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RAINFALL-DRIVEN EPISODIC FLOOD EVENTS: ARE THEY A MAJOR FACTOR IN MOULDING AUSTRALIAN ARID LAND VEGETATION

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ABSTRACT

Arid vegetation is subjected to more or less frequent fire, drought, sporadic flooding events and grazing. Whilst fire, drought and grazing have been the subject of considerable research, little is known of the impact of flooding in arid environments. We examined the effects of a flooding event, and its interaction with fire and grazing on moulding the arid vegetation. Number of species per area dropped (from 12 to 6 per 25 sq m), while average cover increased (from 27 to 83 %). This increase in cover was greater when plots had been burnt than when not burnt. Vegetation in plots left open to grazing by vertebrates differed from fenced plots. The exotic *Nicotiana glauca* was found associated with flooded unfenced plots. Major flooding events not only trigger native species' germination and recruitment but also create an avenue for exotic species to invade.

INTRODUCTION

There is a widely held view that Australian arid zone vegetation is shaped by erratically occurring high rainfall events (Stafford-Smith & Morton 1990). Such events are critical in triggering regeneration of long-lived perennials (Griffin & Friedel 1985). Noble (1986) considered the chances of these events occurring in different situations and determined that only on roadsides was there any real probability of these conditions co-occurring. Even on roadsides he estimated the chance as one in 250 years. Whilst fire, drought and grazing have been the subject of considerable research, little is known of the impact of flooding in arid environments and its interaction with other impacts. During February 1997, an extreme rainfall event caused flooding in the Olary Creek and inundated its flood plain. One branch of the creek created a terminal lake within mallee vegetation on Nagaela Station, far western New South Wales. The flood path of Olary Creek and this terminal lake provide an opportunity to study the importance of rainfall-driven flood events in shaping vegetation in arid environments. These sporadic events may have played a major role in determining Australian arid-zone vegetation. Our main objective was to evaluate the relative importance of fire, flooding and grazing on native vegetation by placing pairs of permanent plots within vegetation that had experienced different combinations of fire and flooding.

METHODS

To assess the relative impact of flood, fire and grazing, permanent 25 x 25 sq m plots were established in September 1999, after the flooding (February 1997) and fire (December 1996) events. The permanently marked plots were placed in pairs in areas that had one of the following histories: (i) Not flooded, not burnt (n = 2); (ii) Flooded, not burnt (n = 2); (iii) Not flooded, burnt (n = 2); (iv) Flooded, burnt (n = 2). One of the plots in the pair was left unfenced while the other was fenced to prevent grazing by vertebrate animals. Detailed vegetation data were collected in October 2000 and October 2002. The objective was to monitor recovery of vegetation following different combinations of impact. Each plot was further divided into 5 x 5 sq m subplots. Within each of these sub-plots, species were recorded along with a cover estimate based on the Braun-Blanquet cover scale. The data were analysed with both univariate and multivariate methods.

RESULTS

Number of species per area dropped (from 12 to 6 per 25 sq m), while average cover increased (from 27 to 83 %). This increase in cover was greater when plots had been burnt than when not burnt.

Vegetation in plots left open to grazing by vertebrates differed from fenced plots, but the amount of variation explained was small compared with flooding and the change over time (Table 1). Twenty-seven native species from 13 families were recorded both in the enclosed and open plots located on the flooded area. Further, eleven exotic species from five families were recorded in the flooded (both enclosed and open) plots over the study period. The shrub *N. glauca* invaded a large part of the lake and extended into the surrounding mallee shrubland. In September 1998, no *N. glauca* was found across flooded and control plots. In October 2000, 24 and 12 *N. glauca* seedlings per ha were recorded from flooded unfenced and fenced plots respectively. This number had significantly (P = 0.0001) increased by October 2002, when 756 and 468 per ha were recorded in the flooded unfenced and fenced plots respectively. *N. glauca* was not recorded from control (unflooded) fenced and unfenced plots.

Table 1. Decomposition of the explainable variation according to four different partial Redundancy Analysis

ENVIRONMENTAL VARIABLES	Co-variables	Explained variance (%)	F-Value	***P- Value***	Permutation blocks defined by: (samples per block)
A: Fire/No fire	B, C, D	2.0	0.853	0.5106	A, B & C (4)
B: Flooded/Not flooded	A, C, D	12.9	5.619	0.0002	A, C & D (4)
C: 2000/2002	A, B, D	19.4	8.731	0.0008	D & plot id (2)
D: Open/Exclosed	A, B, C	3.5	1.596	0.0284	C & plot id (2)

DISCUSSION

It is well known that annual plant species respond strongly to annual variation in rainfall. How botanical composition responds to high rainfall-driven flooding events however has received little attention, mainly because such high rainfall-driven flooding events have been ignored as "once in a lifetime". No serious attempt has been made to explore these rare opportunities to understand the effects and response of native and exotic species in arid landscapes in Australia and other parts of the world. To look at the plant response to this rare flooding event in the context of the theory of water availability effects on arid land plant species, it is essential to consider the 1997 high rainfall-driven episodic flooding event. Our study not only shows that a significant number of annuals irrupted in response to this rainfall, but perennial species also respond more positively in the flooded plots than unflooded plots. The 1997 rare episodic flooding event not only facilitated native annual and perennial species recruitment but also brought exotic plant species into this newly created lake. One exotic species, *N. glauca*, is a major concern. In conclusion, these rare flooding events have created suitable conditions for annuals and more importantly, long lived perennial species. It seems that *N. glauca* is potentially a serious weed in arid catchments such as Olary Creek. Our study suggests that *N. glauca* tree density is significantly higher in the open flooded plots where grazing has eliminated competition from pre-existing shrub and grass species. The knowledge gained from this study would contribute to improved management strategies for arid land vegetation.

ACKNOWLEDGEMENTS

We would like to acknowledge the support of Per Milberg in providing statistical help and Marion O'Keefe, Mark Irvin, and Brock Baker for field assistance. The University of Ballarat provided financial support for this study.

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