# Comparative analysis of land cover maps obtained from vertical aerial photographs and panchromatic Spot images.

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## ABSTRACT

The land cover map is one of the most important spatial data in many geographical information systems applications. Most of the environmental analyses use land cover and land use maps (CAHILL et al., 1995). This study focuses on the integrated watershed land cover planning as a basis to water quality assurance to be used by local governments. Thinking on one of the main problems suffered by local governments and small watershed associations, the resource scarceness, this study made a comparison between two remote sensing sources in a low cost digital land cover classification.

## 1 INTRODUCTION

The regional watershed planning approach of most of the Brazilian towns are characterized by shortage of the basic data. Without any doubt, this data privation is one of the most important restrictions for the watershed planning developments and land cover zoning implementation. Because of that, the proposal and the use of low cost methodologies that could increase the viability of the basic data acquisition for the planners' demand are important tasks in the regional scenario.
The regional scenario could be described as the decision makers that work in small watershed planning and frequently have scarceness of resources to develop their planning tasks. In this context, the optimization of the resources was the main approach of the present study, and this philosophy must be remembered at the employed classification method analysis. With this approach, the method adopted in this study was based in the panchromatic image classification and aerial photographs, in order to evaluate the degree of difficulty to obtain the land cover map. Also because of this approach, one of the main objectives of this study was to identify, between two sources of digital remote sensing data sources, the most adequate for the regional scenario.

## 2 LAND COVER MAP GENERATION METHODOLOGY

### 2.1 The remote sensing data sources analyzed

The present study used a vertical aerial photograph which was obtained in a 1:25.000 scale. This photograph was converted for the digital environment by a 600 dpi optical scanner device. The other source used was an HRV Spot panchromatic satellite image (K716/J397) obtained ten months after the photogrammetric flight over the Ibaté-Mirim watershed. This watershed is one of the main water sources for urban supply of the Araçariguama town situated in the state of São Paulo, southeast of Brazil.
Since both remote sensing data have different spatial resolutions, they were submitted to a compatibilization process to enable the accuracy analysis described later on. Both of the digital remote sensing sources were imported in to the Environment for Visualizing Images – ENVI (RESEARCH SYSTEMS INC., 1997) for digital processing (RICHARDS, 1994).

### 2.2 Geographic and geometric compatibilization

This compatibilization was done through the digital registration procedure, which in the first phase was applied only for the SPOT image. In this phase, topographic maps were used to extract the geographical coordinates, also recognizable in the digital image. These coordinates were used as referential points for geometric corrections. The registered SPOT image was used in the digital aerial photo registration through the "image to image" register mode. Submitted to this procedure, the digital aerial photo resultant had the same spatial resolution of the SPOT image, which reduced the details of the original aerial photo. These procedures made both remote sensing data compatible because they had the same size and the same georeference system. It is important to note that after this compatibilization, both remote sensing data were sampled in order to distinguish different land cover classes. These classes were preconceived from a classification system with four land cover classes: "tropical rainforest (Ca)", "degraded tropical rainforest (Cb)", "herbaceous (Ps)", and "grass (Pa)" (ANDERSON, 1979). The first and second classes are two types of forest. The third and the fourth are two types of grass. In this way, it was possible to establish a pre-classification of the Ibaté-Mirim watershed land cover map based on those samples, which is shown in Table 1.

Table 1: Gray level intervals found in samples of both remote sensing source data.

| | Aerial photograph | | | | | SPOT image | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Classes** | **Min.** | **Max.** | **Mean** | **S.D.** | **C.V** | **Min.** | **Max.** | **Mean** | **S.D.** | **C.V.** |
| Ca | 29 | 67 | 43,26 | 7,64 | 17,66 | 15 | 65 | 35,32 | 7,97 | 22,56 |
| Cb | 61 | 121 | 85,37 | 15,92 | 18,65 | 57 | 77 | 61,80 | 4,59 | 7,43 |
| Ps | 73 | 150 | 102,09 | 16,58 | 16,24 | 65 | 90 | 74,37 | 5,08 | 6,83 |
| Pa | 148 | 211 | 176,97 | 15,66 | 8,85 | 88 | 140 | 108,68 | 11,96 | 11,00 |
| Mean | - | - | - | 13,87 | 15,35 | - | - | - | 7,4 | 11,95 |

S.D. = standard deviation, C.V. = coefficient of variation.

Note through the dispersion measures, standard deviation and variation coefficient, that the variability of the gray level values of the aerial photo are higher than those of the SPOT image. This was clearly noticed in all the land cover classes with the exception of the "Ca" class. This variability is related to the mapping effort or with the class limits delineation when producing the land cover map from a digital image.

### 2.3 The "true" land cover map

The same vertical aerial photographs were used to produce the true land cover map of the same watershed. For that, the Kartoflex-Zeiss stereoscopic device was employed in order to rectify the pair of stereo photos. The land cover map obtained by this process was used to analyze the accuracy of both pre-classification data described above. It is important to notice that the map scale adopted for the "true" land map cover was the 1:25000.

## 3 THE ACCURACY ANALYSIS

Both remote sensing data sources pre-classifications were compared with the true land cover map through the misclassification matrix method (GOODCHILD & KEMP, 1991; JENSEN, 1986). Using this method it was possible to evaluate the accuracy level of each remote sensing source through the omission and comission error indexes. The accuracy coefficient and the kappa index were calculated from the misclassification matrix too. It is important to consider that each land cover class described previously was individually compared with the true land cover map. This accuracy analysis was facilitated by the Envi software.

## 4 RESULTS

The results are presented in the Table 2. These results are the arithmetic mean calculated from each land cover class misclassification matrix. In this way, these results summarize four matrixes for each land cover class from each remote sensing data source. Observing the results, it is possible to notice that the digital aerial photograph presents a higher variability of the gray level values in comparison with the SPOT image. This consideration is based on the accuracy coefficient: 91.11 % for the SPOT image and 88.62 % for the aerial photograph, and on the kappa index: 0.62 for the SPOT image and 0.57 for the aerial photo.

Table 2: Summary of the results obtained from the accuracy analyses.

| | Aerial photograph | | SPOT image | |
|---|---|---|---|---|
| **Index (%)** | Land cover classes | Other classes | Land cover classes | Other classes |
| Comission | 6.5 | 14.4 | 5.7 | 10.6 |
| Omission | 50.3 | 1.0 | 45.2 | 1.0 |
| Accuracy | 49.7 | 99.0 | 54.8 | 99.0 |
| Land cover classes | 11.0 | 0.8 | 13.5 | 0.8 |
| Other classes | 10.6 | 77.6 | 8.1 | 77.7 |
| Kappa | 0.57 | | 0.62 | |
| Total accuracy | 88.62 | | 91.11 | |

## 5 CONCLUSIONS

According to the presented results and to the applied methodology in this study, it is possible to conclude the following:
- A land cover map produced from the digital aerial photograph consumes more processing efforts than from the SPOT image.
- The SPOT image is more adequate for the land cover map of watersheds at the analyzed map scale than the aerial photograph.

It is important to remember that these statements are valid for the regional approach land cover mapping, which is characterized by the demand for low cost technology and procedures, and which has small watershed planning its main study focus.

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