THE APPLICATION OF SOFTWARE SPRING (INPE) IN MAPPING OF TOURISTIC SITES – STUDY CASE OF THE MUNICIPALITY OF SÃO SEBASTIÃO, NORTH SHORE OF SÃO PAULO STATE, BRAZIL

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ABSTRACT

Observing that digital touristic mapping with cartographic concepts were not explored in depth in Brazil, this paper was proposed as a contribution for this theme, objectifying an application of cartographic concepts with GIS technologies for design of thematic cartographic with digital touristic information. For this the software SPRING (INPE) was used in elaboration of mapping of touristic sites. Besides that, a map-image based on a TM-Landsat satellite image was designed, and the software AutoCAD R.12 was used to draw cartographic symbols. After this a test of efficiency to cartographic symbols with students was applied. The study area was São Sebastião city, which is located on the North Coast of São Paulo State (209 Km from São Paulo city), Brazil. As conclusion we could observe that it was possible to generate cartographic symbols for São Sebastião City maps with touristic information, and a map-image, according to cartographic concepts, despite the difficulties with symbols transformation. An Internet home page was also a final product of this paper, and the address is: http://www.seb.iconet.com.br/adri

1 INTRODUCTION

Touristic maps involving precision of geo-referencing and the localization with a coordinate system have been produced in depth in Brazil.
This paper was elaborated based in cartographic concepts and GIS techniques for the digital touristic cartographic production. This paper was based in cartographic communication theories. For this the software SPRING (2.04 and 2.05 for linux) was used.

1.1 Objectives

The main objective were: 1) the use of the software SPRING (GIS developed by INPE – National Institute of Spatial Research) in mapping of touristic sites and other points with touristic interest; 2) the design of a map-image based on a TM-Landsat satellite image; 3) the elaboration of cartographic symbols for touristic sites and other points with touristic interest for the tourist to decode the right information quickly; 4) the application of a test of efficiency to cartographic symbols with students; 5) the elaboration of a hypertext for Internet, to aim the divulgation and to make public the mapping of touristic sites with cartographic quality.

2 METHODOLOGY

The study area was São Sebastião city, which is located on the North Coast of São Paulo State, Brazil, for this city has much natural touristic attractions, like beaches and Atlantic Forest, besides that there's beautiful islands, Ilhabela ferry crossing and historic buildings of XVII and XVIII centuries.

2.1 Material

The main material used was:

- Five topographic maps from IBGE, 1:50.000 scale;
- A satellite image – Landsat – TM with 6 spectral bands, 07/20/1994 in digital format;

- DXF Municipality mapping files, 1:50.000 and 1:10.000 scales;
- A computer 586 – 100 MHz, 2 GB, SVGA, 16 MRAM;
- A digitizer – DIGIGRAF – A0;
- Printer DeskJet 600;
- Scanner;
- Software SPRING – linux;
- Software AutoCAD R.12

2.2 Methods

The first stage in methodology was the digitizing and editing of interest feature (municipal limits, hydrography, road, and Petrobrás harbor) from 1:50.000 scale IBGE (Brazilian Institute of Geography and Statistics) maps in a "TURISMO" project with plans coordinates, UTM projection, Córrego Alegre datum and Hayford evolution ellipsoid. The road wasn't up-to-date then the DXF Municipality mapping files was used to bring up-to-date.
The DXF Municipality mapping files 1:10.000 scale was used for São Sebastião City maps elaboration. In this files were applied geo-referencing with the Resíduos software (ERTHAL, 1993) which use Similarity Transformation. The center 1:10.000 scale file and Boiçucanga beach 1:10.000 scale file were chosen for mapping, then the similarity transformation was applied in these. The transformation conclusion was within cartographic standard for 1:10.000 scale, with is 5 m (5 m and 2 m respectively for center and Boiçucanga files) and it was considered satisfactory for touristic maps.
Thus, these files were imported for SPRING and edited for the mapping. For the map-image were used a TM-Landsat satellite image with R-5, G-4, B-2, where the sea is visualize in blue, the Atlantic forest in green and urban spot in magenta. The geometric registration was made in SPRING resulting spatial resolution of 29 m.

2.3 Cartographic Symbols Elaboration, Digital Map-Image and City Maps Design

The pictorial symbols were chosen for this paper just they simplified or stylized way represent what they stand for. For this it was used AutoCAD R.12 (SPRING didn't make this task). It was selected touristic points like beaches, Petrobrás harbor, Ilhabela ferry crossing, historic buildings from XVII and XVIII centuries (church, chapel, museums), squares, touristic information office, and touristic interest points like hospital, post office, municipality, police station, bus station, and Petrobrás build which is a localization reference in São Sebastião.
The pictorial symbols elaboration was very complicated, because SPRING didn't accept the DXF symbols. For this, the symbols were elaborated with very simplification, using BERTIN (1983) concepts about visual variables and other symbols design concepts: BOS (1984), FORREST; CASTNER (1985), BLOK (1987), CAMPBELL (1991), FILIPPAKOPOULOU; NAKOS (1995), MORRISON; FORREST (1995), besides touristic maps, guides and Internet maps.
The maps elaborated were: São Sebastião map-image, São Sebastião center map with touristic information, São Sebastião historic center map with touristic information and Boiçucanga beach map with touristic information. The main features in these maps were distributed in layers: road, hydrografy, municipal limits, coast line and streets. According to LIBAULT (1975) this maps were designed eliminating the word "street" and summarizing the word "avenue" besides eliminate the word "beach" in the text layer. So, the maps layout was fixed with legend, symbols and texts.

2.4 Cartographic Symbols Tests

It was applied two tests with the symbols elaborated according to FORREST; CASTNER (1985); BLOK (1987); MORRISON; FORREST (1995) realized with students from Colônia dos Pescadores Highschool in Caraguatatuba Municipal District – North Coast of São Paulo State – Brazil. The first test was to assess the communication efficiency (decode) with restricted choice; the second test was to assess the search time for identify the symbols.
In the first test were 14 symbols and three answers alternatives for it one, for 43 students in total. For the second test were 14 symbols randomly distributed over the map. Seven symbols were tested with 22 students and the other seven with 21 students. The examiner presented for the student the map and he or she could look at it for as long as they liked. Then, when the student finished his or her observation the legend was covered and some questions were done, like "Where's the church?" The search time was stopwatched.

3. RESULTS AND ANALYSIS

3.1 Cartographic Symbols, Map-Image and City Maps Elaborated

The cartographic symbols elaborated in this paper were: church, chapel, museum, theater, Petrobrás harbor, Ilhabela ferry crossing, touristic information office, police station, bus station, post office, hospital, municipality, Petrobrás, all elaborated in AutoCAD and imported for SPRING; the symbols were elaborated with same size frame. There were elaborated two letter symbols (touristic information office and Petrobrás) and one pictorial and letter symbols (Municipality), all the other were elaborated as pictorial symbols. It was difficult the symbol transference from analogic to digital format, but the results were satisfactory.
The map-image and São Sebastião city maps were elaborated objectiving the computer visualisation, for the elaboration of Internet home page. These maps could be looked in site: http://www.seb.iconet.com.br/adri, and in PEREIRA (1998).

3.2 Analysis

Analyzing the method used with SPRING it's shows that was possible the generation of cartographic symbols and São Sebastião City maps with touristic information for computer visualisation, besides the map-image generation within the cartographic concepts. This paper was the first application of SPRING in touristic cartography. The city maps were the first digital cartographic databases with coordinate system designed for touristic and other applications.
The map-image precision analyse was done chosen control points in image and in trustly 1:10.000 scale map, like in table 1.

Control Points	E_i (m)	N_i (m)	E_c (m)	N_c (m)	$\Delta E = \lvert E_c - E_i \rvert$ (m)	$\Delta N = \lvert N_c - N_i \rvert$ (m)
01	453.962	7.365.223	453.950	7.365.200	12	23
02	447.037	7.364.654	447.100	7.364.670	63	16
03	443.487	7.368.893	443.500	7.368.830	13	63
04	442.897	7.369.111	443.070	7.369.080	83	31
05	436.755	7.369.592	436.800	7.369.570	44	22
06	429.703	7.369.848	429.680	7.369.800	23	48
07	427.062	7.367137	427.040	7.367140	22	3
08	426.456	7.371.437	426.410	7.371.440	46	3
09	422.681	7.372.288	422.750	7.372.270	69	18
10	429.227	7.376.353	429.220	7.376.400	7	47
11	436.508	7.373.892	436.440	7.373.870	68	22
12	444.471	7.371.621	444.500	7.371.610	29	11

Table 1. Image and map coordinates of control points

The table 1 shows that the numbers of control points were little, it was because the study area is in a difficult territorial space for control points satisfactories (sea and forest).
In the map-image the Random Mean Square (RMS) for E and N (47 m and 31 m respectively) and for E, N (56 m) was within the expected precision for a touristic mapping.
The first test analyse of cartographic symbols elaborated is in table 2. It's a simple analyse for correct answer percentage for it one symbol.

SYMBOLS	CORRECT INTERPRETATION	WRONG INTERPRETATION	NO ANSWER	% CORRECT INTERPRETATION
1) Church	42	1	0	97,7
2) Chapel	42	1	0	97,7
3) Museum	31	12	0	72,0
4) Theater	43	0	0	100,0
5) Petrobrás harbor	31	12	0	72,0
6) Ilhabela ferry crossing	17	26	0	39,5
7) Beach	42	1	0	97,7
8) Tourist information office	38	3	2	88,4
9) Police station	40	1	2	93,0
10 Bus station	42	1	0	97,7
11) Municipality	26	17	0	60,5
12) Post office	43	0	0	100,0
13) Petrobrás	43	0	0	100,0
14) Hospital	41	2	0	95,3

Table 2. Results of 1° test statistics analysis

From the table 2 could be observe that the Ilhabela ferry crossing symbol had 39,5%, which is % correct interpretation very low, because it was difficult the design of this symbol in digital way like its real appearance. The other symbols had a % correct interpretation satisfactory; then, these symbols arrived at the main objective.
Still for the 1° test was applied the χ^2 Yates correction for little sample with hypothesis (SPIEGEL, 1974). The expression was:

$$\chi^2 = [\sum_{i=1}^{n} (|o_i - e_i| - 0,5)^2] / e_i \qquad \text{where: } o_i = \text{observed values for correct interpretation}$$
$$e_i = \text{expected value} = \text{mean correct interpretation} = 37,21 \qquad (1)$$

The result was: $\chi^2 = 19,94$
Hypothesis: H_0: students will set right the symbols
H_1: students won't set right the symbols
In the χ^2 table for 13 free grade (14 symbols), $\chi^2 = 19,94$ at 90 and 95 per cent level of significance is 19,8 and 22,4 respectively. Thus, it was concluded that H_0 is accepted at 90% confidence, then the students will set right the most of the symbols.
The table 3 shows the results of statistics analysis for 2° test with mean and standard deviation for time search.

Mean: $x = \sum_{i=1}^{n} x \sqrt{n}$ (2)

Std. Dev.: $s = \sqrt{\sum (x_i - x^2)} / n$ (3)

SYMBOL	TOTAL NUMBER OF SEARCHES	TOTAL NUMBER OF CORRECT SEARCHES	MEAN SEARCH TIME (SECONDS)	STANDARD DEVIATION OF MEAN SEARCH TIME (SECONDS)
CHAPEL	22	22	2,2"	1,5"
THEATER	22	22	2,5"	2,3"
TOURISTIC INFORMATION OFFICE	22	21	1,3"	2,5"
ILHABELA FERRY CROSSING	22	21	2,6"	2,4"
POST OFFICE	22	22	1,8"	1,2"
PETROBRÁS	22	20	1,2"	1,6"
POLICE STATION	22	22	2,5"	3,2"
CHURCH	21	21	1,8"	1,3"
MUSEUM	21	21	2,0"	2,0"
BEACH	21	20	1,4"	0,7"
PETROBRÁS HARBOR	21	17	1,7"	1,7"
HOSPITAL	21	21	2,0"	2,5"
MUNICIPALITY	21	21	1,4"	0,5"
BUS STATION	21	21	1,7"	1,2"

Table 3. Results of 2° test statistics analysis

The table 3 shows that within the map context the symbols were better identified. The Ilhabela ferry-crossing symbol had a 2,6" mean search time, very satisfactory, but it was still the worse symbol, which need to be modified.

4. CONCLUSIONS

The results demonstrated that the main objective was fully reached.
It was concluded that the specifics objectives showed an example of cartographic resources and remote sensing used in thematic mapping, and the tests application for efficiency in symbols decode were developed within the cartographic concepts. The city maps and map-image were elaborated with accepted precision for this proposal.
The method was developed within research concepts and showed that there were limitations in SPRING for cartographic symbols, but in general, this software had satisfactory performance for this application.
The efficiency test of cartographic symbols showed that the symbols were efficients in communication, they had a satisfactory student's interpretation and the search time was better than the hope for it.

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