Background briefings on emerging issues for fire managers from AFAC and Bushfire CRC.

# FIRE NOTE

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# PROTECTING OUR WATER RESERVOIRS WITH SEDIMENT TRAPS

## CONTEXT

**This study aimed to investigate the rehabilitative effectiveness of three different sediment traps – hay bales, coir bales and silt fencing – in reducing the amount of mobilised sediment reaching the water reservoir after a bushfire.**

## BACKGROUND

Bushfires reduce vegetation cover and alter soil properties, which often results in the ensuing erosion being a management concern for drinking water reservoirs. After rainfall, ash, charcoal and sediment can be washed into the reservoir, affecting the water quality by altering the turbidity, taste and odour of the drinking water and by adding additional nutrients. Sediment traps are used as an emergency response after fire to capture mobilised sediment to reduce potential contamination of water reservoirs. In 2007 a bushfire occurred at Mount Bold reservoir, located 35 km southeast of Adelaide, South Australia. The reservoir is managed by SA Water (the South Australian Water Corporation), which had witnessed erosion and subsequent water quality problems in ACT reservoirs following the Canberra 2003 fires. Following a bushfire in January 2007, SA Water undertook immediate restoration action at Mount Bold using sediment traps. This provided the Bushfire CRC an opportunity to study the effectiveness of these traps. Fifty-three sediment traps were installed and monitored at Mount Bold to capture mobilised sediment from rainfall events following the bushfire in January 2007. Research has also been conducted on older fires (Holocene paleofires), dated approximately between 600 to 6000 years ago, and recent prescribed fires in the Mount Lofty Ranges, South Australia, in order to better understand post-fire erosion.

## BUSHFIRE CRC RESEARCH

This Bushfire CRC PhD research project monitored the success of the trapping program by assessing the sediment structures, measuring the captured sediment and analysing the geomorphogical change, that is, change in the landform surface. Methods used at Mount Bold included erosion pins, sediment traps and terrestrial laser scanning (see 'Definitions' box). Three types of

▲ Mount Bold Reservoir after the 2007 bushfire


## SUMMARY

The impact that the erosion of sediment after bushfires has on the quality of drinking water in reservoirs is of crucial concern. Emergency rehabilitation such as sediment trapping in Australian water catchments need to be monitored post rainfall to assess their effectiveness in protecting our water reservoirs. This research provides guidance on the type of sediment traps to use depending on expected runoff velocity, cost, ease of construction and duration required. Importantly, follow-up monitoring and maintenance is necessary for all sediment traps tested as traps alone cannot guarantee against reduced water quality through sediment movement following bushfires.


## ABOUT THIS PROJECT

This research is part of project B 3.1: Impacts of Fire on Ecological Processes and Biodiversity, within Program B: Managing Prescribed Fire in the Landscape. For more information about this project contact: rowena.morris@adelaide.edu.au

The author: Rowena Morris (right) is a PhD candidate at The University of Adelaide and the recipient of a Bushfire CRC scholarship.

**Table 1: Comparison between the three different types of sediment traps used at Mount Bold.**

| | | ADVANTAGES | DISADVANTAGES |
|---|---|---|---|
| **Hay Bales** |  | • Simple to install<br>• Inexpensive – cheapest of the three options<br>• Fast to construct<br>• Easily transported<br>• Easily obtained<br>• Material decomposes<br>• Simple removal | • Not suitable for high velocity water<br>• Can introduce weeds*<br>• Eaten by fauna*<br>• Last for a short time frame (6 months)*<br>• Needs monitoring and maintenance |
| **Coir Bales** |  | • Very simple to install<br>• Very fast to construct<br>• Does not introduce weeds<br>• Easily transported<br>• Lasts for a reasonable time-frame (1.5 to 3 years)<br>• Material decomposes<br>• Simple removal | • Not suitable for high velocity water<br>• Not always quickly available<br>• Needs monitoring and maintenance |
| **Silt Fencing** |  | • Can deal with high velocity water<br>• Does not introduce weeds<br>• Can trap large amounts of sediment depending on trap size<br>• Material can be stockpiled ready for an emergency response | • Slow construction<br>• Trap construction is not simple<br>• Requires trenching to install which disturbs the site<br>• Material does not decompose<br>• Complex removal<br>• Needs monitoring and maintenance |

** Geotextile Bags were filter bags that the hay bales were placed into. They remove silt from water. The geotextile bags at Mount Bold minimised weed spread, prevented fauna damage and extended the life span of the bales. They add considerably to the cost of hay bales traps and the speed of installation.*

sediment traps were compared: hay bales, coir bales and silt fencing (see table this page). Geotextile Bags were trialled at three of the hay bale trap locations.

Thirty-four hay bale traps were installed by SA Water due to its concerns about potential serious erosion following a predicted 50mm rainfall event. A further 18 coir traps and one silt fence trap were also installed for comparisons with the hay bale traps. The coir material arrived after the first rainfall event. Problems with 27 of the hay bale traps were attributed to inappropriate size (48 per cent), wrong location (30 per cent), poor construction (15 per cent) or wildlife interference (seven per cent). The coir traps lasted longer than the hay bales with only two being considered unsuccessful at retaining sediment. The silt fence was not strong enough to hold a one in five-year rainfall event and subsequently failed in the middle section, however it still managed to retain the second highest volume of sediment, measuring 22m$^3$. Sediment traps located in two unburnt control sites were not subjected to any mobilised sediment. After one year, substantial vegetation regrowth occurred in the burnt area and sediment transfer was dramatically reduced.

## DEFINITIONS

**Paleofire:** fires from our past.

**Photogrammetry:** obtaining reliable measurements by means of photography.

**Pyrocolluviation:** fire induced valley-fill aggradation. This means the build-up of charcoal-rich sediment at the bottom of a valley due to hillslope erosion following fires (see photos page 4).

**Rock gabion:** a fortification cylinder filled with rocks.

**Terrestrial laser scanning (TLS):** land based surveying using laser technology that creates highly accurate 3D data (See photo page 3).

After the first rainfall, visual observations of the water reservoir found areas with floating charcoal and higher turbidity. Sediment had clearly entered the reservoir and some areas adjoining the traps had visible algal growth. Water samples taken from near the dam wall did not appear to be adversely affected, based on the routine water sampling conducted by SA Water. The water required no additional filtration or treatment following the bushfire. More extensive water sampling would be needed to conclude that the bushfire had no impact on the water quality.

## RESEARCH OUTCOMES

An assessment of the sediment traps at Mount Bold Reservoir found that over half the traps had problems due to their size, material and location. Large amounts of sediment breached the traps and entered the water reservoir system even though 160m$^3$ of sediment was captured. With improved knowledge the right trap can be used for the right location. This requires understanding about the topography, soil type, fire severity, rainfall characteristics, potential water velocity and sediment load. The sediment traps used at Mount Bold are really only effective for low velocity water. Rainfall amounts after the bushfire at Mount Bold resulted in water velocities and sediment loads that really required other structures such as rock gabions (see 'Definitions'). The rainfall events that did damage the traps were normal yearly events. The one in five-year rainfall event caused considerable damage to both the silt and hay bale traps.

This research validates the notion that rainfall following bushfires will cause erosion. Substantial sediment transfer occurs during a

### END USER STATEMENT

"SA Water complies with the 2004 Australian Drinking Water Guidelines 'source to tap' approach to drinking water quality, which acknowledges the importance of sustainable land management as a key barrier to preventing contamination. Uncontrolled bushfires have the potential to contaminate our reservoirs by increasing sediment and nutrient loads, leading to turbidity and algal problems. Rowena's research has given us a good understanding of what to expect after a fire in terms of sediment movement and what measures we can take to mitigate potential water quality risks. Specifically, her work has been incorporated into a draft Fire Recovery Strategy for the Mount Lofty Ranges watershed."

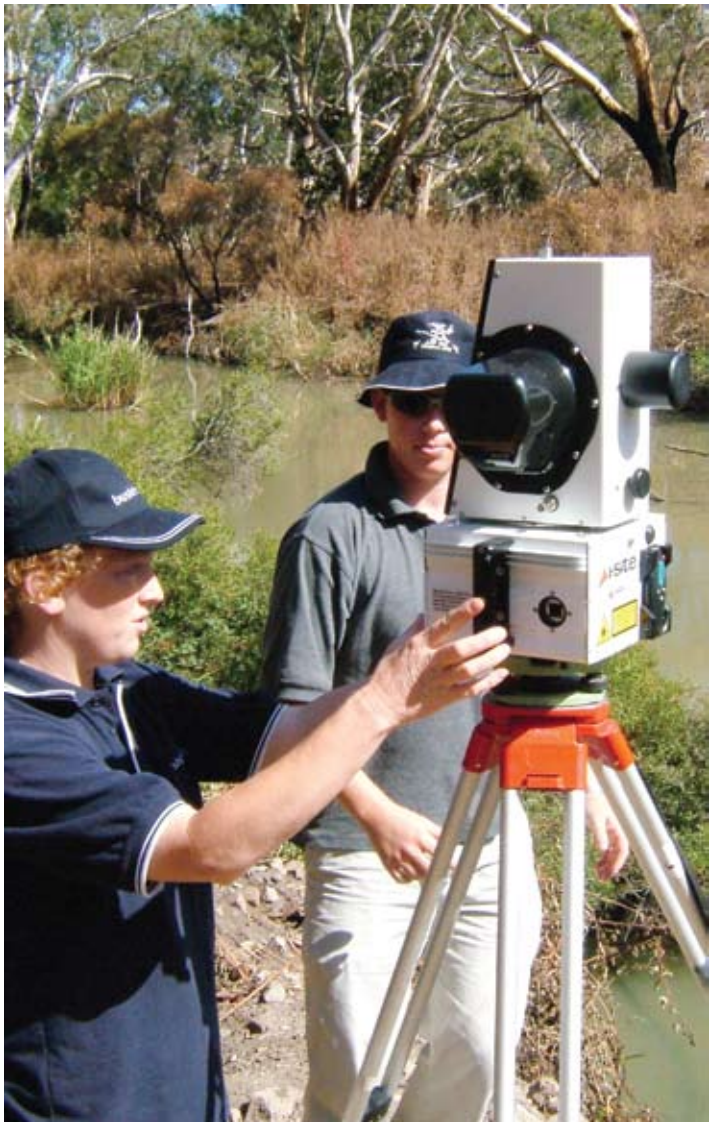
**– Dani Boddington, Fire Management Officer, SA Water.**

one in five-year rainfall event. Both paleofires and current fires result in rapid build-up of charcoal-rich sediment at the bottom of a valley due to hillslope erosion, referred to as pyrocolluviation (see 'Definitions' box). In places with steep slopes greater than 35 degrees, gravity alone is enough to move rocks and sediment. Erosion is a problem immediately after the fire and before the vegetation has had a chance to regrow and stabilise the soil surface. This means that any emergency sediment trapping program needs to be implemented immediately after the fire and before the first substantial rainfall event.

Due to the numerous trap failures, this research indicates that we should not rely entirely on an emergency response to capture the sediment but we should also be investigating alternatives such as advanced water filtration systems, catchment water transfer options, prescribed burning, improved planning and ignition management.

## HOW THE RESEARCH WAS USED

The results of this research were used after the Victorian 2009 fires, when large areas of water reservoir catchments were burnt. Around 30 per cent of Melbourne's catchments were damaged by fire. After these fires the Australian Water Association and Melbourne Water invited the Bushfire CRC to present at an online seminar, entitled 'Fire and Water Quality'. This seminar was organised to share the range of post-fire experiences in water catchments across Australia. The experience at Mount Bold in relation to capturing sediment was appreciated by land managers and many consultants in the water business.



Researcher Rowena Morris and James Moncrief, from Maptek, operating the terrestrial laser scanner.

The Bushfire CRC has been working directly with the South Australian Water Corporation. Many presentations have been made to staff and research was made available for the Fire Recovery Strategy that was, at time of writing, being finalised by SA Water.

At the 2009 International Geomorphology Conference in Melbourne, delegates were interested in the new technique of terrestrial laser scanning for assessing post-fire sediment movement. The application of this method provides new three-dimensional data to improve our understanding of post-fire erosion. The Bushfire CRC worked closely with Maptek in trialling this technique.

### FURTHER READING

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Morris R., Calliss S., Frizenschaf J., Blason M., Dragovich D., Henderson M. and Ostendorf B. (2008) Controlling sediment movement following bushfire – a case study in managing water quality, Mount Bold, South Australia. Proceedings of Water Down Under 2008 incorporating 31st Hydrology and Water Resources Symposium and 4th International Conference on Water Resources and Environment Research. 14-17 April 2008, Adelaide, Australia. 1937-1947

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## FUTURE DIRECTIONS

Part of this research trialled terrestrial laser scanning (TLS: see 'Definitions' box). TLS enables researchers to capture high-resolution temporal and spatial data sets to assess post-fire erosion. The novel approach of this method at Mount Bold provided entire hillslope data in previously inaccessible terrain. The data assists in interpreting where and how the sediment moves following fire. This project is still analysing the TLS data in relation to the sediment traps.

A future focus for this project will be comparing the effect of prescribed burning on post-fire sediment movement with the substantial erosion following the Mount Bold bushfire. Erosion from prescribed fire is being assessed by using erosion pins, close-range photogrammetry (see 'Definitions' box), and rapid visual assessments.

Future directions to measure the effectiveness of sediment traps in reducing adverse effects on water quality needs an extensive dry and wet water sampling program that assesses routine sampling sites, sites adjoining sediment structures and control sites away from sediment structures. This information, combined with mitigation studies from other water reservoirs, can then be used to further our understanding on the effectiveness of sediment structures protecting our water reservoirs.

## ACKNOWLEDGMENTS

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▲ Before and after the April 2007 rainfall event. Pyrocolluviation overtopped the hay bales.

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**Bushfire Cooperative Research Centre**
Level 5/340 Albert Street
East Melbourne VIC 3002
Telephone: 03 9412 9600
www.bushfirecrc.com
Bushfire CRC is a national research centre in the Cooperative Research Centre (CRC) program, formed in partnership with fire and land management agencies in 2003 to undertake end-user focused research.
Bushfire CRC Limited ABN: 71 103 943 755

**Australasian Fire and Emergency Service Authorities Council**
Level 5/340 Albert Street
East Melbourne VIC 3002
Telephone: 03 9418 2388
www.afac.com.au
AFAC is the peak representative body for fire, emergency services and land management agencies in the Australasia region. It was established in 1993 and has 26 full and 10 affiliate members.