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The ongoing development of a pragmatic and adaptive fire management policy in a large African savanna protected area

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ABSTRACT

This paper describes recent changes to the fire management policy of the 1.9 million ha Kruger National Park in South Africa. It provides a real-life example of adaptive learning in an environment where understanding is incomplete, but where management nonetheless has to proceed. The previous policy called for the application of fire to meet burnt area targets that were set for administrative subdivisions, and that were assessed at the scale of the entire park. This was problematic because the park is large and heterogeneous, and because sound ecological motivations that could link burning prescriptions to ecological objectives were missing. The new policy divides the park into five fire management zones on the basis of differences in mean annual rainfall, historic fire return periods, and geology. In addition, it proposes fire management actions designed to achieve specified ecological objectives in each zone, and includes fire-regime related thresholds and associated ecological outcomes against which to assess the effectiveness of management. The new policy is an improvement over previous iterations, but several challenges remain. Most important among these would be to continually improve the understanding of the effects of fire, and to develop frameworks for assessing the impacts of fire together with other ecosystem drivers that interact strongly with fire to influence the attainment of ecological objectives.

1. Introduction

Ecosystem management has to proceed in the face of changing environmental conditions and values, incomplete understanding of ecosystem processes and interactions, and of how management will affect these processes. A growing response to dealing with this complexity has been to implement adaptive management (Walters and Hilborn, 1976; Holling, 1978; Keith et al., 2011), where management goals are defined, alternative strategies are developed to achieve those goals, and outcomes are monitored and evaluated in terms of achieving the defined goals (Lindenmayer and Burgman, 2005). Adaptive management explicitly embraces uncertainty, recognising that management strategies may not deliver the desired results, that changes to these strategies may be required, and that understanding can be improved by experimenting with alternative approaches combined with monitoring, assessment and reflection (Biggs et al., 2011; Keith et al., 2011).

Vegetation fires shape the structure and composition of savannas, and fires are either applied or excluded to improve range condition and provide grazing for large herbivores, to promote tree growth, to conserve biodiversity, and, more recently, as a means to generate carbon credits (van Wilgen, 2009; Hassan et al., 2007; Russell-Smith et al., 2009). Early colonial experiments in savannas focussed on fire effects on trees, as the colonial governments placed a high value on tree cover (Laris and Wardell, 2006), but range scientists subsequently promoted burning to improve grazing (Tainton, 1999). Fire management provides substantial scope for the development of adaptive approaches to management and, in South Africa, adaptive ecosystem management has been pioneered in National Parks, notably the Kruger National Park (KNP, see Biggs and Rogers, 2003; Roux and Foxcroft, 2011; van Wilgen and Biggs, 2011).

The understanding of the ecological role of fire in savannas grew substantially in the late 20th century (Scholes and Walker, 1993; Andersen et al., 2005), which in turn led to changes in fire management in South Africa (Mentis and Bailey, 1990; van Wilgen, 2009). The switch from promoting grazing for large herbivores to conserving biodiversity in a broad sense left managers without a sound scientific basis to guide fire management (Bond and Archibald, 2003). Fire management, like other forms of ecosystem

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management, needs therefore to be continually adaptive to accommodate changes in understanding and shifts in management priorities. How well this is done, and whether it is effective in practice, is seldom reported in the scientific literature.

This paper describes recent changes to the fire management policy of the KNP. It provides a real-life example of the challenges faced by managers of fire-prone savanna ecosystems, and of how evolving ecological and other understanding has been used to formulate pragmatic approaches to fire management. The purpose of the paper is to document the rationale behind the changes, and to examine retrospectively whether the new policy would have affected past fire management decisions had it been in place over the past decade. It also examines the ecological basis for the management policies that have been adopted, and highlights remaining challenges.

2. The study area

2.1. Salient features of the Kruger National Park

The KNP (ca. 1,900,000 ha, elevation 260–839 m) is situated in north-eastern South Africa, sharing international borders with Mozambique to the east and Zimbabwe to the north. Mean annual rainfall varies from 750 mm in the south to 350 mm in the north (Fig. 1A), and variations about the mean can be marked from year to year. The western half of the KNP is underlain by relatively nutrient-poor granites, while the eastern half is predominantly underlain by relatively nutrient-rich basalt, but includes the Lebombo Hills (primarily rhyolite formations) running from north to south. The granite and basalt areas are separated by a relatively narrow shale band in the south (Fig. 1B). The KNP is traversed from west to east by the perennial Crocodile, Sabie, Sand, Olifants, Letaba, Levuvhu and Limpopo Rivers. There are four broad vegetation types in the KNP. These are savanna woodlands on granite, dominated by broadleaved trees in the genus *Combretum* in the southwest, relatively open grassy woodlands dominated by fine-leaved trees in the genus *Acacia* on basalt in the southeast, and woodlands dominated by mopane trees (*Colophospermum mopane*) on granites and basalts respectively in the northern parts of the KNP. The KNP supports a variety of large grazing and browsing mammal species, notably elephant (*Loxodonta africana*), white rhinoceros (*Ceratotherium simum*), hippopotamus (*Hippopotamus amphibious*), buffalo (*Syncerus caffer*), giraffe (*Giraffa*

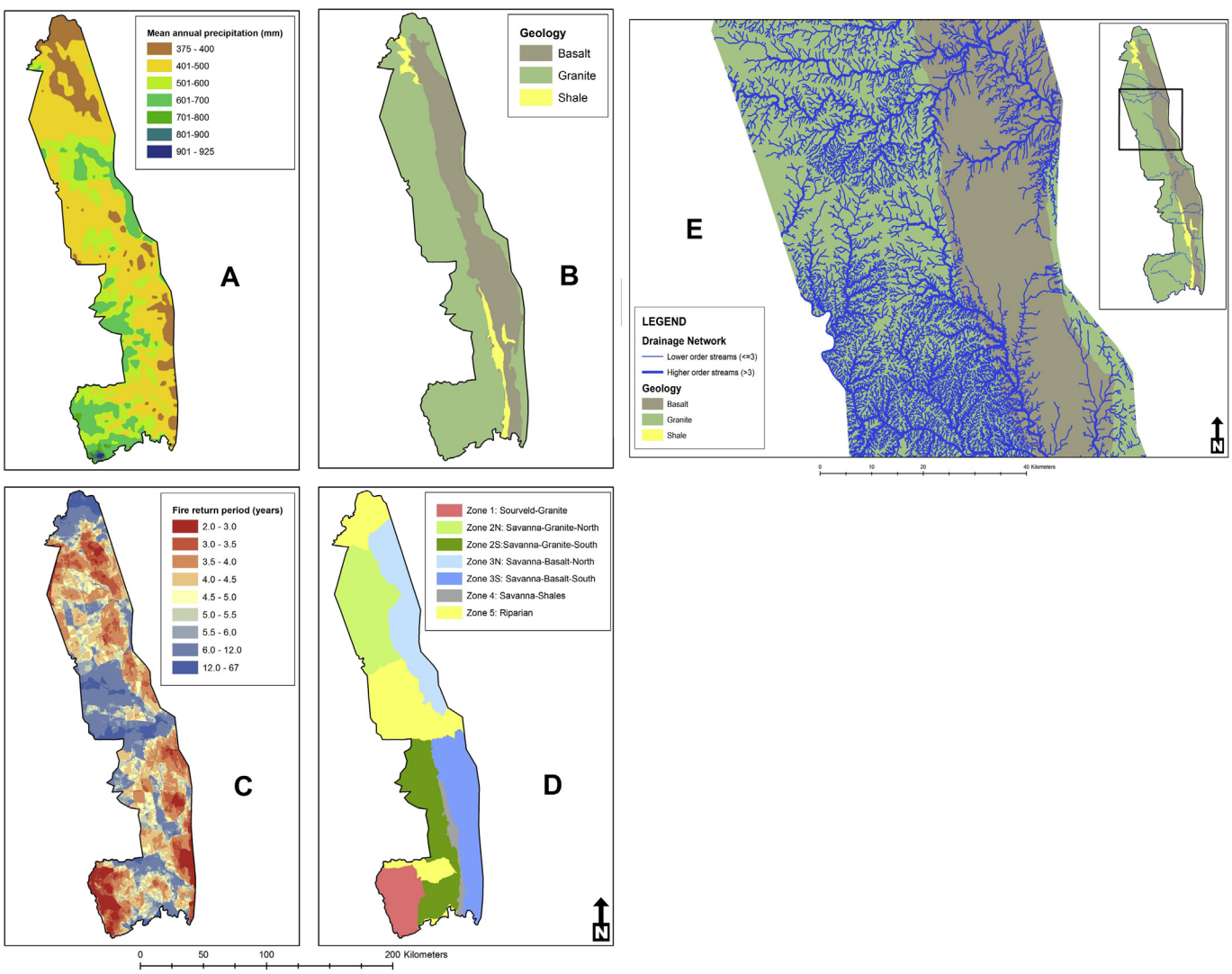

Fig. 1. Biophysical features used in the delineation of fire management zones in the Kruger National Park. A: Mean annual precipitation; B: The distribution of broad geological substrates; C: The distribution of mean fire return periods; D: Fire management zones; E: Drainage lines, included here to illustrate the marked differences in topographical heterogeneity between granite and basalt areas.