English Version

Measurement of rural areas by using aerial photographs with nominal and medium scale compared with the topographical GPS receiver

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Abstract

The present work refers to the planimetric evaluation applied to the Boa Esperança farm, located in Botucatu city by using the Global Positioning System and comparing with the values obtained through aerial photographs. Measurement with a topographical GPS receiver over fifteen points that were considered important to delimit the farm borders correctly was initially made. The data were submitted to the Datageosis software and the area was calculated. After that, using aerial photographs in scales 1:6000 and 1:30000, the farm border area was located and was submitted to a measurement with and without scale correction by using the SPLAN, software that permits the electronic area integration. The results obtained according to the methodology used allowed to verify that an average scale of aerial photographs enabled a great improvement in the area values. The area resulted from average scale 1:30832 is nearest to the measurement made by using the topographical GPS receiver.

Key-words: topography; GPS topographical receiver; aerial photographs

Introduction

The data acquisition related to the angular and linear quantities for the purpose of planimetric survey and/or planning on properties in rural area, regardless of their sizes becomes increasingly important. In this survey or planning, one must considerate all the variables involved. The topographic and cartographic information, directly obtained in the field of by aerophotogrammetric surveys, must be linked by geographic coordinates, appearing with it the need for the production of charts or maps reliable to facilitate the project elaboration.

The representation of the surface of the Earth is, nowadays, in a phase of integration between the conventional system and the digital on the production process, generating a paper chart or a "digital map", according to Philips (2002). Therefore, one can declare that the conventional mapping has improved by a dataset of graphic or geometric elements, referenced to the physical space by the coordinates of the points.

In accordance with Lattman and Ray (1963), the registration of plane areas in aero photographs allows measures of horizontal distances without significant errors. Oppositely, the authors affirm that when the ground is steep there is a necessity of providing image shift corrections.

The remote sensing, orbital or not orbital, constituted a safe solution to raise the potentialities and conditions of the natural resources, as well as determine the antrophic actions in a determined region of interest (CRUZ, 1981).

The accuracy of a survey, either it is planimetric, altimetric or aerophotogrammetric will always be a preoccupation observed in the construction of a representation of part of the surface of the Earth, and consequently, orthogonal projection to be used, whether the tools used are traditional or innovative. According to Tragueta (2008), the use of receivers (GPS) without the knowledge of their limitations may lead the user to practice or effectuate incorrect considerations on the values raised.

Topographic survey, in a general way, is based on measures of several natures aiming to determine degrees, distances and positions. It is important to

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understand that every measure performed by man may contain errors, regardless to the technology used, which spread when conducting this survey, affecting, for instance, the determination of the coordinates of the adjacent vertex of a property. The accuracy is closely linked to the acquisition methodology, basic support, densification and edition of the superficial information and its form of representation (ISHIKAWA, 2007).

Therefore, in accordance with Monico (2003), the accuracy of a survey is related to the ability of the redundant observations to detect errors in the models and in the actual survey.

In this context, this work aims to compare the values of the obtained areas, procedures and methodology of survey in rural areas, using the Global Positioning System (topographic receiver) and aerophotogrammetric material with nominal and average scales.

Material and Methods

The studied area, called Boa Esperança Farm, is located on Botucatu municipality, state of São Paulo, on the coordinates: 48º 22' 52" W and latitude 22° 49' 52" S, on the region called peripheral depression, with altitudes ranging from 480 to 558 meters.

In the planimetric survey by the Global Positioning System it was used the topographic GPS receiver brand Trimble ProXR with accuracy less than 50 cm, configured with the geoids SAD 69, the microcomputer and the software *datageosis* to calculate the area and to make the corresponding drawing.

To obtain the boundary of the Farm trough the aerophotogrammetric material it was utilized colored photographs scale 1:6000 and 1:30000; engineer's scale; tablet, with assistance of *splan* system, to determine the area and other drawing materials.

The area was firstly covered with the goal of previous recognition to dimension the number of pickets to be used during the research, as well as to have a definition of the best position of the receiver, always trying to avoid, when it was possible, the presence of intense canopy. It was elaborated, during the recognition, a sketch containing fifteen corner points of the property to be surveyed, aiming a rational survey in the area.

The survey of the studied area with assistance of the topographic receiver was accomplished in April 10th 2008, sunny day without clouds, collecting points of 60 positions in 05 seconds, enough time for tracking the satellite in each boundary point, observing the accuracy required by law to this kind of rural survey.

After the accomplishment of the raising by the GPS system, the latitude and longitude values obtained were inserted on the program called *datageosis*, where it was generated the values of directions, horizontal alignment distance, area and drawing of the polygon.

The drawing of the area obtained by GPS facilitated the localization and definition of the boundaries of the farm, study object on the aerial photographs. Colored photos were used in the nominal scale 1:6000 and 1:30000, both referent to the year 2005, with the area of interest in the picture number 47 (1:6000) in the lateral region of the image and in the picture number 48 (1:6000) in the central part. In the aerial photography with approximate scale 1:30000 the studied area is located in the center region of the photo.

The average scales were determined, having as a right reference the plant obtained by GPS as shown in Figure 1, where it can be seen by the dotted lines the directions taken, six in total, resulting thus on the average scales 1:6150 and 1:6113, with the first one located in the useful area of the image and the second one in the peripheral region. It was also determined the average scale 1:30823, having as a field reference the planimetric raising effected by the topographic receiver.

The areas obtained by aerial photographs, either on nominal scales, 1:6000 and 1:30000, or on medium scales, 1:61150, 1:6113 and 1:30823, had their values determined by the tablet with *splan* program.

Results and discussion

Figure 1 represents the perimeter of Boa Esperança farm, in which are represented the alignments taken to determine the average scale of

the aerial photographs and Table 1 shows the value of the areas in hectares, the difference between the areas in hectares and in percentage comparing to the value determined by the global positioning system and the scale of the photographs taken into account in this study.

In the planimetric survey accomplished on Boa Esperança Farm, Figure 1 and Table 1, by the global positioning system assisted by the topographic receiver, it was obtained the value of 125.49 hectares, value considered correct once it was observed all the parameters for a rural survey within the requirements of INCRA, according to the Law 10267/2001.

Taking only the perimeter of the studied property obtained in the central part of the aerial photograph, approximate nominal scale 1:6000, the calculations were made by splan system, reaching the value of 118.43 hectares. Comparing to the field survey, as it can be seen in Table 1, there is a difference, the smallest with 7.06 hectares, i.e., 5.6% of difference. Likewise it can be verified on Figure 1, the evaluated area located on the sideway of the photograph resulted in 118.55 hectares, representing 6.94 hectares (5.53%) less then the control.

Still in Table 01 it can be verified the area of 118.49 hectares which corresponds to the calculation when it is used aerial photographs in approximate nominal scale of 1:30000. This area is located on the center region of the picture, moreover, it presents a shifting of 7.00 hectares (5.58%) less than the value considerate correct.

Analyzing the value of the areas obtained and considering the values of the nominal scale according to Table 1, it can be affirmed that the value of the areas 118.43 ha, 118.55 ha and 118.49 ha obtained on the photographs at scales 1:6000, 1:30000 on the center region of the picture, and 1:60000 on the lateral region, are considerably close. It indicates that the location of the property on the photograph, center or lateral, in this scale conditions, has produced no

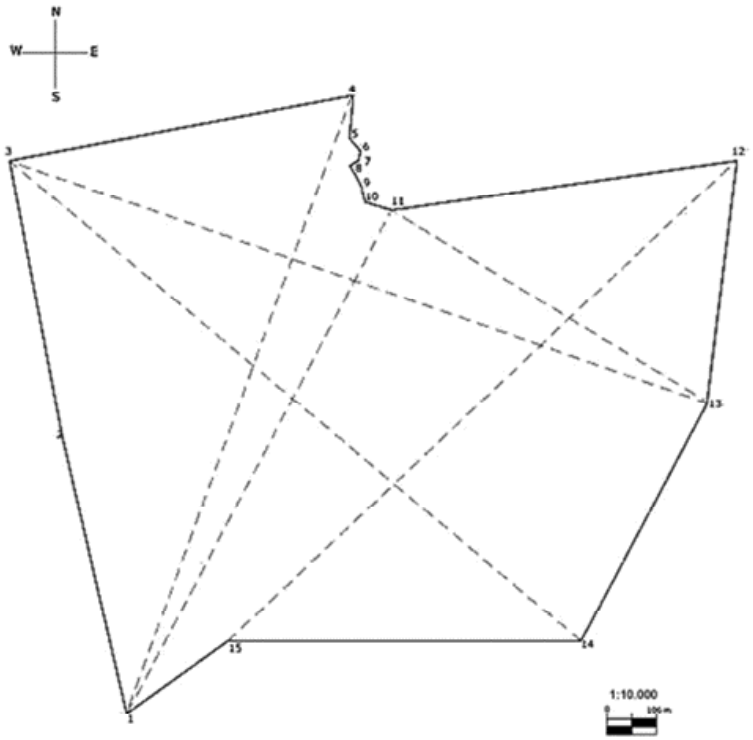

Figure 01. Boa Esperança Farm Perimeter, and the position of the alignments taken to determine the medium scale on the aerial photographs.

Table 01. Value of the areas obtained with topographic receiver and aerial photographs, in nominal and medium scales on the center region (C) and lateral region (L) of the image

GPS -- Photos	Area (hectares)	Difference in ha	Percentage (%)
GPS	125.49	0.00	0.00%
1:6000 (C)	118.43	< 7.06	5.60%
1:6150 (C)	124.40	< 1.09	0.87%
1:6113 (L)	123.06	< 2.43	1.94%
1:30000 (C)	118.49	< 7.00	5.58%
1:30823 (C)	125.08	< 0.41	0.33%

significant differences, however, the value obtained is distant from the value considerate correct, i.e., 125.49 hectares.

The determination of an average scale, in the photographs, referenced to the survey executed by the topographic receiver, as it can be seen on Table 1, made the values of the area change significantly, i.e., the photograph in which the property lies on the center region with average scale 1:61150 the value of area was 124.40 hectares, with an approximation of 5.97 hectares from the considered value, increasing to 1.09 hectares (0.87%) the value that was earlier 7.06 (5.6%). It may be verified in Table 1 that when the property is on the lateral portion of the picture, scale 1:6113, the value of the area is farther from the control, namely, 2.43 hectares. It is important to consider that the difference between the control area and the area obtained with average scale 1:61150 was 1.09 hectares.

Still regarding to Table 1, it may be ascertained that the medium scale 1:30823, in which the property was situated on the center region of the photograph, generated a value of area of 125.08 hectares. This area is 0.41 hectares (0.33%) smaller than the value of area obtained by the topographic receiver, thus, it is the smallest difference among the methodologies studied in this work.

Conclusions

By the analysis of the results to the conditions of this study it can be concluded that:

1. The determination of average scale on the aerial photograph showed a noticeable improve regarding to the values of area. Scale 1:30823 produced the value of area closest to the survey considerate correct;

2. The area of the evaluated property presented no important alteration when situated on the center region or on the lateral region of the aerial photograph when using the approximate nominal scale indicated on the aerial photography material. The value of the areas, though, were distant from the considered exact by the global positioning system;

3. The values of area ranged from 5.53% (1:6000 L), 5.58% (1:30000 C) to 5.60% (1:6000 C) and lower to the experiment area, when using nominal scale of the aerial photographs;

4. The values of area ranged from 0.33% (1:30823 C), 0.87% (1:6150 C) to 1.94% (1:6113 C) and lower to the experiment area, when using medium scale of the aerial photographs.

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