THE USE OF DIGITAL PHOTOGRAPHS TO QUANTIFY VEGETATION GROUND COVER IN DEGRADED AREAS

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ABSTRACT

This study was aimed at assessing the possibility to use digital photographs to evaluate success of the reclamation of a gravel-mined degraded area. The indicator used to measure success was the degree of vegetation ground cover. Photographs were taken with a Canon camera (model Power Shot A 100). On 11th of October 2003, in a sunny day (without clouds), a total of 24 photographs were taken of the centre of the 24 experimental plots. All the 24 photographs were processed with ENVI 3.5 software following the same procedures applied to process satellite scenes. In each scene analysed, two classes - vegetation cover and bared soil - were identified with the maximum likelihood algorithm. Results showed that digital photographs can be used in the quantification of vegetation ground cover and that the technique employed in this study can be applied to evaluate methodologies of reclamation of mined areas in which the establishment of vegetation is expected. The technique tested in this study can be employed by government agencies in charge of land reclamation plans because it is efficient in determining vegetation ground cover, is easy to perform and is not expensive.

Keywords: Land reclamation, degraded areas, mined areas, assessment of vegetation ground cover.

INTRODUCTION

Civil engineering works demand natural resources in large scale. Loam, silt, sand, gravel rock, among others natural materials extracted from nature are employed in construction of roads, dams and buildings. In general, large areas of land are degraded in the process of extraction of these materials.

In the Federal District of Brazil, a combination of facts which started in 1955 with the beginning of the construction of Brasília, the transference of the capital of the country from

Rio de Janeiro to Brasília in 1960, rapid urbanization, great expansion of the regional population and deficiencies of the environmental legislation regulating the extraction of natural resources, resulted in large tracts of lands degraded.

According to Corrêa & Baptista (2004), in the Federal District of Brazil (total land area of 5 814 km^2) 3 419 hectares of land have been degraded by the extraction of gravel and loam. Soil erosion, losses of biodiversity and silting of water reservoirs are some of the problems derived from the exploitation of gravel and loam in the Federal District. For Rocha et al., 2001, mined area is one of the principal environmental passive in the Federal District of Brazil.

To deal with the environmental passive caused by extraction of gravel and loam, plans to reclaim degraded areas are required. Most of the plans to reclaim degraded areas include the establishment of vegetation.

Among the attributions of the official environmental agencies in charge of land reclamation is the supervision of the implementation of plans to reclaim degraded land. There is a lack of field techniques, efficient and cheap, appropriated to assess vegetation ground cover in degraded areas.

This paper contains results from a research aimed at testing the use of digital photographs, obtained with portable camera, to assess vegetation ground cover in a gravel-mined degraded area where soil conservation measures were implemented in 1992.

MATERIAL AND METHODS

Area studied

The site studied is located at the National Park of Brasilia, Federal District, Brazil, and covers an area of approximately 6 hectares (Figure 1). Gravel was extracted from the area in the early 60's. The original savannah vegetation of the site was removed and the mineral was extracted up to a 2 meters depth. Nothing was done for almost 30 years to reclaim the mined area. As a consequence, the surface of the gravel pit remained bared, without vegetation cover.

In 1992, as part of a research project supported by the Brazilian Institute for Environment and Natural Renewable Resources (IBAMA), conducted by members of the research staff of the Ecology Department of the University of Brasilia, soil conservation measures, including terracing, subsoiling and manuring were realized in the area (Figures 2 a,b). Experimental design of the 1992 research, including size of plots, treatments and replications is illustrated in Figure 2c.

Figure 1: Aerial view of the gravel pit where an experiment aimed at developing methodology to reclaim mined land with savannah species were implemented in 1992. The area is located in the National Park of Brasília, Federal District of Brazil

Procedures for the acquisition of photographs

A portable Canon camera (model Power Shot A 100) was used to take digital photographs of the experimental site. Photographs from approximately a 2,10 meters high, perpendicular to the ground, were taken of the centre the 24 experimental plots on the 11th of October of 2003, in a sunny day (without clouds), from 10 to 12 am. The same photographer took all the 24 photographs used to assess the vegetation ground cover (Figure 3).

(A)

(B)

Block 1	**T 2**	**T 3**	**T 2**	**T 1**	**T 1**	**T 3**
Block 2	**T 3**	**T 1**	**T 3**	**T 2**	**T 1**	**T 2**

TERRACING

Block 3	**T 3**	**T 1**	**T 2**	**T 2**	**T 3**	**T 1**
Block 4	**T 1**	**T 3**	**T 1**	**T 3**	**T 2**	**T 2**

(C)

Observations:

(I) Six plots per block. Each plot in blocks 1, 2 and 3 measures 20 m x 25m. In block 4, each plot measure 15 m x 25 m.

T 1, T 2 and T 3 are treatments tested in the experiment, which started in 1992

Figure 2: Details of the substrate preparation (A and B) and the experimental design (C) employed in the original research, which was established in 1992

Figure 3: Photographer taking pictures from approximately 2.10 meters high with a digital camera and, on the right, details of the demarcation of the centre of each experimental plot

Digital Classification of the Photographs

All the 24 photographs were processed with ENVI 3.5 software following the same procedures applied to process satellites scenes. In each scene, few representative pixels of the two classes used - bared soil and vegetation cover - were selected as a reference for the algorithm classification.

The algorithm selected was the Maximum Likelihood, which is a method that calculates the median of the pixels taken as a reference. The probability of the pixels to belong to one of the two classes – bared soil or vegetation cover – is determined based on statistical analysis by the algorithm. No limit of probability was selected which means that all pixels present in the scene processed were classified and included in one of the two classes.

As all scenes contained the same number of pixels, areas of the two classes –bared soil and vegetation cover - were calculated. The percentage of the vegetation ground cover was

calculated through the ratio between area of vegetation cover and total area (vegetation cover + bared soil). Despite the fact that photographs did not have scale, results were normalized as all photos were obtained in the same manner. The percentage of vegetation ground cover was then used to assess the efficiency of the three treatments applied in the research, which started in 1992, aimed at developing methodology to reclaim mined land with savannah species.

RESULTS AND DISCUSSION

Figure 4 contains three photographs and its respective scene classified with the ENVI 3.5 software. The three photographs are representative of the three treatments included in the research, which started in 1992, aimed at reclaiming the degraded area by promoting the reestablishment of savannah vegetation species. The original vegetation of the site was removed during the exploitation of mineral. Vegetation ground cover varies in the three treatments tested.

(T 1) **(T 2)** **(T 3)**

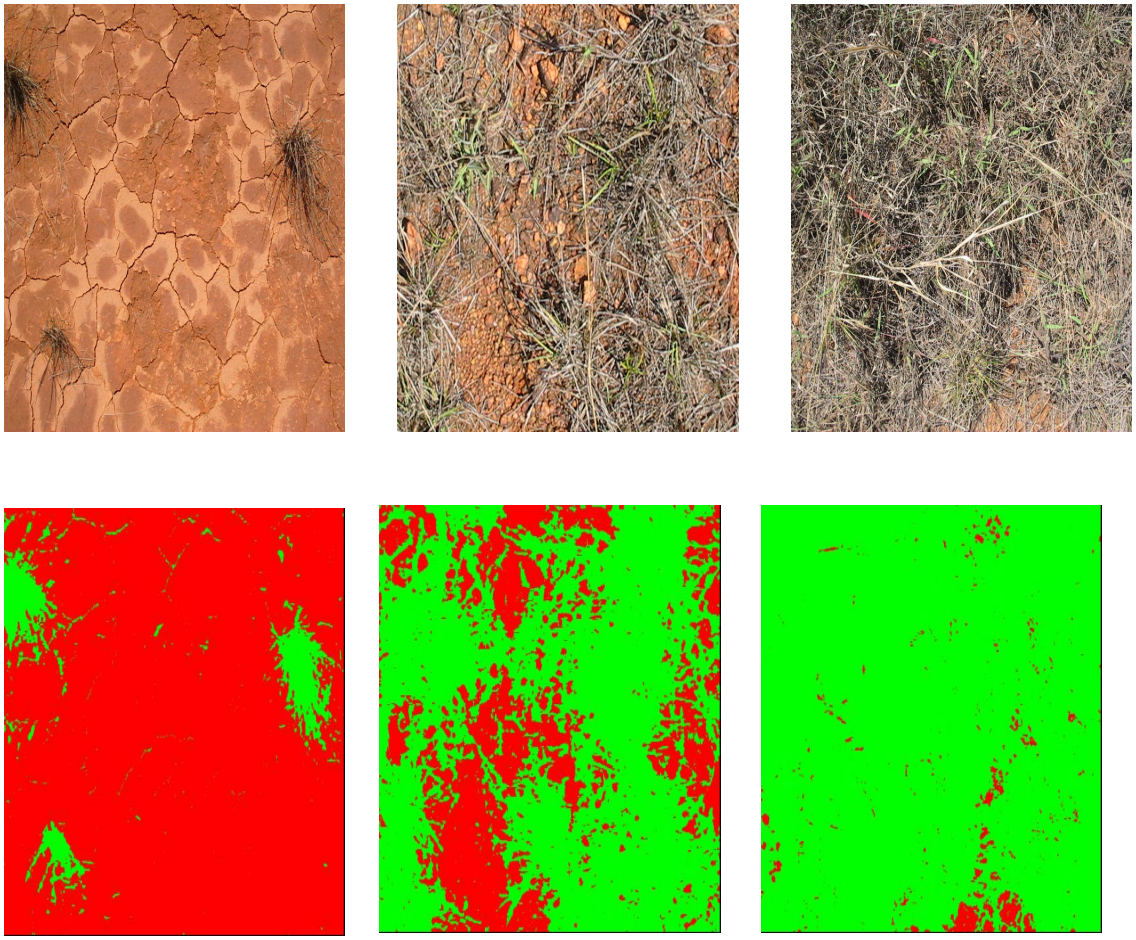

Figure 4: Photographs of the center of three experimental plots representatives of the three treatments and their respective classifications realized with ENVI 3.5 software (green= vegetation cover; red= bared soil, T 1, T 2 and T 3 are treatments.

Statistics related to the percentage of vegetation ground cover are presented in **Table 1**. In treatment T 3, vegetation ground cover averaged 85%, varying from 75% to 97%. Treatment 1, which did not receive any kind of fertiliser, presented the worst vegetation ground cover.

For results from research conducted in the experimental site Figure 1, published since 1992, see Leite et al (1992), Martins (1996), Leite et al. (1994), Baptista & Leite (1997), Martins et al. (2001).

Table 1: Statistics related to **v**egetation ground cover calculated from photographs taken with portable digital camera classified with ENVI 3.5, through the Maximum Likelihood algorithm, in the experimental gravel pit studied.

Treatment/Replication	**Vegetation Ground Cover (%)**		
	T1	**T2**	**T3**
R1	0	75	78
R2	0	69	85
R3	0	14	74
R4	11	43	97
R5	0	25	80
R6	3	34	87
R7	5	20	93
R8	7	24	92
Mean	**3.25**	**38.00**	**85.75**
Minimum	0	14	74
Maximum	11	75	97
Standard deviation	4.13	22.79	8.03

CONCLUSIONS

Photographs taken with portable digital camera can be used to assess the degree of vegetation ground cover in degraded land.

The technique employed in this study to determine vegetation ground cover can be used to assess efficiency of plans to reclaim degraded land in which the establishment of vegetation is expected.

Due to its low cost, easy of application and efficiency in estimating vegetation ground cover, the technique used in this study can be adopted by government environmental agencies responsible for monitoring plans to reclaim degraded land.

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