABLE 2 - WORKDAYS NECESSARY FOR EACH ACTIVITY

ACTIVITY	RESTITUTION	ORTHOPHOTOMAP	TOPOGRAPHY
Planning	16	16	16
Photogrammetric Flight	45	45	-
Ground Control	298	298	298
Identification of Properties	521	417	1250
Boundary Monumentation	781	781	1250
Restitution	272	99	-
Digitizing	149	8	-
Survey of Unidentified points	781	391	1250
Individual Maps	169	169	169
Calculations and Memorials	329	329	329
General Map	284	164	1250
TOTAL	3645	2717	5812

From this table it can be concluded that mobilizing the same work force, the time spent per Restitution is 37% less than would be spent in the Topography process and 53% less by Orthophotomap.

9.0 - Accuracy

The item accuracy cannot be considered here with the same rigor that would be expected of a cartographic map, for the points that define the boundaries of the properties. That is because almost always these limits are determined in the field by natural details such as: hedges, bottom of valleys, water divides, etc., where the ideal point of separation between one property and another is practically impossible to be determined with the required exactitude for a sharp point in a conventional cartographic map, in the same scale.

Taking as reference some properties surveyed with geodetic accuracy, we arrived, for the same areas with the following average variations:

Restitution: +2.7%
 Orthophotomap: + 2.5%
 Topography: + 1.8%

Taking into account the relative low value of the lands in these regions, we consider inexpressive the differences found and therefore as to the accuracy aspect, any of the three processes for determination of rural areas is completely satisfactory.

10.0 - Final Considerations

A project of legalization of rural estate ownership, besides the essentially social character it presents, has as an objective the collection of socio-economic information, these subsidies being of great importance to the public administration in the national planning and integrated as government strategy.

Therefore, we consider the approach of this theme of the highest importance, which in a country with Brazil's characteristics assume vital proportions in its process of socio-economic development.

As it was said in the beginning of this report, the best method for registration of properties for legalization of rural estate ownership is conditioned to innumerable variables, such as:

- Dimension of the Area
- Availability of financial and technical resources
- Urgency in the execution of the project, as in Brazil presently
- Enormous extension of the Land
- High index of rural population
- Urgency in the solution of agrarian problems
- Scarcity of financial resources. The same research leads us to conclude that among the studied methods, the

process of registration for legalization of rural estate ownership, through the use of orthophotomap is the most recommended one.

11.0 - References

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