Positional accuracy of Curitiba's digital orthophoto map

Hamilton Carlos Vendrame Junior[1], Maria Cecilia Bonato Brandalize[2]

[1] Universidade Federal do Paraná, Curitiba – Paraná - Brasil
hcvjunior@gmail.com
[2] Universidade Federal do Paraná, Curitiba – Paraná - Brasil
Maria.brandalize@ufpr.br

Abstract

This work evaluates the positional quality of maps produced by the municipality of Curitiba. The Brazilian Cartographic Accuracy Standard (PEC) was applied in order to evaluate the geometrical quality of the orthophoto maps at scales 1:3.000 e 1:5.000. For this purpose, it was used the prescriptions of Decree No. 89817 of June 20, 1984, which deals with the technical requirements of National Mapping, establishing regulatory instructions for the systematic mapping at Brazilian territory. The study methodology comprehended the: availability of digital orthophoto maps at scales 1:3,000 and 1:5,000; determination of the sample size; establishment of a methodology for the identification, distribution and collection of ground control points; data collection and processing of ground control points coordinates, identification and collection of coordinates of homologous points in the digital orthophoto maps; statistical analysis of the collected coordinates and quality assessment according to the PEC. The initial results of the transformations between coordinate systems resulted unsatisfactory once were found discrepancies between the parameters officially adopted and made available by the Institute of Geography and Statistics and those adopted by the municipality. After investigation of the parameters, the products were finally classified as "A" (optimal geometric quality), according to the PEC

Keywords: urban cartography; mapping standards; geodetic systems.

1. Introduction

This work evaluates the positional quality of cadastral maps produced by the municipality of Curitiba. The products evaluated were made available by the Institute for Urban Research and Planning of Curitiba (IPPUC). More specifically, the Brazilian Cartographic Accuracy Standard (PEC) was applied in order to evaluate the geometrical quality of the planimetric features represented in the orthophoto maps at scales 1:3,000 e 1:5,000 that were produced by the referred Institute.

For this purpose, it was used the prescriptions of Decree No. 89817 of June 20, 1984, which deals with the technical requirements of National Mapping, establishing regulatory instructions for the systematic mapping at Brazilian territory. Such Decree, although it makes reference in its 7th Article that scales greater than 1:25,000 shall be governed by its own standard, makes clear in its 5th

Article, that mapping services include cartographic representation of the entire surface or part of it, with images, letters, plans and other forms of expression.

Thus, in the absence of standards for cadastral scales, we used the instructions of Decree 89.817/84 to assess the geometric quality (accuracy) of the orthophoto maps mentioned. The study also considered the implementation of the referred Decree on the classification of products generated digitally, as is common knowledge that it was designed to evaluate the products generated in analog form. This problem occurs because of the PEC is originally limited by the scale.

2. Methodology

The study methodology comprehended the following steps or stages:
- Availability of digital orthophoto maps at scales 1:3,000 (2006) and 1:5,000 (2002), on a DWG format, of a Curitiba's region that encompasses the Polytechnic Centre of the Federal University of Paraná, including the neighborhoods of Jardim Botânico, Jardim das Américas, Guabirotuba e Padro Velho, which encompasses an area of about 1.92 square kilometers (Figure 1);
- Determination of the sample size, that is, the number of ground control points to be surveyed and to be used to evaluate the referred cartographic products in accordance with the Brazilian Cartographic Accuracy Standard (PEC);
- Establishment of a methodology for the identification, distribution and surveying of ground control points with higher positional quality than the products assessed (Figure 2). For the distribution of points it was used a grid of coordinates spaced by 0.2 km x 0.2 km and, for each graticule of the grid it was identified at least one point as near as possible of its centre, with a minimum distance of 0.2 km between points in order to cover as much as possible the entire area (Figure 3);

Figure 1: Limits of the studied area in Curitiba city.

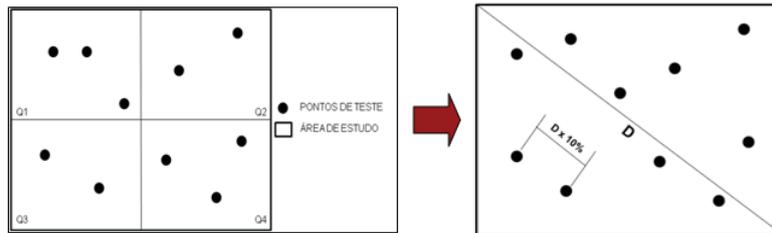**Figure 2:** Graticule of the grid for the study.

Figure 3: Example of point distribution inside the grid and according to a minimum distance.

- Data collection and processing of the ground control points coordinates (Figure 4) comprehend the employment of a GPS system and the technique applied was the rapid static positioning. It was collected 85 points, at least one for each graticule of the grid, however, because of some identification and processing problems, it was used only 30 points for the evaluation of the 1:3,000 orthophoto map and 42 points for the evaluation of the 1:5,000 orthophoto map;
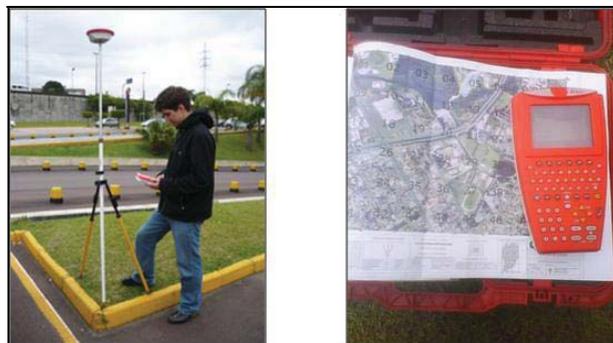

Figure 4: Surveying of control points.

- Identification and collection of the coordinates of the homologous points on the digital orthophoto maps (Figure 5);

Figure 5: Identification of homologous points on the orthophoto maps.

- Transformations (Figure 6) and statistical analysis of the collected coordinates (ground and orthophoto maps); and
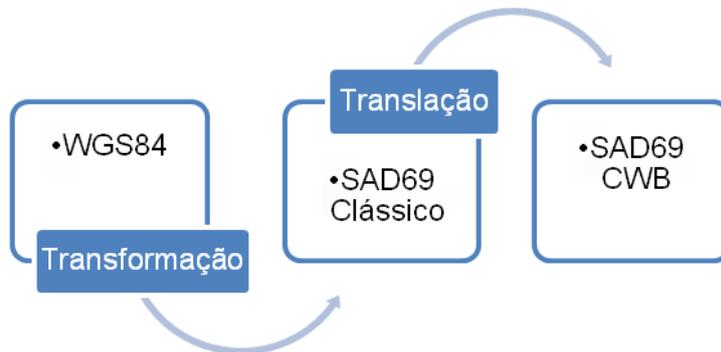

Figure 6: Transformations between systems.

- Quality assessment according to the PEC (Table 1). For the quality assessment it was calculated the discrepancies between the coordinates (terrain and map) of the gathered points and the planimetric error was evaluated. The mean error was evaluated for both scales as well as the standard deviation. It was also conducted a tendency analysis in order to compare the theoretical and amostral statistics. They were rejected for both scales. The tendencies were minimized and the calculations redone. The statistics for both scales were then accepted. For the precision analysis it was made a comparison between the theoretical and amostral chi-square for both scales and they were accepted.

Table 1: Classification of the products according to he PEC.

ORTHOPHOTO MAP AT 1:3,000 SCALE		
Class	PEC	STANDARD ERROR
A	0.5 mm x E = 1.50 m	0.3 mm x E = 0.90 m
B	0.8 mm x E = 2.40 m	0.5 mm x E = 1.50 m
C	1.0 mm x E = 3.00 m	0.6 mm x E = 1.80 m

ORTHOPHOTO MAP AT 1:5,000 SCALE		
Class	PEC	STANDARD ERROR
A	0.5 mm x E = 2.50 m	0.3 mm x E = 1.50 m
B	0.8 mm x E = 4.00 m	0.5 mm x E = 2.50 m
C	1.0 mm x E = 5.00 m	0.6 mm x E = 3.00 m

The work of evaluating the digital orthophoto maps would have been considered a simple task if the Geodetic System used as basis for mapping activities in the Curitiba region was the one officially adopted in Brazil. Once the work demanded some transformations between systems (WGS-84/SIRGAS2000 to SAD-69 classical network of 1996 to SAD-69 CWB), some of the parameters adopted are only known locally and they don't behave equally for the entire network.

3. Conclusion

The initial results of the transformations between coordinate systems (WGS84/SIRGAS2000 e SAD-69) resulted unsatisfactory once were found discrepancies between the parameters officially adopted and made available by the Institute of Geography and Statistics (IBGE) and those adopted by IPPUC for their geographic database.

After the investigation of the parameters, the transformations were applied and the products were finally classified as "A" (optimal geometric quality), according to the PEC. So, at least 90% of the well defined points on the map and tested on the terrain didn't present an error greater than the planimetric PEC established.

In conclusion, the products evaluated are in accordance with what is established by the Class "A" of the planimetric PEC for the selected sample, however, the parameters imposed to the transformations lead to the questioning about the validity of the assessment of such products, since the Geodetic System adopted by the IPPUC (SAD-69/CWB) does not fit the officially one adopted by the IBGE (SAD-69/96).

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