HOTSPOTS FACT SHEET

Case Study: Fire, vegetation and climate change in the Greater Blue Mountains World Heritage Area

High intensity fire near Pulpit Rock in the Blue Mountains in 2006

This fact sheet is an adaptation of information from 'Vegetation, Fire and Climate Change in the Greater Blue Mountains World Heritage Area' a book published in 2010[1].

BUSH FIRES, VEGETATION AND CLIMATE ARE LINKED

Bush fires and vegetation are closely linked, and both respond strongly to climate. When and where bush fires occur depends on four factors being present and 'switched on' in a landscape: (1) a sufficient quantity of fuel, (2) fuel that is dry enough to burn – i.e. 'available' to the fire, (3) weather conditions suitable for fires to spread – determined by the weather on any given day, and (4) a source of ignition[2]. If any one of these factors is missing, then landscape-scale fires (i.e. major bush fires) won't occur.

This 'four-switch' model provides a useful framework for considering the likely impacts of climate change on bush fires, as different switches are 'limiting' in different regions, turn on at different rates, and are likely to respond differently to climate change. Identifying the limiting switches in a particular region may enable better predictions to be made about climate change.

In south-eastern Australia, **fuel quantity** is generally not limiting. The sclerophyll forests and woodlands that dominate most landscapes support abundant and largely continuous fuel. This fuel is comprised of dead leaf litter and living vegetation, both of which accumulate rapidly – typically within 4-10 years of being burnt[3,4]. However, its **availability to burn** (i.e. its dryness) is often limiting. Only when long dry spells occur, as in El Niño-induced droughts, when the surface leaf litter, grasses and shrubs dry to the point at which they can readily burn, does the fuel actually become 'available' to the fire[5,6]. As a result, severe bush fire seasons in south-eastern Australia often occur once or twice per decade, corresponding with the occurrence of El Niño events.

Also limiting are the **daily weather conditions** necessary for a fire to spread *rapidly* once it has been ignited - and thus become a major landscape-level fire. These weather conditions are described by the Forest Fire Danger Index (see below), and also occur more commonly during El Niño events. Studies in the Greater Blue Mountains/Sydney region have clearly demonstrated the very strong link between weather and major fires. While fuel and terrain do influence the behaviour and spread of fires in local areas, weather exhibits the strongest influence at the landscape level[7,8].

Finally, even when fuel loads are substantial, dry enough to burn, and the weather conditions are conducive to fire spread, unless there are **ignitions**, fire will not occur. In the Blue Mountains National Park, lightning is responsible for approximately a third of ignitions, and arson a further third.

Climate change and fire

Recent regional projections of average temperature and rainfall for NSW[9] suggest average temperatures for the Sydney region could increase by 1.5 ºC to 3 ºC (both average minimum and maximum temperatures in all seasons) by 2050. Projections of rainfall are much more uncertain, however for Katoomba the current projections indicate that average summer rainfall could increase, while average winter rainfall could decrease. This modelling has been carried out for all of NSW, in each of nine broad regions. Summaries of the results can be downloaded from http://www.environment.nsw.gov.au/climatechange/nswreports.htm.

FOREST FIRE DANGER INDEX

Fire weather is described in the Forest Fire Danger Index (FFDI; Noble *et al*, 1980). This index is used by fire-fighting agencies to assess fire risk, schedule prescribed burns, declare Total Fire Ban days and assign Fire Danger Ratings. It includes four variables: daily temperature, rainfall, relative humidity and wind-speed. The FFDI categories are low-moderate (0-11), high (12-24), very high (25-49), severe (50-74), extreme (75-99) and catastrophic (100+). Very high, severe, extreme, and catastrophic are the categories of most concern to fire-fighters, as this is when fires are much more likely to become intense and uncontrollable.

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Global temperature and rainfall projections have been used to model how the frequency of dangerous fire weather might be altered by climate change[10]. This modeling suggests that by 2020 there could be 2–3 extra days per year of 'very high' to 'extreme' forest fire danger in south-eastern Australia, and by 2050 there could be 3-6 extra days of such weather in the Sydney region. Although many other weather variables substantially affect bush fires, these variables are not able to be taken into account in the current models.

Based on these fire weather models, researchers have predicted how fire regimes, in turn, might respond to climate change. They suggest that, on average, by 2050 the area burnt annually by bush fires in the Sydney region could increase by up to 35%, the interval between fires could decrease by up to 25%, and the probability of high intensity crown fire could increase by 20–25%[11]. Nevertheless, these same researchers caution that these figures do not incorporate all components of climate change, and that doing so may substantially alter the results. For example, they speculate that an initial climate-caused increase in fires could be followed by a subsequent decrease as a result of climate impacts on vegetation (see opposite).

Indirect impacts of climate change

Indirect impacts of climate change on fire regimes are also likely, such as through changes to plant growth rates and hence the resulting fuel loads. These effects are likely to be complex and in some instances counteract each other[2]. For instance, increased CO_2 may enhance plant growth through an effect known as 'CO_2–fertilisation', while reduced rainfall would have the opposite effect. The authors of the Sydney bush fire study[11] suggest that once accumulated fuel loads have been burnt, the slower plant growth that may result from changed climate could actually lead to a reduced incidence of bush fires. Other indirect impacts are also possible. For example, changes in climate could alter the patterns and timing of dry lightning storms - in the Blue Mountains, such storms ignite a third of all fires.

It is therefore worth recognising that with all of these models, especially those that make predictions about possible changes in fire regimes, that even though they call on enormous computing power, they are still very simplified and possess unknown predictive capabilities.

This intense fire in the Grose Valley in November 2006 resulted from a back-burn converging with a bush fire. The towering flames are in the vicinity of the Blue Gum Forest.

Effects of fire regimes on vegetation

Fire plays an important positive role in many Australian ecosystems: many native plants in sclerophyll vegetation depend on fire to break dormancy in soil seedbanks or release seeds from woody cones to stimulate flowering, and to create the conditions necessary for them to flourish. Fire releases nutrients into the soil and removes competitive plants that have come to dominate, allowing more light and rain to reach the soil surface. The absence of fire can cause many fire-requiring plants to decline. Of course, fire can also negatively impact on plants, although these negative effects are much less common than might be expected. Where fires occur too often, species that are slow to recover may be lost or go into decline. Intense fires can sometimes cause a decline or loss in species sensitive to fire-intensity (such as some native cypress pines), although, in general, they simply result in slower rates of recovery.

The impacts of fire are undoubtably complex. What happens after a fire strongly depends on the **intensity** of the fire, the **season** in which it occurred, the **frequency** at which fires have repeatedly occurred at that particular place, and whether the fire burnt underground (as in a peat fire). The weather following a fire can also greatly affect subsequent rates of recovery. Different fires can produce very different results. While a single intense fire may significantly impact individual plants and animals, it is the repeated pattern of fires across the landscape that determines the long-term *survival of species*.

Potential effects of altered fire regimes

Recent research in the Greater Sydney region suggests that most **dry sclerophyll forests**, in general, are unlikely to be adversely affected by the projected changes in fire frequency and intensity as a result of climate change[11]. Some more sensitive and restricted species and ecological communities, however, with narrow habitat requirements, may be at risk. For example, more intense or frequent fires could potentially negatively impact stands of fire-sensitive Blue Mountains ash (*Eucalyptus oreades*). Killed by crown fires, these trees only recover from seed, and are at risk if fires recur at short intervals.

In **wet sclerophyll forests**, increased fire frequencies could lead to a decline of rainforest shrubs in the understorey since many of these species have relatively thin bark and a limited ability to resprout after intense or repeated fires. Resprouting ferns, grasses and herbs may fill the resulting gaps as these shrubs decline, leading the structure of these forests to change toward a more open, grassy understorey. Intense fires can damage the crown of tall, wet sclerophyll forest eucalypts, many of which are only 'weak' resprouters, and this could lead to significant impacts both on canopy structure and the arboreal fauna.

Small **rainforest** pockets and those in drier, more marginal environments may decrease in size and number if penetrated by fires of increased frequency or intensity. Rainforest communities possess some inherent resilience because of the fire-retardant nature of their foliage, the resprouting ability of many of their plants, and the long-distance dispersal of the fruits and seeds of many rainforest plants by animals, such as flying foxes. Fires can nevertheless burn into rainforest communities given conditions of extreme fire weather or prolonged drought. If the occurrence of this is more than occasional, the impacts of fire on these communities may be particularly severe.

Higher fire frequencies in **heathland** communities and heath **swamps** are likely to most affect populations of species that depend on seeds for recovery after a fire, particularly those with longer maturation periods. Many heathland plants have seeds that are dispersed relatively short distances, often only tens of metres[12], and heathlands and heath swamp patches are often small and isolated. Consequently, local extinctions in heathland patches may not be readily reversed by recolonisation from elsewhere. Extended dry periods may also reduce the capacity of wetland vegetation to recover from fire, as well as increase the likelihood of it burning and of the substrate being consumed. Such below-ground fires are particularly damaging, and can lead to erosion, loss of soil moisture-holding capacity and an overall decline of the habitat. In turn, the survival and breeding success of specialised swamp fauna may also be adversely affected.

Many native plants, such as waratahs, depend on fire to regenerate and flourish.

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WHAT CAN YOU DO?

1. Keep a map and/or notes of every fire that occurs on your property. This allows you to build up a fire history; documentation crucial for detecting changes in the fire regime. Having a fire history allows you to determine for any particular place how long it is since it was burnt, how many fires have occurred in a given period, and – over much longer periods – whether the frequency, season or intensity of fires has changed. At a minimum, the boundary of the fire should be mapped or sketched (where possible), the date of the fire recorded, and some visual estimates made of its severity at several places. For example, is the tree canopy undamaged, scorched or completely consumed? Similarly, is the understorey undamaged, scorched or completely consumed?

2. Note any interesting observations of the impacts on, and recovery of, plants and animals, along with the date of the observation. This may be particularly important if you have rare or threatened species, since in general their response to fire is poorly understood.

3. Get involved with your local Hotspots group or Bush Fire Management Committee, or access more information on the impacts of fire on the native vegetation in your area from the Hotspots website at www.hotspotsfireproject.org.au

Acknowledgements

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Reading

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Credits

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