A METHOD BASED IN *IDRISI* GIS FOR MAPPING THE MOST PROBABLE AREAS OF FIRE OCCURRENCE IN NATIONAL PARKS OF BRAZIL.

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Abstract

A methodology was tested for mapping the most probable areas of fire occurrence in a national park of Brazil, using a model based on environmental parameters. The model was implemented in IDRISI GIS in a spatial modeling structure based on boolean algebra. The results show that it is possible to identify sites of high preview the fire risk in a test area by analysis of thematic maps and to identify preservation areas in a national park.

1. Introduction

Forest fire is a constant hazard in forest reserves and national parks of Brazil, and has increased drammatically in the last several decades. In tropical climate areas with four or five months of dry season, forest fire occur frequently in winter and spring. Most of the fires are caused by arson or by farmers living nearby.

The National Park of Serra da Canastra site in state of Minas Gerais, brazilian in southeastern Brazil, is the most affected by this environmental problem. This park has an area of 75.525 ha, and was set aside in 1972 to preserve the São Francisco river high basin and to protect the fauna and flora of *campos, cerrados* and *campos rupestres* of southeastern Brazil [4]. The objective of this study was the development of a spatial model based on the IDRISI geographical information system [3], applied to assessment and mapping of the most probable areas of fire occurrence and to extend these results to other parks with similar geographical characteristics in Brazil. A test area was selected in the park to study the capability of GIS to model fire occurrence.

2. The probability fire ocurring model

This study was based on utilization of environmental parameters of probability of fire occurrence model [1]. This model is specified as:

$$U = \beta_0 + \beta_1 \, AREA_i + \beta_2 \, ASPECT_i + \beta_3 \, SLOPE_i + \beta_4 \, ROAD_i + \beta_5 \, BUILD_i + \beta_6 \, ROTAT_i + \beta_7 \, RAIN_i + \beta_8 \, TEMP_i + \varepsilon \qquad (1)$$

where i is the ith geographical unit

AREA is the area of ith geographical unit
ASPECT is slope aspect
SLOPE is slope gradient
ROAD is proximity of transportation system
BUILD is proximity of buildings
TEMP is maximum temperature during the dry season
RAIN is annual average precipitation
ROTATE is a fire rotation factor.

The probability of fire occurrence is obtained by a logistic function [5]:

$$P_i = \exp(U_i)/1+\exp(U_i) \qquad (2)$$

where P_i is the probability of the ith geographical unit burning, and assumes values between zero and unity.

3. Mapping the environmental parameters for national park

The ASPECT and SLOPE parameters were obtained by generation of digital elevation model (DEM) of the national park, using the command INTERCON of IDRISI.The gradient and aspect maps were obtained using the command SURFACE. The gradient map was classified in five classes ($0-5^0$, $5-10^0$, $10-15^0$, $15-35^0$, $35-60^0$ and over 60^0) and the aspect map classified in nine classes (the azimutal octant and the plane surface. Both maps were structured using a 30 meters resolution grade, compatible with LANDSAT digital data.

The vegetation was surveyed by fieldwork during dry and wet season, mapped by digital classification in IDRISI Imaging Processing module. The following vegetation units were identified in the national park: *tropical subcaducifolia forest, campo rupestre, cerrado and campo limpo.* These patherns were used to do vegetation digital mapping based on supervisioned classification, with MAXLIKE command.

ROAD and BUILD parameters were mapped by fieldwork and photointerpretation. The analogic maps of roads, trails and buildings were digitalized in vector format using digitizing table. TEMP was mapped by interpolation of temperature data of São Roque de Minas, Sacramento and Delfinópolis stations, all sites nearby national park. For a better precision of interpolation, elevation was used as a weight factor, because experiments in the national park show that the temperature decreases 0.7°C with each 100 meter increased in elevation. The isotherms TEMP map was obtained by use of command INTERPON. A similar procedure was used in mapping of isohiets (RAIN map), but using Delfinópolis and Passos stations as reference for interpolation.

4. Implementation of model in IDRISI GIS

The implementation of model in IDRISI environment was made by adaptations of equations 1 and 2 to spatial data modeling structure of a GIS. Each parameter of equation 1 was considered as a layer, organized in 12000 pixels as a 300 columns by 400 rows matrix (test area located to the northeast of the national park). ROAD and BUILD layers were converted in proximity levels using DISTANCE command and selecting the 500 meter level (RECLASS command) as critical value to start the fire. In ASPECT layer, NNE and NNW intervals was considered the most important in start of fires in the national park, because these slopes face north are sites of high insolation during the dry season, and are exposed to dry winds from the northeast.

In SLOPE layer, the lowers gradient labels ($0-5^o$ and $5-10^o$) was selected as most important in fire origin, due the high wind velocity in plane surfaces site in high sites of the national park. In RAIN layer, the levels of lower precipitation (1100 mm - 1200 mm) were selected, whereas soon as in TEMP layer, the highest temperatures were selected. For the spatial combination of maps, the boolean logic was used and specified as:

U = ASPECT(315-360 *XOR* 0-15) *AND* SLOPE(0-5 *XOR* 5-10) *AND* ROAD(0-500) *AND* BUILD(0-500) *AND* VEGET(camprup *XOR* camplimp) *AND* RAIN (1100-1200) *AND* TEMP(30-40). (3)

The probability of fire ocurrence in each pixel, was defined as:

$$P = EXPO(U_i)\ DIVIDE\ (1\ ADD(EXPO(U_i))) \quad [4]$$

5. Results

The preliminary results show that the most probable areas of fire ocurrence in the National Park of Serra da Canastra test area, are sites of high risk. These sites were visited in the field and it was verified that these areas had a higher incidence of forest fire in the past several decades than other areas. We identified two possibilities to explain the origin of fire in these sites: the daily visitors and touristis that travel on the central road of the park, or the north and northeast park farmers. In addition, the natural characteristics of the area also show that it is possible to start wildfires spontaneounsly in *Cerrado,* as has been shown by other brazilian researchers.

The next step of this study is to extend the test area to entire park area, to learn the relation between the environmental parameters and the fire occurrence at a statistic level. The preliminary results show that the use of GIS IDRISI may be useful for modeling the most probable areas of fire ocurrence.

6. References

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