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Subsides to the creation of a regional model of forest fire hazard: Taquari River Springs Park, MS—A case study

L.M. Mercê de Albuquerque[a,*], A.C. Paranhos Filho[a], T.G. Torres[b], E. Kassar[c], H.J.S. de Matos Filho[b], M.G.G. Carrijo[d], H.G. Pavão[c], A. de Souza[c]

[a]*DHT, UFMS, Brazil*
[b]*PGTA, CNPq, UFMS, Brazil*
[c]*DFI, UFMS, Brazil*
[d]*IMAP, Costa Rica, Brazil*

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Abstract

Using map algebra, in the GIS (geographic information system) environment, this study integrates the B-RAMS, Brazilian Regional Atmospheric Models Software (CPTEC, 2005) climate model data with remote sensing data, intending to obtain a wildfire hazard map. The Taquari River Springs Park (TRSP) was chosen as a case study, due to the presence of springs which are considered important contributors to the Upper Paraguay River Basin, and it also contains essential remnants of the Cerrado Biome. The B-RAMS model has provided relative humidity, components of the horizontal wind and temperature. The TRSP land cover was identified by object oriented classification of a LANDSAT ETM+ image, supported by field observations. From the land cover phytophysionomic type characterization, a forest wildfire fuel map has been elaborated. The integration of the different maps has been made using a GIS, and a new map with its associated GIS database was generated showing the most vulnerable zones to wildfire hazard.

Keywords: Forest fuel; Atmospheric modeling; Remote sensing; Map algebra

1. Introduction

The naturally caused wildfires can reach environmentally preserved areas, such as parks and springs, causing considerable environmental damages, impairing the survival of biodiversity.

The forest wildfires in Mato Grosso do Sul have occurred mainly during the drought (July to October). Actually, the atmospheric humidity in this period is low, and it is not possible for the formation of rain and sky coverage (nebulosity). Low precipitation and low relative humidity of the air, combined with high temperature, make the vegetation dry and which becomes a vegetable fuel, while high precipitation and high relative humidity of the air, combined with low temperature, make the vegetation humid and green.

Nowadays, forest fires in Brazil are monitored by the National Institute for Space Research (INPE), using data of meteorological satellites, which can measure ground surface temperature over 47 °C and

*Corresponding author. Tel.: +55 06733457491; fax: +55 06733457490.
E-mail address: leilamma@nin.ufms.br (L.M.M. de Albuquerque).

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identify them as hot spots, which does not absolutely mean that it is a burning focus or a forest fire. So, a fire focus is confirmed only after it happens with its consequent damages.

Thus, this system is not preventive, it causes considerable environmental impacts. In Mato Grosso do Sul State, wildfires periodically always take place, when there is sufficient fuel material accumulated which propagate the fire. This generally happens in the interval of two or three years (Matos Filho, 2005). If this vegetation fuel increase is great, it can produce a fire of large proportions, requiring high financial resources and a great number of persons in order to extinguish the fire; sometimes these wildfires become totally uncontrollable giving rise to environmental impacts in the air and water quality, and mainly over the fauna and flora of the affected region (Matos Filho, 2005).

So, this work approaches the results obtained in GIS environment from crossing data of forest fuel obtained by means of remote sensoring system, with climatic data, obtained by numeric modeling.

Utilizing remote sensing data and a GIS tool, this work seeks to indicate the outstanding parameters for the identification of the forest wildfire risk, taking into account the availability of forest fuel and the climatic parameters and thus subsidizing the prevision and modeling of forest wildfires in the Cerrado Biome.

Intending to be preventive, the present work aims at the evaluation of forest wildfire risk, which constitutes the best possibilities for the safeguard of mankind, properties and natural resources. The scope of this study has been to develop know-how in order to subsidize the production of the wildfire risk cartography, based on satellite images, meteorological information and other auxiliary information, such as field control.

Numerical modeling tools were utilized to simulate the atmospheric circulations together with accurate data of vegetation, land cover and topography, which has proportionated the analysis of the availability of forest fuel at Taquari River Springs Park (TRSP) and consequently informing about the areas with adequate climatic conditions and high accumulation of fuel material, thus avoiding exceeding expenses and negative environmental impacts.

The TRSP area was selected for this study because it constitutes a conservation unit of restricted antropic use and where the studied forest wildfires have had their origin confirmed by natural causes.

2. Study area description

The study area is situated in the Cerrado Biome, which represents 23% of the Brazilian territory, where the natural wildfires are part of the natural processes. The TRSP is located between the coordinates 17°59′ and 18°15′ South, 53°10′ and 53°26′ West, with 26849.62 ha in Alcinópolis Municipality and 3769.34 ha in Costa Rica Municipality, totalizing an area of 30618.96 ha. This region is also near the watersheds of three great hydrographic basins: Paraná, Araguaia and Paraguay (Fig. 1).

In a general description, the Park vegetation cover is composed of specimens of forest, open pasture, field and along the streams the typical riparian forest, with bypasses and palm-fiber rope occurring near the springs and in humid areas.

Close to these areas also occur open pasture and forest. Where the slope is greater, the presence of open pasture is more common, tending towards a field. Over the hillsides of the depressions, prevails a gramineous known as cambaúva (actinocladum verticillatum). In this study, these areas were denominated by cambaúva fields because they constitute areas of particular identification on the satellite image (Carrijo, 2002) and they also have a special interest as potential wildfire areas.

At the valley, the typical vegetation is the forest and it also presents species which lose leaves totally and partially during the dry season. The defoliation ratio is related to the duration and intensity of the dry period, during which several species present flowering and fructification. The annual precipitation in the region of the TRSP ranges from 1800 to 2100 mm, but with two well-defined seasons: the dry period from June to September and the rainy period from October to May (Carrijo, 2002; Lamprecht, 1990).

3. Methodology

The methodology has included different stages: climatic data modeling and the integration of this data with the forest fuel chart which has been obtained by remote sensoring analysis and field control. In the sequence, in GIS environment, these charts were compared to the points where the natural forest fires of September 2004 have occurred.