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Fires in the cerrado, the Brazilian savanna

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15.1 ABSTRACT

The cerrado is the largest area savanna formation in South America, and originally covered approximately 25% of the Brazilian territory. The savanna forms of cerrado are characterized by a ground layer of grasses, small palms, shrubs, and trees. During the wet season there is a high production of biomass that dries as the dry season progresses, favoring the occurrence of fire. For thousands of years, natural fires, during the wet season, and anthropogenic fires, during the dry season, coexisted in the cerrado region, suggesting that fire, together with the seasonality of rainfall and the poor nutrient soils, is one of the determinants of the cerrado vegetation form. Cerrado fires can be characterized as surface fires, consuming basically the fine fuel of the herbaceous layer. Most species of the herbaceous layer are highly resistant to fire and resprout a few days after a fire. For open forms of cerrado, nine months after a fire, dead biomass (grasses + litter) represents 65% of the total, suggesting that it is possible to have a sustained fire, even during the short dry spells of the next rainy season. The woody vegetation presents several adaptive characteristics, such as thermal insulation of live tissues and the presence of underground organs that store water and nutrients. However, fire frequency and time of fire affects the structure and species composition of cerrado’s woody plant communities. In this chapter, we present a review of cerrado fire ecology, with emphasis on fire behavior, changes in the structure and composition of the vegetation, and its effects on water use and carbon flux.

15.2 INTRODUCTION

Savannas are a major component of the world’s vegetation, covering a land surface of $15 \times 10^6 \text{ km}^2$ (IPCC, 1990). The savanna formation of South America covers
2.5 × 10^6 km^2, of which 2.0 × 10^6 km^2 constitute the Brazilian cerrado. The cerrado originally covered approximately 25% of the Brazilian territory, spanning more than 20° of latitude. The climate in the region is tropical (Köppen's Aw, but Cwa in southern sites) with mean annual precipitation varying from 1,100 mm to 1,600 mm of which 90% occurs from October to April. Dry spells are common during the wet season and may last for a maximum of five to ten days in the west side of the region and from 20 to 25 days in the east side (Assad et al., 1993). The average annual temperature range is from 18°C to 28°C. The soils are mostly dystrophic, latosols and sandy soils, with low pH, and high levels of available aluminum (Haridasan, 1994).

The savanna forms of cerrado are characterized by a ground layer of grasses, small palms, shrubs, and trees. Many physiognomic forms are described for cerrado vegetation (Eiten, 1994) but campo limpo, campo sujo, cerrado ralo, cerrado sensu stricto, and cerradão are the most commonly known. Campo limpo and campo sujo are both dominated by grasses but they are distinct in appearance since the flora of the campo limpo presents no woody plants while there are some scattered shrubs and small trees in areas of campo sujo. Where the woody layer becomes denser, the vegetation is called cerrado ralo if it is an open scrub, or cerrado sensu stricto if a closed scrub. Both may have scattered trees as tall as 8 m to 10 m. The canopy closure varies from 5% to 20% in cerrado ralo and from 20% to 50% in cerrado sensu stricto. Cerradão can be either open-canopy arboreal woodland with trees up to 15 m and dense grass underlayer or a closed-canopy forest with dense woody underlayer and sparse grasses. Canopy closure may vary from 50% to 90% (Ribeiro and Walter, 1998). Considering all physiognomic forms, the cerrado contains at least 6,670 species of higher plants (Mendonça et al., 1998). The total species richness of trees and large shrubs occurring in denser forms of cerrado ranges between 1,000 and 2,000 (Ratter et al., 2003). The ratio between nonarboreal and arboreal species is estimated to vary from 3:1 to 4.5:1 (Filgueiras, 2002) and the number of described grass species is greater than 300 (Mendonça et al., 1998).

Fire is a common feature in the cerrado region, especially in the more open physiognomic forms that present a well-developed herbaceous layer. During the wet season there is a high production of biomass that dries as the dry season progresses, favoring the occurrence of fire. Many plant species present adaptations to fire such as thick bark and extensive subterranean organs such as rhizomes and xylopodia. Plant adaptation is related to fire regimes, especially to fire frequency that may affect plant’s growth cycle. In this chapter, we present a review of cerrado fire ecology, with emphasis on fire behavior, changes in the structure and composition of the vegetation, and its effects in water use and carbon flux.

15.3 FIRE HISTORY AND FIRE FREQUENCY

Salgado-Labouriau and Ferraz-Vicentini (1994), in a paleoclimatic and paleo-vegetational study, registered the occurrence of fire as early as 32,400 years BP in the region of Crominia (GO), in the core area of the cerrado. Other studies report cerrado fires from 19,520 years BP to 5,840 years BP (Ferraz-Vicentini 1999, Coutinho