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Scientific paper

Comparison of planimetric measures obtained by GPS receiver and cartographic material

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Abstract

This study refers to planimetric survey made on the property Fazendinha da Serra, in Botucatu-SP. Using a Topographic Receiver (GPS) was performed a reading of 51 positions of UTM coordinates on the border of the property, being this number of points necessary for an optimal representation of the perimeter, due the property is situated in the part of the "front" and part in the reverse of the "cuesta". The calculation of the area and the perimeter of the property was obtained through the accuracy of the planialtimetric chart of the Geographic and Cartographs Institute of the State of São Paulo (IGC) and panchromatic aerial photographs of 1972 and colored of 2005, compared with the values obtained by the cartographic survey done directly in the field through the GPS Topographical Receptor. The results revealed that the area closest to the ground truth was obtained by planialtimetric chart in a scale 1:10.000, followed by aerial photographs from 1972 (T.A.) with denominator of average scale of 1: 25.987 and 2005 with approximate nominal scale of 1:30.000.

Keywords: topography; photogrammetry; planialtimetric chart

Comparação de medidas planimétricas obtidas por receptor GPS e material cartográfico.

Resumo

O presente trabalho se refere uma pesquisa com levantamento planimétrico realizado na propriedade denominada Fazendinha da Serra, localizada no município de Botucatu-SP. Utilizando um Receptor Topográfico (GPS) percorreu-se toda a divisa da propriedade onde se efetuou a leitura de 51 posições de coordenadas UTM, sendo este número de pontos necessário para uma perfeita representação do perímetro, devido a propriedade estar situada parte no "front" e parte no reverso da "cuesta". O cálculo da área e do perímetro da propriedade foram obtidos por meio do programa Datageosis versão 2.3 profissional. O objetivo foi verificar a precisão da Carta Planialtimétrica do Instituto Geográfico e Cartográfico do Estado de São Paulo (IGC) e de Fotografias Aéreas pancromáticas do ano de 1972 e coloridas de 2005, comparando-se com os valores obtidos com o levantamento planimétrico realizado diretamente no campo por meio do Receptor GPS Topográfico. Os resultados obtidos permitiram constatar que a área que mais se aproximou da verdade de campo foi obtida através da carta planialtimétrica em escala 1:10.000, seguidas das fotografias aéreas de 1972 (A.T.) com denominador de escala média de 1:25.987 e de 2005 com escala nominal aproximada de 1:30.000.

Palavras-chave: topografia; fotogrametria; carta planialtimétrica

Comparación de las medidas planimétricas obtenidas por receptor GPS y material cartográfico.

Resumen

El presente trabajo se refiere a una investigación com levantamiento planimétrico realizado en un sítio nominado Fazendinha da Serra, ubicada en Botucatu-SP. Con el uso de un receptor topográfico (GPS) se ha recorrido todos los límites de la propiedad donde se hizo la lectura de 51 posiciones en coordenadas UTM, y este número de puntos es necesario para una perfecta representación del perímetro, ya que la propiedad se encuentra en el "front" y parte en reverso de la "cuesta". El cálculo de la superficie y el perímetro de la propiedad se obtuvo a través del programa Datageosis versión 2,3 Professional.

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El objetivo fue verificar la exactitud de la Carta planialtimétrica del Instituto Geográfico y Cartográfico del Estado de São Paulo (IGC) y de fotografías aéreas pancromáticas del año de 1972 y en color del año de 2005, en comparación con los valores obtenidos directamente en el campo a través del receptor GPS topográfico. Los resultados revelaron que el área más cercana a la realidad del terreno se obtuvo mediante la carta planialtimetrica en escala de 1:10.000, seguido por fotografías aéreas de 1972 (AT) con denominador de escala media de 1:25.987 y de 2005 con escala nominal de aproximadamente 1:30.000.

Palabras clave: topografía, fotogrametría, carta planialtimetrica.

Introduction

Notably a large number of systems used today for the benefit of the civilian population have been designed with warlike purposes, as good examples may be related the taking of "aerial" photographs from balloons, the aerial photographs obtained through planes and more recently the use of satellites continuously tracking the planet Earth.

Currently a large portion of these technologies has been reverted to help researchers and tin he decision takings to meet, create means, evaluate and produce solutions.

In accordance with SCHAFER and LOCH (2005), the aerial photography is cited by MONTEIRO FILHO (1961) as a more rational solution, efficient and economic, in surveys of large areas, where appear difficult stretches.

Aerial photographs constitute a extremely rich storehouse of cartographic, geographic, geological information, etc., because they are the faithful representation of the land by them registered (AFFONSO, 2002).

According PISSARA et al (2003), since 1858, a period in which were taken the first aerial photographs, the remote sensing techniques were developed with the goal of identifying on the land surface the various components of image analysis.

BARROS et al (2010) using denominator of medium scale in aerial photography noted that there was a marked improvement in the values of area.

Also linked with satellites comes the Global Positioning System (GPS), these satellites are specialized in sending position information from any point of interest on the surface of the earth, such information in the form of longitudes and latitudes can be captured with greater or lesser degree of accuracy, depending on the quality of the receiver used and also of the good formation technique the operator.

In 1973, the Department of Defense of the United States developed a positioning system for military purposes. From this date, beginning to form a new horizon for execution of surveying and topographic works (ALBUQUERQUE and SANTOS, 2003).

The signals sent by GPS satellites are captured on the planets surface by suitable equipment (GPS), allowing determination of the 3D position. This is only possible if at least four satellites are simultaneously tuned by the receiver (HASEGAWA et al, 1999).

What reaches the sensor is certain intensity of energy that later turns into a signal subjected to interpretation (NOVO, 1995).

To BAIO et al. (1998) when using the GPS system the main sources of errors for positioning are the geometric arrangement of the satellites, the effect of multipath, the clock error of the GPS receiver, the interference of the ionosphere and the satellite orbital error.

According TRAGUETA (2008), the use of receivers (GPS), without knowledge of their limitations, can lead the user to practice or perform incorrect considerations in the raised values.

The objective of this study is to verify the accuracy of the raised area through the planialtimetric letter of the Geographic and Cartographic Institute of the State of São Paulo (IGC), of the panchromatic aerial photographs from 1972 and colored of 2005 when compared to the values obtained with the planimetric survey through the Topographical GPS Receiver.

Materials and Methods

The area of study, called Fazendinha da Serra, located in Botucatu-SP, in the geographical coordinates 48º 25'18 "to 48° 25'50" of longitude W Gr. and 22° 47'32 'to 22° 48 '12 " of latitude S.

It was used a GPS Topographical brand Trimble ProXR with precision less than 10cm, configured with WGS 84 geoid, where 51 positions were obtained from UTM coordinates on the perimeter of the property, noting the accuracy required by law, where each vertex positioned received a picket and a numbering from 00 to 50.

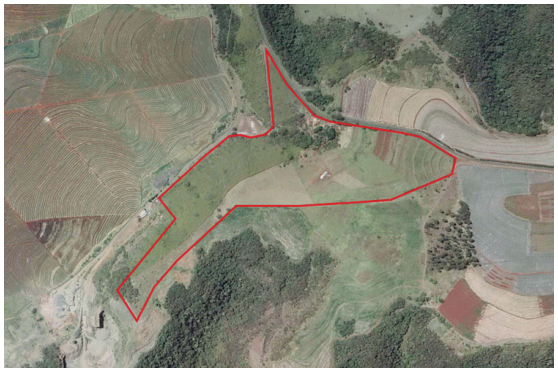

Figure 1. Limit of the property Fazendinha da Serra, (S / E).

The values of longitudes and latitudes obtained in the survey were processed on a microcomputer with a program in Windows environment called Datageosis professional version 2.3, where, besides generating angles and distances gave the design and calculation of the area.

It was used the planialtimetric letter of the Lageado Farm, Sheet SF-22-Z-B-VI-3-NO-D, 1:10,000 scale, with equidistance of contour lines of 5 meters from the Cartographic Plan of the State of São Paulo, vertical aerial photographs at nominal scale, approximately 1:25,000 panchromatic of 1972, range 23, photos 34 363 and 34 364 and vertical aerial photographs in nominal scale of approximately 1:30,000 of 2005 of the project B-917, range 26A, photos 8741 and 8742, both the municipality of Botucatu-SP, where defined in the after letter and in the photo the borders of the farm, it was proceeded determination of the area in both, with the help of the digitizing tablet, brand Digicon model MDD 1812 programmed by the System of Scanned Planimetry - SPLAN according (SILVA, 1993).

Results and Discussion

Table 1 shows the values of the area obtained in acres of property by GPS receiver, by letter planialtimetric, by the vertical aerial photographs in nominal approximate scale and the differences in hectares and percentage in relation to the value obtained by the Topographical GPS.

The area of the property object of study, Table 1, showed 29.12 ha when measured by Topographical GPS receiver, which is considered as ground truth data to compare other values found through the other cartographic materials.

The value of area found for the planialtimetric Letter 1:10,000 scale was of 29.24 ha presenting 0.12 ha as difference (higher) and of 0.41% in relation to the ground truth area, this difference is certainly due to the difficulty of obtaining the exact route of the perimeter of the property, since a portion of the property does not have perfect clarity on its borders.

Table 1. Values of areas and differences in (ha) and (%) obtained by the GPS Topographical, Planialtimetric letter and vertical aerial photographs.

	Scale	Area (ha)	Difference (ha)	Difference (%)
Topographic GPS	-	29.12*	-	-
Letter	1:10.000	29.24	< 0.12	0.41
Photography of 1972	1:25.000	27.46	>1.66	5.70
Photography of 2005	1:30.000	27.81	>1.31	4.50

** True area of the field*

The value of 27.46 ha Table 1 where obtained by means of aerial photographs of 1972 approximate nominal scale 1:25,000, resulted in a difference (minor) of 1.66 ha and 5.70% in relation to the control area .

In the colored vertical photographs of 2005, 1:30,000 scale, the area presented 27.81 ha with difference less than 1.31 ha and 4.50% in relation to that obtained by the GPS receiver.

Analyzing the area values obtained for the photographs of 1972 and 2005, Table 1, it can be seen that the differences in areas and their respective percentages found in relation to the area obtained by the topographical GPS may have occurred mainly due to the influence of the relief in the calculation of approximate nominal scale of the aerial photographs, because the studied area, Figure 2, presented two slope classes of the six intervals suggested by LEPSH et al. (1991), with 16.33 ha in steep slope with a slope of 9% (lower slope) and 12.79 ha with craggy relief representing 54% slope (greater slope), having an altitude difference of 115 meters (740 to 625 meters).

For a better assessment and comparison of the area with the ground truth, were made necessary calculations of Denominators of Average Scale of the aerial photographs in order to evaluate the methodology used by (BARROS et al, 2010).

Table 2 is presented as the reference to the area of 29.12 ha, obtained through the GPS receiver, the values of total area (TA) and the values obtained with the Denominators of Average Scale of the photographs of 1972 and 2005, besides the differences in hectares and percentage.

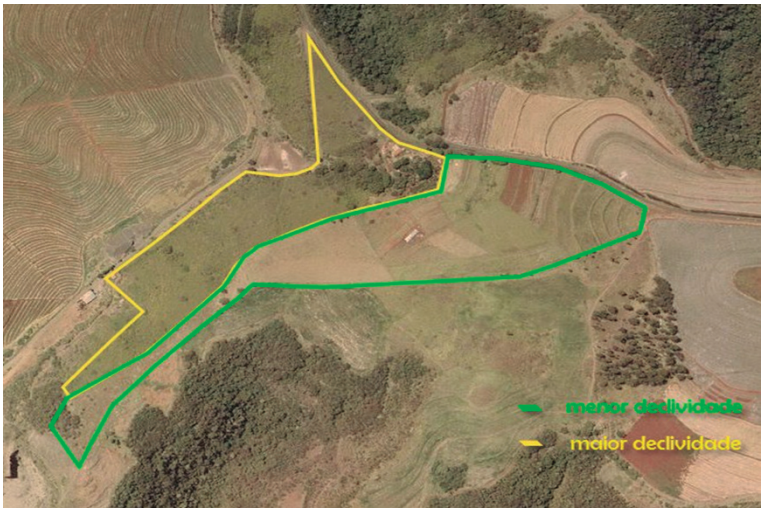

Figure 2. Perimeter of the property Fazendinha da Serra, and the limits of the areas of higher and lower slope (S/E).

Table 2. Values of area obtained through Denominator of Average Scale (DAS) and differences in (ha) and (%) in relation to the area obtained by the Topographical GPS Receiver.

	Scales	Area (DAS)	Difference (ha)	Difference (%)
Topographic GPS	-------	29.12*	-------	-------
Photography of 1972 (T. A.)	1:25.987	29.66	<0.54	1.85
(area of smaller slope)Photography of 2005	1:30.522	28.79	>0.33	1.13
(area of greater slope)Photography of 2005	1:30.313	28.39	>0.73	2.51
Photography of (T. A.)	1:29.889	27.60	>1.52	5.22

** True area of field. (A.T) - total area of the property.*

The value of scale calculated average, Table 2, for photography of 1972 (TA) showed the value of 1:25.987, resulting in an of area of 29.66 ha, showing a difference from hectares greater than 0.54 and 1, 85% in relation to that obtained by the GPS.

In colored vertical aerial photographs for the year 2005, the average scale calculated in the area of lower slope presented the value of 1:30.522, resulting in an area of 28.79 ha showing a difference lower than 0.33 ha and of 1.13 %and the region of greatest slope obtained an average scale of 1:30.313, resulting in an area of 28.39 ha, thus presenting a difference lower than 0.73 ha and 2.51% in relation to the control area.

The aerial photography referring to the year 2005 (TA), Table 2, which were also calculated a denominator average scale of which showed the value of 1:29.889 resulting in a value of 27.60 ha, with a difference lower than 1.52 ha and of 5.22% over the test area.

The differences of areas in hectares and percentage of aerial photographs, Table 2, of 1972 (TA) with DAS indicates quite proximity to ground truth data, while photographs of 2005 (AT) show a greater difference between these parameters.

These differences between the pictures of 1972 and 2005 (TA) Table 2 may be occurring due to the geometry of the obtainment of the images of the property, since, when the object is removed from the center of the photograph it tends to have higher distortions directly influencing the scaling value,as in the photo of 1972 the property is located near the central portion, less distortion region, while in the picture of 2005 the property is located on the side of the image.

It also can be seen during the development of this work that the aerial photograph of 1972 (TA) has a vegetation cover less dense when compared with the vegetation in aerial photography of 2005 (TA), thus enabling a better tracing the boundary of the property, and may therefore be influencing a minor

difference in hectares and percentage when compared with the field survey.

For the photograph of 2005 (the lowest part of the slope), Table 2, the results presented showed greater proximity of the value obtained by the field survey, a fact easily justified since the scale of aerial photography is directly connected to the physiography of the local relief.

Conclusions

Analyzing the results, it can be seen that:
The value of area that is closer to the ground truth was obtained through the planialtimetric letter in the scale 1:10,000.

Regard the differences of areas between the Aerial Photographs, considering the total area (TA) of the property, the year of 1972 with 1:25.987 of denominator scale was the one presenting a smaller discrepancy, followed by photography of 2005 in nominal scale 1: 30 000.

Considering the variations of relief contained in the property, there is smaller difference in area on the region of lower slope in the year of 2005 with (DAS) of 1:30.522.

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