FIRE AS AN AGENT OF GEOMORPHIC CHANGE IN SOUTHEASTERN AUSTRALIA: IMPLICATIONS FOR WATER QUALITY IN THE AUSTRALIAN CAPITAL TERRITORY.

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INTRODUCTION

In the forested part of southeastern Australia, bushfires that bare soil on slopes and in riparian zones, followed by intense rainfall, dramatically increase erosion rates on hillslopes and valley floors. This results in large amounts of sediment and organic matter transport and deposition in rivers, and decreased water quality in water-supply reservoirs. After ground and riparian vegetation cover recovers following fire, rates of transport of sediment and organic matter decline to very low levels, and water quality returns to high levels. Indeed, bushfires are one of the most potent agents of geomorphic change in this region.

In January 2003, a severe bushfire burned almost all of the catchment of the Bendora and Corin water-supply reservoirs in the Brindabella Range, ACT. Intense rainfalls on the 8th and 9th of February, and in March, August and November 2003, mobilised large amounts of sediment and organic matter from hillslopes, stream banks and other stores, and turbidity rose in both reservoirs to levels that made the water unusable for human consumption. The events of early 2003 provided a rare opportunity to understand landform and water quality change in a landscape where disturbance is, in a historical context, infrequent.

HISTORICAL SEDIMENT YIELD AND SOURCES

Estimates by Wasson *et al*. (2003a) of the amount of sediment and organic matter entering the Corin Reservoir since its construction in 1968 suggest an annual input of 316 t/yr of inorganic sediment and 23 t/yr of particulate organic carbon, a sediment yield of 2.3 t/km^2/yr. Estimates for 2003 are of 1663 t of inorganic material and 137 t of particulate organic carbon, a sediment yield of 9.2 t/km^2/yr. A similar story was found in the Corin Reservoir after the 1983 fire at Licking Hole Creek, a sub-catchment of the Corin Reservoir. This fire burnt approximately 29% of the Corin Reservoir catchment, and while this may be considered only a small area of the catchment, the sediment yield recorded in the Reservoir suggests an increased sediment yield of 3.6 t/km^2/yr for this event over the total catchment area.

Sources of sediment after such events, determined using the isotopic tracers ^{137}Cs and ^{210}Pb, indicate that during periods before fire and after fire, once the vegetation has re-established, more than half of the material during the 1968 to 1982 period came from topsoil. During the 1983 to 1989 period, the topsoil component was approximately 48 ± 8% of the material deposited in the reservoir. These results stayed about the same until 2003.

The 2003 post-fire sources were different, at least after the initial flush of sediment, with 43 ± 8% topsoil that was presumably in storage in channels derived from previous erosion. With the large area burned, and the intensity of multiple rainfall events that followed, large amounts of topsoil were mobilized, which overwhelmed any sediment derived from channels. Several samples from deposits in palaeochannels, in-channel deposits and on fans in both the Bendora and Corin catchments, are 95% to 100% topsoil (Wasson *et al*. 2004 a, b). It is clear from analysis of the sediments produced by these runoff events that sediment and organic matter yields increased markedly within a few weeks and then decline to pre-fire levels in the following 2 to 10 years. The amount of sediment derived by erosion from topsoil and channel sources differs between the events and the locations, reflecting differing intensities of fire, rainfall, shear stress and sub-catchment aspect and gradient.

FIRE AND EROSION

During the Holocene, records from lakes and peat bogs have shown fire to be an integral part of the Australian landscape, following a trend of increased frequency in line with vegetation changes during the early Holocene (Singh *et al*. 1981, Kershaw *et al*. 2002). Fire continues to be a part of the Australian landscape; in historical times the fire regimes have been modified from an increased fire frequency during the early part of European settlement to fire suppression more recently.

The frequency of events where large amounts of material are moved after a fire event followed by erosive rainfall remains a question. Optically Stimulated Luminescence (OSL) results from a valley fill in the Cotter River catchment reveals dates from sand layers at 0.41 ± 0.065 ka, 5.4 ± 0.8 ka and 6.5 ± 0.8 ka. More recently, in 2003, a layer of sand draped the valley floor (OSL dated for verification to 0.00 ± 0.02 ka). This layer has similar characteristics to the dated layers in the profile below the 2003 sand layer, indicating that these layers are most likely due to a fire followed by a rainfall event. While an alternative explanation suggests that a high magnitude flood event could achieve a similar result, the density of vegetation (the impenetrable *Epacris, Richea* and *Kunzea spp.*) would suggest otherwise. It appears that only after the removal (via fire) of such species, would such a stratigraphic layer be possible in this area. However, with these results, the probability of such an event is still largely unknown. Research is currently being undertaken to look at the relationship between fire and erosion and to answer this question.

Stratigraphic data suggest that events of the kind that occurred in 1983 and 2003 have a frequency of several centuries. Future climate change, however, may increase the combined probability of fire and erosive rainfall. This would radically alter the geomorphic system, and increase the yield of sediment and organic matter, subsequently altering water quality in the Cotter River water supply catchment.

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