MEASUREMENT OF DEFORESTED AREAS BY IMAGE PROCESSING TECHNIQUE A METHODOLOGICAL STUDY

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ABSTRACT

A technique of area measurement by mask scanning and image processing is discussed. The efficiency of this technique is compared with the conventional technique of grid-square counting. The techniques were applied to masks stemming from a deforestation mapping project.

1. INTRODUCTION

Recently, the first phases of two mapping projects on deforestation in Brazil have been finished:

- Alteration of the forest cover in Legal Amazonia (Ateração da cobertura florestal na Amazônia Legal; INPE / FUNCATE) [1],
- Atlas of the Atlantic Forest (Atlas Mata Atlântica; S.O.S. Mata Atlântica / INPE / IBAMA / Image / Sensora) [2].

In both projects the areas of interest were detected by the visual interpretation of colour composites of landsat TM 5 data. The results of the interpretation (deforested areas in Amazonia or the rests of the Atlantic Forest) are represented on the base of topographic maps.

One of the main objectives of both projects consisted in the determination of the total area (deforested or still covered, respectively). This step was performed by conventional techniques or manual digitizing. These techniques are relatively time-consuming. Therefore an alternative technique was suggested and tested using the FEAG scanner and an image processing system [3]. In this paper the used technique is discussed with special regard to its efficiency and accuracy compared with the conventional technique of grid-square counting.

2. SAMPLES USED IN THE STUDY

A) a film copy of the thematic overlay for the map sheet Rio Branco (SC 20-Z-B) reduced to an approximate scale of 1 : 550 000,

B) a mask of the deforested area interpreted on the basis of the Landsat TM image 002/067, 26/07/88, approximate scale 1 : 645 000. The interpretation was done on the KARTOFLEX [4] using a 6cm by 6cm - colour slide. The image was divided into four sections for rectification.

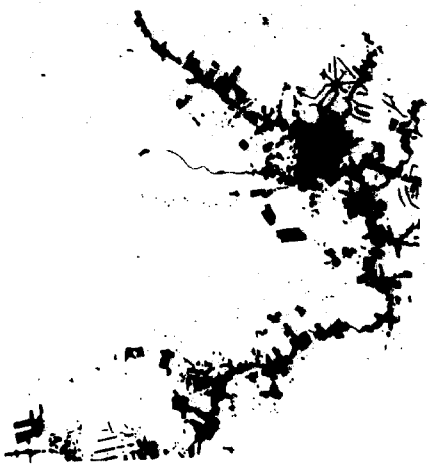
The samples are represented in Figure 1 and Figure 2 reduced to 1 : 4 000 000.

3. AREA MEASUREMENT BY THE CONVENTIONAL TECHNIQUE

Grid-square counting is a conventional technique of area measurement. It was used for comparison with the results of scanning. The grid squares

Figure 1 Thematic overlay (SC 20-Z-B) reduced to 1 : 4 000 000

Figure 2 Mask of the interpreted area in TM-image 002/067 reduced to 1 : 4 000 000



had a size of 1mm by 1mm (i.e. 0.3 sq.km or 0.4 sq.km in nature). In order to reduce possible subjective errors the area was calculated twice: first in the positive film and second in the negative film. The results of this technique are represented in table 1.

4. AREA MEASUREMENT BY SCANNING AND IMAGE PROCESSING

In order to have a relative small film format of the FEAG scanner of 70mm x 91 ... 93mm [3], both original films were reduced by photographic procedures to a scale of approximate 1 : 4 000 000 (see Fig.1 and Fig.2).

Table 1 Measurements by counting

sample	pos.film sq.mm	neg.film sq.mm	mean sq.mm	neg./pos. %	time in minutes
A	1657	1720	1688.5	103.8	54
B	8103	8627	8365	106.5	270

The difference in area measured in the positive and in the negative film leads to the assumption that solid black areas are somewhat underestimated by eyes. This phenomena was not subject of the study but it has to be taken into account when the technique is used only for positive copies. The further discussion is only related to the mean values.
(see table 1)

Sample A was reduced to 13.82 %, sample B was reduced to 16.32 %.

The reduced films were scanned with a raster size of 40 µm, i.e. one pixel represents an area of 2.5 hectares in nature. The accuracy of the interpretation and the preparation of the cartographic originals are not discussed in this paper. The results of mask scanning are represented in table 2.

Table 2 Measurements by scanning

sample	number of black pixels	black area (total) sq.mm	total time in hours
A	18 794	30.1	< 2
B	163 073	260.9	

The scanning and the image processing were done within two hours, including all preparations, explanations, and discussions connected with a pilot experiment. The scanning of one film took 2 to 3 minutes. The calculation of the number of pixels (histogram) is a very simple function in image processing and was done in a few minutes.

5. COMPARISON OF THE RESULTS

Table 3 shows the results converted to the scale 1 : 4 000 000.

6. CONCLUSION

Each technique of area measurement involves errors. It is a general aim to minimize errors and to be quick. On the basis of the preliminary results of this study some conclusions can be drawn.

Using a scanner, it is possible to eliminate human errors, both systematic (unterestimation) and random ones. However, for the development of a fast technique of aera measurement by mask scanning it is necessary to consider some crucial points not immediately connected with scanning and image processing but with the photographic process. If it is difficult to control the photographic process, the scale of the reduced film must be larger than in the experiment described. It is supposed that a scale of 1 : 2 000 000 would produce satisfactory results in this special case. The increase in scanning and computing time for larger films is not important with regard to the whole technological process.

Table 3 Results of both techniques converted to 1 : 4 000 000

sample	grid square counting sq.mm	scan / image proc. sq.mm	difference %
A	32.2	30.1	- 6.5
B	220.3	260.9	+18.4

At first glance the results of the techniques used differ considerably. They are even contradictory. These differences can only be explained by the quality of the originals and the reduced films. Regarding sample A, it is assumed that the screen of the original film has influenced the edges of the areas. This influence was not noticed with optical enlargement. With the sample B, a synoptical comparison of the original and the reduced film by means of the KARTOFLEX showed that the photographic process did affect the edges. Optical dispersion and photographic development closed gaps and made little white areas in a black environment disapppear.

Comparing the time needed for measuring the areas it becomes obvious that scanning is not much faster than counting if the area in the map sheet is relatively small (sample A) because of the additional time spent in photographic laboratory. If there is a lot of complicated areas in the map sheet the conventional technique takes much more time than scanning. The resolution of scanning was 3 to 4 times higher than that of the conventional technique.

Scanning is advantageous for map sheets displaying large and complicated areas. Moreover, the data digitized by mask scanning can be stored easily in a data bank for monitoring deforestation both in Amazonia and in the region of the Atlantic Forest.

The author believes that the technique of mask scanning of visually interpreted areas is efficient until the interpretation for large regions, e.g. the whole amazonia, can be done completely with the help of image processing systems.

LITERATURE

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[2] Projeto de Dominio da Mata Atlântica, S.O.S. Mata Atlântica / INPE / IBAMA. 1989

[3] FEAG 200 Photoscan/Photowrite System, short description, VEB Kombinat Carl Zeiss Jena

[4] KARTOFLEX Operating instructions, VEB Kombinat Carl Zeiss Jena

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