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Cientific Paper

Use of non-orbital images on the planimetric assessment of large farms

Elvio Gilberto da Silva[1]
Zacarias Xavier de Barros[2]
Bruna Soares Xavier de Barros[3]
Ronaldo Alberto Pollo[4]

Abstract

The use of vertical aerial photographs, which are among the products of Remote Sensing, became frequent in surveying, planning and soil exploration projects, mainly for assisting other cartographic databases. In this study, panchromatic aerial photographs in nominal scale 1:25000 (in 1962) and colored aerial photographs in nominal scale 1:30000 (2010) were used, aiming at showing the possibility of performing a more complete and reliable analyses of area values in Botucatu-SP through the Geographic Information System (GIS). The values were obtained directly from the photograph without corrections scale, using as reference maps from the São Paulo State Cartographic and Geographic Institute, resulting in an error coefficient that shows the differences of the areas through the two study methods proposed. Regarding the aerial photographs in 1962 and 2010, it can be stated that the images from 2010 showed less difference in area (43.48 ha) in relation to the area values determined in reference map, once the colorful images facilitated the interpretation of the landscape, making the border lines more accurate, and thus offering greater precision in their definitions.

Keywords: Aerial Photographs; Geographic Information System; Measurement Area.

Uso de imagens não orbitais na avaliação planimétrica de grandes fazendas

Resumo

O uso das fotografias aéreas verticais dentre os produtos do Sensoriamento Remoto se tornou freqüente nos projetos de levantamentos, planejamentos e explorações do solo, principalmente por auxiliar outras bases cartográficas. Neste trabalho utilizou-se de fotografias aéreas pancromáticas escala nominal 1:25000 (1962) e coloridas na escala nominal 1:30000 (2010), tendo como objetivo mostrar por meio da utilização de um Sistema de Informação Geográfica (GIS) a possibilidade de realizar uma análise mais completa e segura de valores de área no município de Botucatu-SP, obtidos diretamente na foto sem correções de escala, tendo como referência a carta do Instituto Geográfico e Cartográfico do Estado de São Paulo, resultando num coeficiente de erro que mostrará as diferenças das áreas através dos 2 métodos de estudo propostos. Considerando as fotografias aéreas nas épocas: 1962 e 2010, pode-se afirmar que as imagens do ano de 2010 apresentaram menor diferença de área (43,48 ha) em relação aos valores de área determinados na carta referência, uma vez as imagens coloridas facilitaram a interpretação da paisagem, tornando mais seguro o traçado dos confrontantes e consequentemente oferecendo maior precisão na tomada dessas divisas.

Palavras-chaves: Fotografias Aéreas; Sistema de Informação Geográfica; Medições de Área.

Uso de imágenes no orbitales en la evaluación planimétrica de grandes haciendas

Resumen

El uso de fotografías aéreas verticales dentro de los productos del Sensoriamento Remoto se hizo frecuente en proyectos de levantamiento, planificación y explotaciones del suelo, principalmente por auxiliar otras bases de datos cartográficos. En este trabajo se utilizaron fotografías aéreas pancromáticas escala nominal 1:25000 (1962) y de color en escala nominal 1:30000 (2010). Con el objetivo de mostrar a través del uso de un Sistema de Información Geográfica (SIG), la posibilidad

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1 Prof. Dr. Universidade do Sagrado Coração. Centro de Ciências Exatas e Sociais Aplicadas. CEP 17011-970 - Bauru, SP – Brasil. E-mail: elvio@dpsa.usc.br

2 Prof. Dr. Energia na Agricultura. Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP) - Faculdade de Ciências Agronômicas. Botucatu-SP. E-mail: zacariasxb@fca.unesp.br

3,4 PhD - Energia na Agricultura Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP) - Faculdade de Ciências Agronômicas. Botucatu-SP. E-mail: brunasxb@fca.unesp.br, rapollo@fca.unesp.br

de realizar un análisis más completo y fiable de los valores del área de Botucatu-SP, obtenido directamente de la imagen sin correcciones escala, teniendo como referencia la carta del Instituto geográfico del Estado de São Paulo, lo que resulta en un coeficiente de error, que muestra las diferencias de las áreas a través de los 2 métodos de estudio propuestos. Considerando las fotografías aéreas en las épocas 1962 y 2010, se puede decir que las imágenes del año 2010 mostraron una menor diferencia en el área (43,48 ha) en relación con los valores de las áreas determinadas en la carta de referencia, ya las imágenes de color facilitaron la interpretación del paisaje, por tornar más segura la marcación de las bordas y por consecuencia ofreciendo una mayor precisión en la toma de estos límites.

Palabras clave: fotografías aéreas; Sistemas de Información Geográfica; área de medición.

Introduction

In the course of time, the physical space acquired a great importance, because in the present day, the value of the land exceeds that of any currency known in society.

Noteworthy, a great number of systems used nowadays for the civil population benefit, were created with war purposes, as good example, it can be cited the taken of aerial photographs from balloons, through planes and more recently the satellites continuously tracing the Earth.

The aerial photographs constitute in a rich database of cartographic, geographic and geological information, because it is the faithful representation of the land by them registered (AFFONSO, 2002).

Associated to the satellites emerges the Global Positioning System (GPS). These satellites are specialized in sending information of the position of any point of interest in the Earth surface, these informations in the form of longitude and latitude can be captured with greater or lesser precision, depending on the quality of the used receptor and also of good technical formation of the operator.

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

According to TRAGUETA (2008), the use of receptors (GPS), without knowledge of its limitations can lead the user to practice or perform incorrect considerations in the surveyed values. The precision is closely linked to the methodology of acquisition, basic support, densification and edition of the superficial information and its form of representation (ISHIKAWA, 2007).

As stated by ROSA (2005), when people talk about the GIS, they refer specifically to the software and not to the technology. It is frequently noted difficulty of communication between the professionals who use the same nomenclature to refer to different concepts. Thus, for a more complete understanding, it is necessary to explain the main components of a GIS, in which the software is only one of these components. The other elements to be defined are: hardware, data, users and methodologies of analysis.

This study has as objective to show through the use of a Geographic Information System (GIS), the possibility of doing a more complete and secure analysis of the area, obtained directly in the picture without correlations of scale, having as reference the map of the São Paulo State Cartographic and Geographic Institute.

Material and Methods

The studied area covers the Lageado and Edgardia Farms, situated in the Botucatu Municipality, Midwest region of the São Paulo State, located between the plain coordinates UTM Fuso 22, 762 km to 770 km and of 7,478 km to 7,468 km.

In the present study were used the maps SF-22-Z-B-VI-3-NO-F Botucatu II, and Lageado Farm SF-22-Z-B-VI-3-NO-D, which belong to the (IGC), São Paulo State Cartographic and Geographic Institute.

It were used panchromatic aerial photographs from 1962 and colored from 2010, in the nominal scales 1:25000 and 1:30000 respectively, receptor GPS Garmin12XL, computer HP COMPAQ model C700, processor Intel Core 2 Duo, 2GB of RAM memory and HD 120GB.

The software AutoCAD Map 3D 2009 Autodesk was used as support tool for visualization and collect of information in the aerial photographs, while the softwares IDRISI 15.0 The Andes Edition and ArcView 3.2 were used for quantification of the area.

It were determined the UTM coordinates in the planialtimetric maps 1:10000 referent to the Lageado and Edgardia Farms. Several points of borders presented doubts as for the correct localization, this fact showed the need of field visitations using the

GPS receptor, in order to determine points of hard localization in the maps.

The farms perimeter was obtained having as base vertical aerial photographs in the nominal scales of 1962, which are panchromatic and colored referent to the year of 2010.

The maps were inserted, in digital format, in the AutoCAD Map 3D as raster image, being created a layer of drawing for each map. Despite the map (IGC), being aligned and with the correct scale, the same can have an error, called "distortion", due to the fact that it is the representation in two dimensions of an object of three dimensions.

The image distortions were corrected by the own software AutoCAD, it is important to point out that were chosen randomly in the maps Botucatu

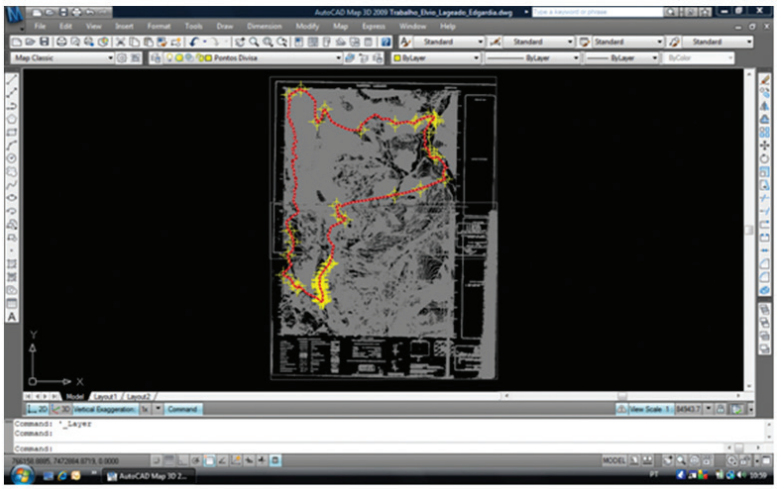

Figure 1. Demarcation of the border indicated by the red line.

II and Leageado Farm, many points (latitude and longitude) located in the property border. These points were used as base to trace the polygon which delimited the study area (Figure 1).

Next, it was calculated the area and perimeter of the Lageado and Edgardia Farms, according to

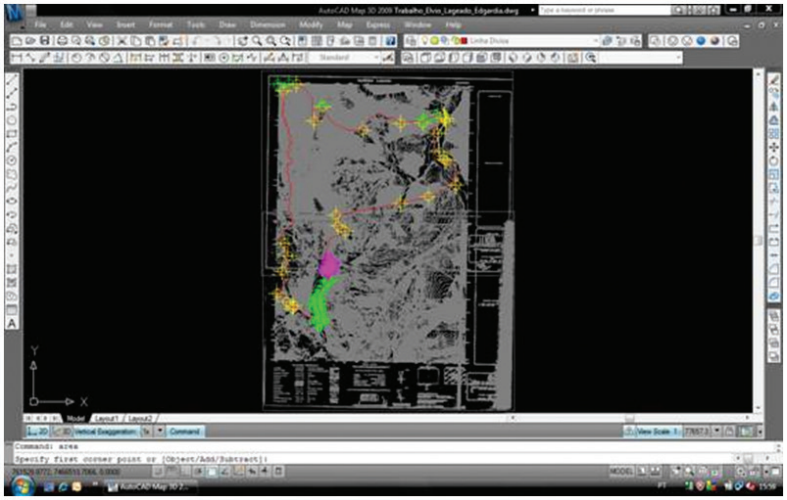

Figure 2. Software calculating the IGC map area.

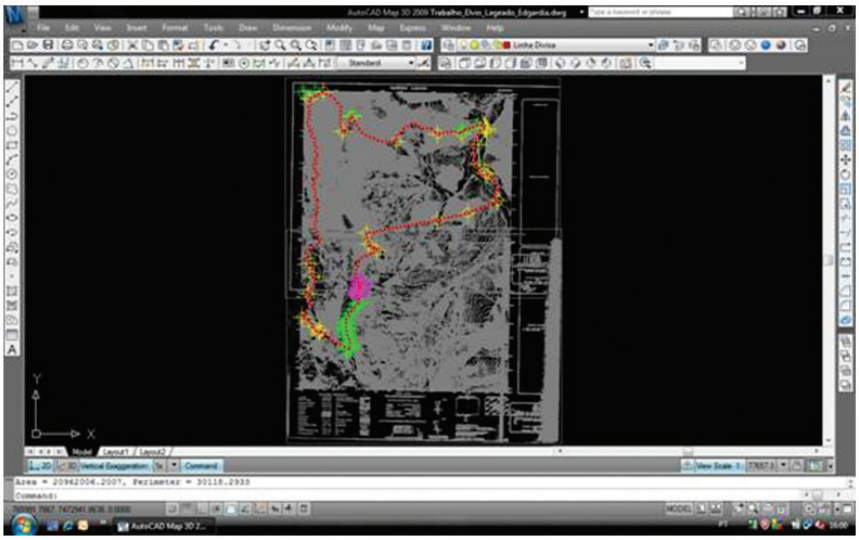

Figure 3. Software calculating the IGC map perimeter.

the border obtained by the IGC map and reading of longitudes and latitudes done in field with the assist of a GPS (Figures 2 and 3).

The area and perimeter values of the farms obtained by the AutoCAD were exported to the software ArcView and then to the IDRISI, for the calculations of these quantities and subsequent comparisons between the used programs.

Results and Discussion

The acquisition of data related to the angular and linear measures for planimetric surveying purposes and/or planning in properties in rural areas, independent of its size, becomes more important. In this surveying or planning, is necessary to take in consideration all the involved variables, where the topographic and cartographic information, obtained directly in field or through aerophotogrammetric surveys are connect by geographical coordinates, that according AFFONSO (2002) which are linked by geographical coordinates coming up with the need of production of reliable maps to facilitate the elaboration of projects.

The precision of a surveying, whether planimetric, altimetric or aerophotogrammetric, will be always a concern in the construction of a representation of a part of the land surface. By CASTRO (1996) consequently, of the orthogonal projection to be used, regardless if the used tools are traditional or latest generation.

Analyzing the area values obtained in the Lageado and Edgardia Farms, having as reference the map of the IGC, provided by the GISs, ArcView and IDRISI, in Table 1 is shown that the calculated area through the ArcView resulted in 2096.18 ha while the area of the same farms through the IDRISI presented a value of 2096.21 ha.

The area values observed in Table 1 did not present difference between the programs, certainly due to the procedures in the achievement and insertion of latitudes and longitudes respect the particularities of each one of the softwares.

Still according to Table 1, it is verified that the perimeter of the farms vary from 30.12 km when calculating through the ArcView, to 37.09 km when calculated by the IDRISI, representing 6.97 km of difference, that is, 23.14%, being this value considered high in the perimeter determination of a property, once it can influence in the final shape of the property plan. Thus, being able to completely alter the systematic of internal planning of a rural property

According ROSA (2005) such variation can be occurring due to the form the softwares generate the matrices (images) to perform the calculation, considering the number of pixels and the raster shape, respectively.

In figures 4, 5, 6 and 7 are represented the planimetric plans of the Lageado and Edgardia

Table 1. Area values calculated by the ArcView and IDRISI.

	ArcView	IDRISI	Dif. Ha	Dif. km	Dif. %
Area (ha)	2096.18	2096.21	0.03	-	0.001
Perimeter (km)	30.12	37.09	-	6.97	23.14

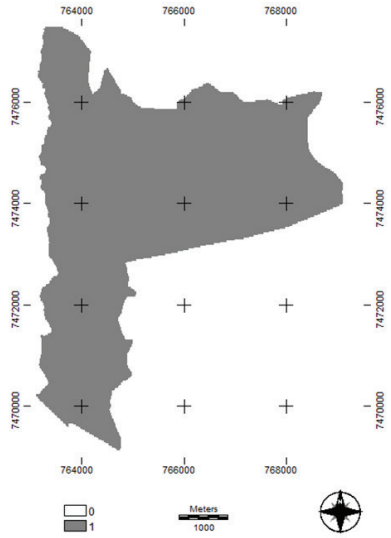

Figure 4. Plan generated by the IDRISI, photos 1962

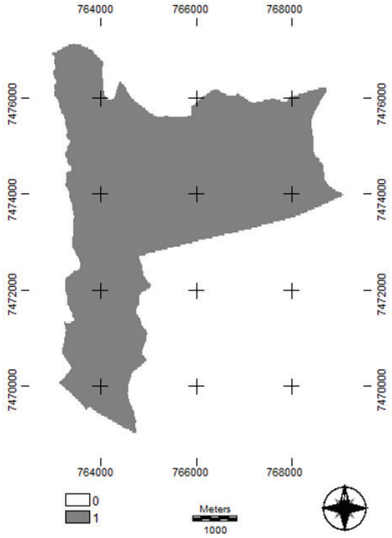

Figure 5. Plan generated by the IDRISI, photos 2010

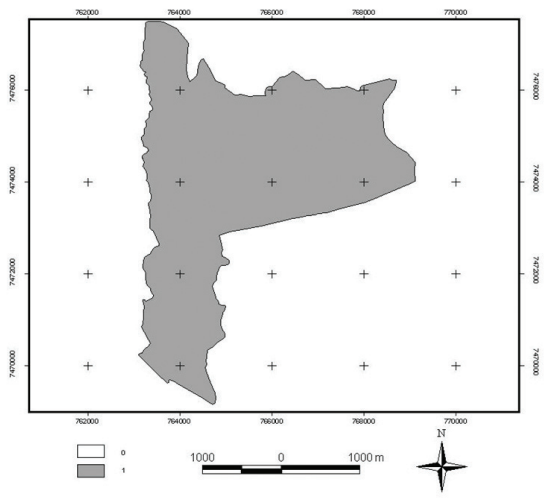

Figure 6. Plan generated by the ArcView, photos 1962

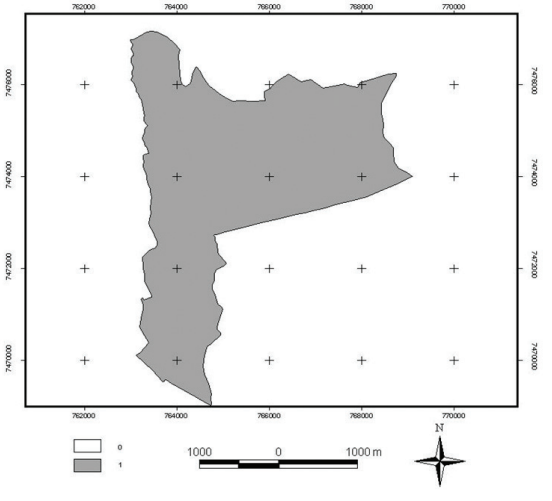

Figure 7. Plan generated by the ArcView, photos 2010

Farms, obtained using aerial photographs referent to the years of 1962 and 2010, respectively.

Analyzing the figures obtained through the photographs and the obtained by the maps of the IGC, through GISs, figures 8 and 9, it is observed that the figures 4, 5, 6 and 7 did not presented notable visual differences, showing with this, that the delimitation of edges of the farms in the photographs are in agreement with the obtained from the maps of the IGC, along with field visitations to survey doubtful points with the use of the GPS receptor.

Table 2 presents all the area and perimeter

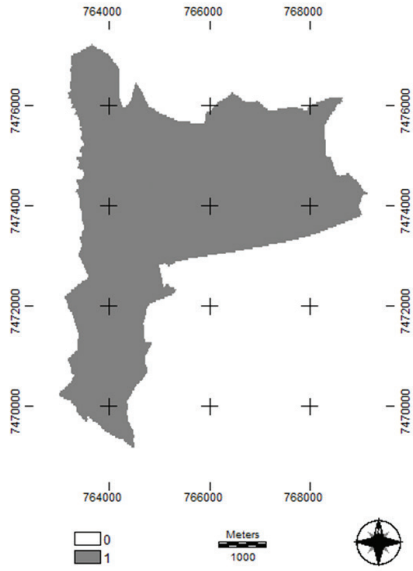

Figure 8. Plan generated by the IDRISI with geographical information (IGC)

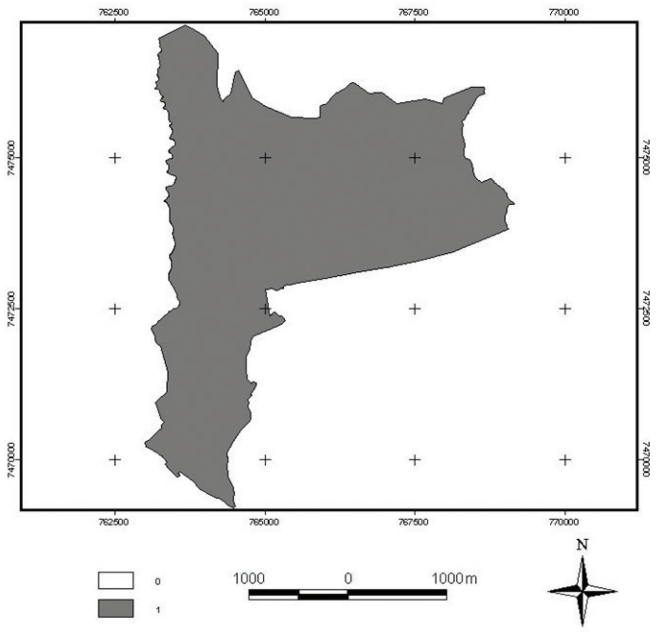

Figure 9. Plan generated by the ArcView with geographical information (IGC)

values of the plans generated by the GIS IDRISI from the edges delimitations of the Farms directly in the aerial photographs, considering the panchromatic images of 1962 and colorful of 2010.

In the same Table, it can be verified the area and perimeter values of the control plan, obtained by the GIS, from values of longitudes and latitudes of the planialtimetrics maps of the São Paulo State

Table 2. Area, Perimeter and Percentage Values in relation to the test Area obtained from the maps by the GIS IDRISI.

Photos Year	Area. A ha	Perim.P km	Reference Map Area	Perim.	Dif. A ha	Dif. P km	Dif. A %	Dif. P (%)
1962	2237.96	37.30	2096.21	37.98	141.75	0.68	6.76	1.79
2010	2139.78	36.61			43.57	1.37	2.08	3.61

Cartographic and Geographic Institute.

Analyzing the areas and perimeter variation values in Table 2, it can be seen that the difference of area in 1962 in relation to the map was of 141.75 ha, a difference of 6.76%, the highest compared to value considered as control. The difference between perimeters was of 0.68 km, i. e. 1.79%. Still in Table 2, it is noted that the difference of area reduced to 43.57 ha, or 2.08% for the year of 2010 in relation to the test area, being that the difference of perimeter remained in 1.37 km (3.61%).

According to Table 3, it can be seen that the area values of the Lageado and Edgardia Farms, achieved through the ArcView, with data obtained in the IGC maps, compared with the area values obtained by the photos, the difference in hectares was 141.78 and 43.48,

Table 3. Area, Perimeter and Percentage values in relation to the test Area obtained from the maps by the ArcView.

Photos Year	Area. A ha	Perim.P km	Reference Map Area	Perim.	Dif. A Ha	Dif.P km	Dif. A %	Dif.P (%)
1962	2237.96	29.81	2096.18	30.12	141.78	0.31	6.34	1.03
2010	2139.76	29.11			43.48	1.01	2.03	3.35

related to the years of 1962 and 2010, respectively.

Analyzing Table 3 and Table 2 together, it is noted that there was no significant difference for the calculus of the area, when using either one Geographical Information System, for both analyzed years.

The differences verified in the perimeters between the years of 1962 and 2010, when the plan was obtained through the ArcView presented values of 0.31 km and 1.01 km, that is, 1.03% and 3.35%, respectively, and the differences in the perimeters between the years 1962 and 2010 obtained by the IDRISI were 0.68 km and 1.37 km, i. e. 1.79% and 3.61% respectively.

Different from the area values, the perimeter differences between the used programs presented considerable contrast, showing again that the program ArcView appears to be more consistent with the actual field, both for the area calculation as for the perimeter, in a rural property.

Closely analyzing the differences of the areas in percentage terms, Tables 2 and 3, in relation to the value of the test area, it is noted that these were proportionally reducing during the dates considered for the current study, being 6.76% for 1962 and 2.08% for 2010, considering the program IDRISI and 6.34% for 1962 and 2.03% for 2010 using the program ArcView.

The decrease in these differences, towards more recent times is certainly associated to the technological advance of the achievement techniques, both of in the aircrafts as in the materials and instruments used, mainly in the case of the images from 2010, where these are in a colorful format, facilitating the photointerpretation of the landscape, thus making the delimitation of bordering more secure and consequently offering greater precision in making the borders.

Considering that the area in study is inserted in the region known as *Cuesta* of Botucatu, with

altitudes varying from 492 m in the Peripheral Depression, going up to 833 m in the "Front" and Reverse of the *Cuesta*, certainly considerable variations occur in the nominal scales of the aerial photographs due to relief differences. This principle was descrpit for AVERY and BERLIN, (1992).

Taking into consideration that the geometry of the taken aerial photographs as well as the central projection can also influence the quality of the aerophotogrammetric surveying, when it comes to precision in the scale of the material associated to the differentiated relief, the value of 43.48 hectares corresponding to 2.03% in the photographs of 2010 in relation to the test plan, can be taken as acceptable in this dimension of value in rural planning.

Conclusions

The program ArcView presented results for area and perimeter very close to the actual field, being that the IDRISI showed pronounced differences in the representation of values of perimeter.

Considering the aerial photographs of 1962 and 2010, it can be stated that the images referent to 2010 presented smaller differences of area (43.48ha) in relation to the determined in the reference map.

The colorful images of 2010 facilitated the delimiting of borders, thus offering greater precision in the demarcation of the same.

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