

# *International Journal of Wildland Fire*

Scientific Journal of the International Association of Wildland Fire

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Volume 12

Number 3 & 4

2003

## **'Fire and savanna landscapes in northern Australia: regional lessons and global challenges'**

*Edited by J Russell-Smith, RJ Williams, PJ Whitehead and MD Flannigan*

Preface	(v)–(ix)	
<b>Theme 1. Fire patterns at the savanna-wide scale</b>		
A review of current space-based fire monitoring in Australia and the GOFc/GOLD program for international coordination <i>Christopher O. Justice, Richard Smith, A. Malcolm Gill and Ivan Csiszar</i>	247–258	This paper provides an overview of satellite-based fire monitoring and an assessment of operational satellite fire monitoring in Australia. These capabilities are presented in the context of a new international program GOFc/GOLD designed to improve global observing systems for natural resource management and global change research.
Remote sensing of burned areas in tropical savannas <i>José M.C. Pereira</i>	259–270	Satellite-based mapping of areas burned in tropical savannas needs to take into account specific aspects of these ecosystems, namely the heterogeneity of fuel types, the short persistence of combustion residues, tropical cloudiness, the presence of smoke and haze layers during the fire season, and the difficulty of detecting understory burns in savanna woodlands. These problematic aspects are reviewed, and recommendations are provided for handling them. The capabilities and limitations of major satellite systems for pan-tropical burned area mapping are also addressed.
Effects of biomass burning and lightning on atmospheric chemistry over Australia and South-east Asia <i>Yutaka Kondo, Nobuyuki Takegawa, Yuzo Miyazaki, Malcolm Ko, Makoto Koike, Kazuyuki Kita, Shuji Kawakami, Tomoko Shirai, Toshihiro Ogawa, Donald R. Blake, Ben Liley and Jeremy Russell-Smith</i>	271–281	Over South-east Asia, the O <sub>3</sub> precursors produced by biomass burning and lightning were rapidly transported from the BL to the FT due to convection, leading to O <sub>3</sub> formation in the upper troposphere. By contrast, over northern Australia, the majority of the trace species emitted by biomass burning remained in the BL due to strong regional subsidence, leading to O <sub>3</sub> formation in the BL. These trace species either deposited over northern Australia or were transported westward within the BL. Elevated concentrations of the trace species in the FT over Australia were due to long range transport from other regions.
Contemporary fire regimes of northern Australia, 1997–2001: change since Aboriginal occupancy, challenges for sustainable management <i>Jeremy Russell-Smith, Cameron Yates, Andrew Edwards, Grant E. Allan, Garry D. Cook, Peter Cooke, Ron Craig, Belinda Heath and Richard Smith</i>	283–297	The paper presents a five year assessment, 1997–2001, of the patterning of savanna fires in northern Australia derived from NOAA-AVHRR imagery. On the basis of that assessment, the paper then addresses the implications of these data for understanding changes in fire regime since Aboriginal occupancy, impacts on biodiversity, and emerging greenhouse issues.

<p>Application of NDVI for predicting fuel curing at landscape scales in northern Australia: can remotely sensed data help schedule fire management operations?  <b>Grant Allan, Andrea Johnson, Shane Cridland and Nikki Fitzgerald</b></p>	299–308	<p>Within the tropical savannas of northern Australia, abundant grass growth during the wet season rapidly becomes senescent each dry season to create high fire danger. Appropriately timed early dry season burning programs are key to reducing fire danger. However, variable characteristics of each wet season and variations in fuel loads within major landscape types affect curing rate and the success of burning programs. A 2-year sampling program derived significant relationships between ground data and NDVI satellite images, with distinct differences by soil type and seasons. The next stage is to improve the timing of aerial control burn operations in remote and inaccessible areas.</p>
<b>Theme 2. Fire regimes and regional landscape dynamics</b>		
<p>Using simulation to map fire regimes: an evaluation of approaches, strategies and limitations  <b>Robert E. Keane, Geoffrey J. Cary and Russell Parsons</b></p>	309–322	<p>Fire regimes maps are important to fire management and this paper compares three methods of mapping fire regimes—(1) classification; (2) statistical modeling; and (3) simulation modeling—for a small landscape in Idaho, USA. The sensitivity of three important simulation parameters were then explored to determine their influence on spatial fire regimes. Next, two simulation models (LANDSUM and FIRESCAPE) were applied to a small neural landscape and results were contrasted to illustrate the importance of simulation model design on fire regime mapping. Challenges to fire regime mapping are presented last.</p>
<p>Fire-created patchiness in Australian savannas  <b>A. Malcolm Gill, Grant Allan and Cameron Yates</b></p>	323–331	<p>Understanding the nature of the chance of occurrence of fire at points and as patches is important to understanding the responses of flora and fauna to fire regimes. Patches may be defined by their time since fire or their between-fire interval. Patch areas change with time as shown by this study in the savannas of Australia, but determining the ecological significance of this change remains a challenge</p>
<p>Fire impacts on surface heat, moisture and carbon fluxes from a tropical savanna in northern Australia  <b>J. Beringer, L.B. Hutley, N.J. Tapper, A. Coutts, A. Kerley and A.P. O’Grady</b></p>	333–340	<p>Radiative, energy and carbon exchanges were measured over unburned and burned (both before and after low and moderate intensity fires) open forest savanna at Howard Springs, Darwin, Australia. The influence of fire and fire intensity on albedo, surface fluxes, Bowen ratio, canopy processes and local/regional climate are examined.</p>
<p>Experimental comparison of four remote sensing techniques to map tropical savanna fire-scars using Landsat-TM imagery  <b>D.M.J.S. Bowman, Yue Zhang, Angie Walsh and R.J. Williams</b></p>	341–348	<p>There is no consensus as how best to map fire scars from Landsat imagery, with consequent uncertainty of the reliability of such fire mapping. To advance this problem we used a landscape-scale fire experiment, conducted over two consecutive dry seasons in a large tract of tropical savanna in north Australia, to evaluate four methods to map fire scars: (i) systematic visual; (ii) semi-automated; (iii) automated; and (iv) change detection. All of the methods showed rapid fading of the fire scars following recovery of the vegetation. Visual and automated classifications were able to discriminate burnt areas for longer than the other methods, although the latter method had the disadvantage of a high rate of falsely</p>

		identifying burnt areas. Consequently, Landsat-TM imagery cannot be used to reliably determine the spatial extent and timing of individual savanna fires, thereby limiting the utility of this data source for fine-scale ecological studies.
Fire regimes and vegetation sensitivity analysis: an example from Bradshaw Station, monsoonal northern Australia <i>Cameron Yates and Jeremy Russell-Smith</i>	349–358	The paper presents an analysis of (1) a detailed decadal fire history, and (2) the fire-sensitivity of savanna vegetation types, for a 9100 km <sup>2</sup> property in northern Australia. Results indicate that contemporary fire regimes are unsustainable, especially for longer-lived obligate seeder species occupying rugged sandstone habitats.
Assessing woody vegetation cover change in north-west Australian savanna using aerial photography <i>R.J. Fensham and R.J. Fairfax</i>	359–367	Aerial photography suggests that tree cover has increased in north-western Australia in the second half of the 20th Century. Changes may be driven by a complex of factors but coincide with wetter than average rainfall and follow a period that included some major droughts.
Patterns of landscape fire and predicted vegetation response in the North Kimberley region of Western Australia <i>Rohan Fisher, Tom Vigilante, Cameron Yates and Jeremy Russell-Smith</i>	369–379	A decadal fire history derived from interpretation of Landsat imagery, and associated modelling of woody species responses, is presented for a fire-prone region of north-western Australia. Assembled data point to the need to undertake a thorough appraisal of the status of regional biota in this remote, ostensibly ecologically intact region.
<b>Theme 3. Managing fire for desired landscape states</b>		
Confronting complexity: fire policy choices in South African savanna parks <i>William J. Bond and Sally Archibald</i>	381–389	Changes in ecological concepts and a shift towards biodiversity as a central conservation objective have led to changes in fire policies in South African savanna parks. We discuss three different fire policies, ‘natural’ fires, ‘patch-mosaic’ burning, and fire regimes designed to achieve specified ecological criteria, in the context of their ability to maintain specified conservation objectives within ‘thresholds of potential concern’. We compare the merits of the different policies for managing successional shifts from savannas to forest and for changing grassland states by altering grazing patterns. We conclude that different policies will be required in different ecological settings
Fire experiments in northern Australia: contributions to ecological understanding and biodiversity conservation in tropical savannas <i>R.J. Williams, J.C.Z. Woinarski and A.N. Andersen</i>	391–402	In this paper we describe the contribution that fire experiments have made to ecological understanding and biodiversity management in Australia’s savannas. While few in number, they have highlighted important ecological responses. Importantly, a range of responses to differences in fire regime is possible, such that no single fire regime can optimise all biodiversity outcomes.
Ecological and economic assessment of prescribed burning impacts in semi-arid pastoral lands of northern Australia <i>Rodd Dyer and Mark Stafford Smith</i>	403–413	Savanna pastoralists must trade off short-term use of grass for animal production against its longer-term use as fuel to manage tree–grass balances. We combined simplified versions of several models with local research and expert knowledge to quantify the economics of these tradeoffs for various fire treatments. Results show the importance of burning to maintain long-term pasture productivity.

<p>Customary use of fire by indigenous peoples in northern Australia: its contemporary role in savanna management  <b>Peter J. Whitehead, D.M.J.S. Bowman, Noel Preece, Fiona Fraser and Peter Cooke</b></p>	415–425	<p>Can Aboriginal practice in fire management help maintain or improve the condition of north Australian savannas? We argue that it can, because customary methods and knowledge remain relevant to major management challenges. Indeed, we regard it as essential that it should, because Aboriginal peoples' perspectives as major landowners will strongly influence the region's land management goals and performance. We propose ways of identifying and achieving shared goals through increased Aboriginal participation in formal fire management programs.</p>
<p>Monitoring the impacts of fire regimes on vegetation in northern Australia: an example from Kakadu National Park  <b>Andrew Edwards, Rod Kennett, Owen Price, Jeremy Russell-Smith, Greg Spiers and John Woinarski</b></p>	427–440	<p>Between 1995 and 2000, about 40% of the 20 000 km<sup>2</sup> Kakadu National Park burnt each year. Fires occurred earlier in the dry season than in the preceding 15 year period, which was marked by extensive unintended 'hot' late dry season fires. The occurrence of 41 plant species changed significantly in 134 permanent plots; and woody vegetation cover increased, especially in plots that had fewest fires.</p>
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