Chapter 43
Characterization of Fire Regime Descriptors in Botswana Using Remotely Sensed Data

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ABSTRACT

Despite its role and relevance in environmental management at all scales the use of fire has been contentious. The absence of information on fire parameters compounds the situation. This study derives fire parameter information for Botswana by analyzing MODIS fire data for (2001-2012), using conditional statements, and cluster mapping in ArcGIS. The study also related the fire information to other variables to examine how they interact with fire. The results of the study indicates that over the 12 year period the burned area has exhibited an upward trend. It has also shown that most of the fire in the country occur over the late dry season when the fires are potentially destructive. A south-north transect of fire frequency is observed, accompanied by an inverse relationship between frequency and intensity. Of all the factors, rainfall (0.638) and biomass(NDVI) (0.355) were the most significant contributors to the fire activity. The study demonstrated the utility of the MODIS fire data in characterizing the fire regime of the country and thus contribute to the policy process.

INTRODUCTION

Fire has been and continues to be a major disturbance event used by humans to manage their environment (Clerici, Boschetti, & Eva, 2004; Heinl, Frost, Vanderpost, & Sliva, 2007; Perry, 1998; Pricope & Binford, 2012). This notwithstanding, some ecosystems are more prone to fire than others, and the African savannas are among those largely affected annually (Govender, Trollope, & Van Wilgen, 2006; Heinl et al., 2007; le Roux, 2011). This is largely attributed to the marked wet and dry season as well as the anthropogenic practices (le Roux, 2011; Mbow, Nielsen, & Rasmussen, 2000). Predictably, these fires have both negative and positive consequences for both the environment and the livelihoods of the human population (Duncan, Shao, & Adrian, 2009). The negative consequences includes potential to cause human and animal injury and death, change in land cover especially changes in vegetation struc-

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ture, floristic composition, spatial distribution, and cover density (Devineau, Fournier, & Nignan, 2010; Salvador, Valeriano, Pons, & Diaz-Delgado, 2000). Over and above these impacts, fires also contribute to global environmental change by releasing aerosols and greenhouse gases into the atmosphere (Arino & Melinotte, 1998).

However, fires also have positive impacts and for this reason have been harnessed for management purposes by different societies in Africa and elsewhere (Eriksen, 2007; Kull & Laris, 2009). A critically useful role of fire, especially in the African savanna, is the ecological maintenance. Fire ensures the persistence of fire dependent species and together with herbivores minimizes bush encroachment (Manyangadze, 2009). It has in fact been argued that, the African savannas, has evolved with fire and wild land burning remains an important driver in the maintenance of the balance between grassy and woody vegetation (Pricope & Binford, 2012). It is for this reason that ecologists and fire managers have often warned that fire suppression policies adopted by most African countries have a direct hand in the proliferation of the bush encroachment phenomenon in the region (Eriksen, 2007; Kull & Laris, 2009).

Because of these dualistic impacts of fire, its role and relevance in environmental management in the region and indeed globally has been contentious (Eriksen, 2007; Laris & Wardell, 2006; Mbow et al., 2000), a situation not aided by the absence of information on fire parameters. The launch and operation of the Aqua and Terra satellites upon which the MODIS sensor is mounted as well as the ability of other near real-time operational satellites sensors (MSG, NPP-VIIRS), has aided in the reduction of this information gap. In spite of this great achievements, gaps remain about the state of and impacts of fires. This is especially true in the developing world. For the southern African region, this is particularly true at national as opposed to the regional level where a number of publications have recently highlighted the central issues (Archibald & Roy, 2009; Archibald, Scholes, Roy, Roberts, & Boschetti, 2010; Clerici et al., 2004; Devineau et al., 2010; Hudak, Fairbanks, & Brockett, 2004; van der Werf et al., 2004). Whilst these studies have been important in improving the understanding of the African fires especially the fire regime, there has been a dearth of such analysis at national level (le Roux, 2011). This presents a problem in that whereas there is need to understand the broad picture national planning needs country level data to achieve its mandate.

Consequently, this chapter propose to demonstrate how analysis of MODIS data can be used to fill this gap by analyzing MODIS fire data for the national extent of Botswana for the period 2001-2012, and identify the key elements of the country's fire regime. By so doing, the study intends to unpack national trends and patterns of the fire regime. This type of analysis is not only useful for national level planning but is also important for the promotion of Community Based Fire Management (CBFiM), a key component of the Southern African Development Community (SADC) Protocol on Fire Management.

A fire regime defines all ecologically relevant characteristics and dimensions of fire occurrences within a defined area or in a specific ecosystem in a given time (Conedera et al., 2009). The fire regime is usually defined by its elements: frequency, intensity, seasonality, spatial distribution, size, pattern, and type of fires (Dube, 2009; Morgan, Hardy, Swetnam, Rollins, & Long, 2001; Rollins, Keane, & Parsons, 2004; Veblen, 2003), as well as the recovery rates of burned areas (Archibald, Roy, van Wilgen, & Scholes, 2009).

The Study Area

Located in the interior of southern Africa, Botswana is a large landlocked country sandwiched between South Africa, Namibia, Zimbabwe and Zambia. Figure 1, shows the location of the country in its regional