PROGRAM B – Project 4.2 *("Multi-scale analysis of patterns in ecological processes in relation to fire regimes")*

DISTRIBUTIONS OF FIRE WEATHER EVENTS AND FUEL RECOVERY RATES AS DESIGN PARAMETERS FOR EFFICIENT PRESCRIBED BURNING STRATEGIES

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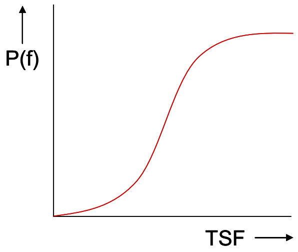
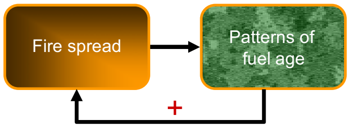
INTRODUCTION

The role of fuel reduction measures in forming a landscape mosaic of fuel ages that suppresses the incidence of large wildfires has been topic of an ongoing debate. Although the debate has focused on (Californian) shrublands, management options in other fire-prone landscapes are likely constrained by the same set of functions. The core of the discussion questions how fuel-age, or time since fire (TSF), determines the probability P(f) of a site burning in a wildfire (i.e. unplanned fire).





Fire spread

Patterns of fuel age

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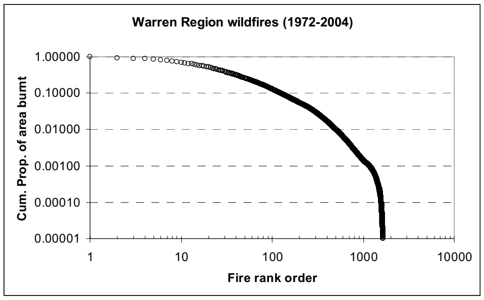
Figure 1: An example of a commonly assumed relationship between the probability of burning, P(f), and the time since the last fire, TSF (Left panel). This function reflects the rate of fuel recovery after fire and the effect of fuel loads on fire propagation. The stronger the increase of P(f) with TSF the weaker the feedback linking past fires to future fires (Right panel). Modelling work by Peterson et al. (2002) suggests that the shape of the P(f)-TSF relationship strongly affects the spatial grain and temporal persistence of fuel age patterns.

A strong control of TSF on P(f) would, in theory, allow a fire-prone landscape to self-organize into a predictable mosaic of fuel age patches (Fig. 1). If such a relationship were true then the sizes and likely locations of wildfires could be managed by manipulating the spatial configuration of TSF in the landscape by prescribed burning or other fuel reduction measures.

Figure 2: Inverse cumulative proportion of area burnt by unplanned fires in the Warren Region of southwest Western Australia against the rank order of fire sizes. 90% of the area was burned by less than 7% of the fires. Data source: CALM.



BIAS IN EMPIRICAL P(f)-TSF RELATIONSHIPS?

When P(f)-TSF relationships are derived empirically from TSF maps the impact of fuel-age on P(f) often appears to be weak (e.g. Moritz et al. 2004), suggesting there is little scope for influencing wildfire patterns through prescribed burning. However, empirical P(f)-TSF relationships implicitly include the effect that major proportions of fire-prone landscapes are typically burned by a relatively small number of fires burning under relatively severe weather conditions (Fig. 2).

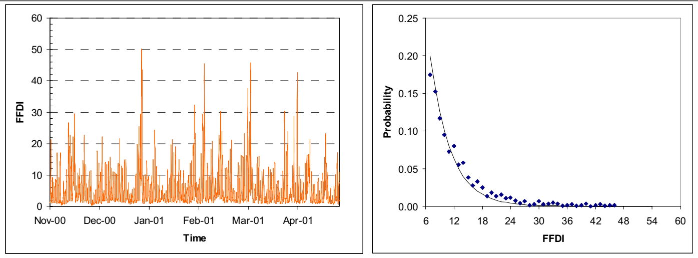


Figure 3: Time series of hourly Forest Fire Danger Index (FFDI) values at Manjimup in southwest Western Australia (Nov. 2000 – April 2001) (Left panel) and the corresponding probability density function of FFDI (Right panel).

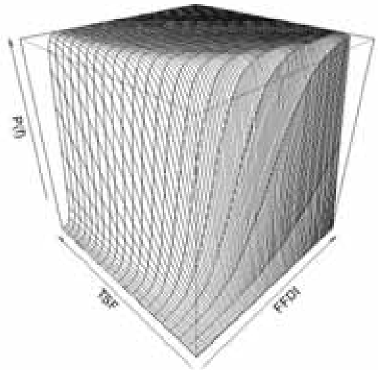


Figure 4: A hypothetical response surface for the probability of burning, P(f), as a function of both time since fire, TSF, and fire weather conditions (here quantified by the McArthur's (1967) Forest Fire Danger Index, FFDI).

ADDING THE METEOROLOGICAL DIMENSION

The weather is a key driver of fire spread and thus affects P(f). Fire weather conditions vary in time and space: on an annual basis severe fire weather conditions are relatively rare while mild fire weather conditions are relatively common (Fig. 3). By adding a meteorological dimension to the P(f)-TSF relationship (Fig. 4) and taking the temporal variation in fire weather conditions into account we obtain a better framework for the assessment of fuel reduction strategies. The extent to which fuel reduction can control the distribution of wildfires may be explored through simulation. A cellular automaton model is being constructed to explore alternative fuel reduction scenarios in hypothetical model landscapes defined by different: i) fuel types and their associated fire behaviours, (ii) fuel recovery rates, (iii) a range of P(f)-TSF-FFDI response surfaces in combination with time series of hourly FFDI, and (iv) spatiotemporal distributions of ignitions.

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