

SYDNEY CATCHMENT AUTHORITY - MACQUARIE UNIVERSITY
COLLABORATIVE RESEARCH PROJECT:

EVALUATING THE EFFECTS OF FIRE AND OTHER CATASTROPHIC EVENTS ON SEDIMENT AND NUTRIENT TRANSFER WITHIN SCA SPECIAL AREAS

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Technical Report 1: Review of the hazards, triggers, mechanisms and frequency-magnitude of extreme erosion-sedimentation events in southeastern Australia with emphasis on post-fire erosion

Technical Report 2: Upland swamp development and erosion on the Woronora Plateau during the Holocene

Technical Report 3: Triggers of extreme erosion-sedimentation events on hillslopes in the Nattai catchment

Technical Report 4: Research outcomes and implications for the Sydney Catchment Authority

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PROJECT OVERVIEW

Introduction

This project, *Evaluating the effects of fire and other catastrophic events on sediment and nutrient transfer within SCA Special Areas*, was one of the initial Collaborative Research Projects commissioned by the Sydney Catchment Authority (SCA) in 2003. The project was a joint undertaking between the SCA and Macquarie University, Sydney, over three years concluding in December 2006. The project was led by Chief Investigator, Associate Professor Geoff Humphreys and students from Macquarie University with assistance from staff at the Science Branch, SCA. The project was initially conducted under the Nutrients, Sediments and Pollutants program within SCA and then subsequently (2005) under the Climate Variability and Extreme Events program to meet the following objective:

Develop a clear understanding of the impact of fire, floods and extreme events evident from the historical and geological record on sediments and nutrients entering streams, rivers and reservoirs (Strategic Plan for Science, Summary, 2005–08)

The project also contributes to achieving Strategies 1.7.4 and 1.4.1 of the SCA Business Plan 2002-07 which concerns minimisation of threats to water quality.

Background and basic themes addressed

In its conception this project sought to determine and evaluate the impacts of extreme erosion-sedimentation events on water supply and water quality within SCA Special Areas. The idea for the project stemmed from earlier research on post-fire erosion in the Nattai catchment where it was recognized that: (i) deposits in the valleys and hillslopes that could not be explained by contemporary processes; (ii) instrumental records in Australia are very limited and were unlikely to have captured rare longer-term events as have occurred and been recorded elsewhere sometimes over thousands of years (e.g. in China, Europe and the lower Nile Basin); and (iii) rainfall and discharge in Australia, especially in southeastern Australia, are known to be amongst the most variable globally.

From the outset fire was targeted, notably because existing data from within Australia and elsewhere indicated that in the immediate post-fire situation the potential for enhanced runoff and erosion was greatest. A combination of a reduction in the protective effect of ground cover and strengthened water repellency are the main factors. In the absence of historical records we targeted Holocene deposits on hillslopes in the Nattai catchment and valley floor upland swamps on the Woronora Plateau.

During the tenure of the project two other related issues emerged as being significant: (i) the relationship between runoff and fire is much more complex and somewhat different from established models; and (ii) landslides, previously scarcely recognised and little studied, emerged as a likely hazard along the shores of Lake Burragorang and elsewhere. These issues were incorporated into the research and explored in some detail.

Project aims

The main aims of the project were as follows. All were successfully addressed.

1. Investigate landforms within SCA Special Areas that are created by extreme erosion-sedimentation events to establish the history and mechanisms of sediment movement. Areas targeted include hillslope deposits in the Nattai catchment and upland swamps on the Woronora Plateau. In achieving this aim, landslides were recognized and incorporated into the project.

2. Determine the scale and potential of an extreme erosion-sedimentation event occurring within the SCA Special Areas based on the distribution and location of landforms investigated in (1).
3. Investigate the triggers or conditions leading to extreme erosion-sedimentation events including wildfire (main focus), severe storms and floods. Earthquakes were also considered with respect to landslides.
4. Estimate the recurrence intervals of the triggers of extreme erosion-sedimentation events in SCA Special Areas and assess the likelihood of future events occurring within management timeframes.
5. Quantify the threats and impacts of event-triggered sediment loads on water supply and water quality within the SCA Special Areas.

Key persons involved in the project

The key persons or groups involved in the project in a substantial capacity are shown in Figure 1. The Chief Investigator and coordinator of the project was Associate Professor Geoff Humphreys from Macquarie University. Data collection and analysis were undertaken by students, Kerrie Tomkins and Grant Taylor. Logistics were organized by Technical Officer, Russell Field, whilst analysis of pollen in cores from upland swamps was contracted to Mike MacPhail from the Australian National University.

Within the SCA, project management was provided by Chris Chafer (2004), Rob Mann (2005) and Henk Heijnis (2006). Provision of data and assistance with field work was provided by James Ray and Martin Gilmour. Access to field sites was arranged through staff at the Warragamba and Cordeaux Catchment Offices, in particular Loretta Gallen, Glen Capararo, Tony Kondek, Brian Waldron, Ross Wallis, Kurt Newport, Martin Krogh and Peter Paterson. We also acknowledge Daniel Deere from SCA who was instrumental in conception of the project in 2002–03.

Rosemary Hooke acted as project facilitator and maintained communication lines between Macquarie University and the SCA. Further collaboration on post-fire erosion was carried out with researchers from the CSIRO, University of Wales (UK) and University of Plymouth (UK).

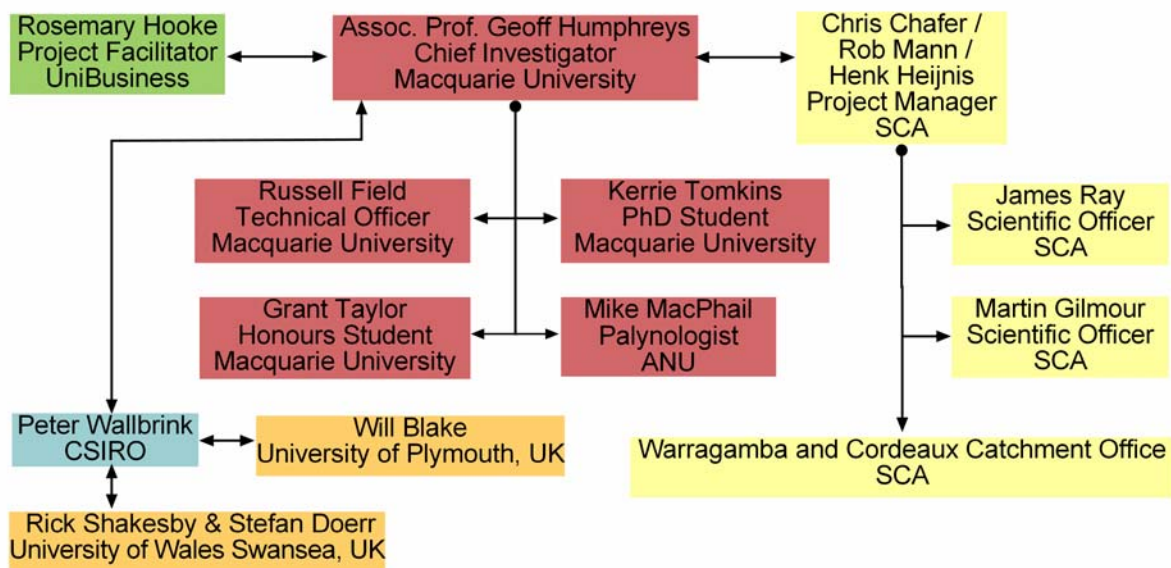


Figure 1. Project team structure

Funding

The project was jointly funded by Macquarie University and the SCA over three years (2004–06) with a total budget of \$290,000 (SCA, \$194,000; Macquarie University, \$96,000) plus in-kind contributions from both parties.

At the same time, on-going research into post-fire erosion in the Nattai catchment was conducted as part of a UK funded (approximately \$240,000) National Environment Research Council (NERC) project titled, *Erosional consequences of different fire intensities of fire induced water repellency in the 'Sydney forest fires' region*, involving Rick Shakesby and Stefan Doerr (University of Wales Swansea, UK), Will Blake (University of Plymouth, UK), Peter Wallbrink (CSIRO) and Geoff Humphreys (Macquarie University).

Project planning

The project was undertaken in several stages with concluding milestones. The first stage involved a review of available literature on the hazards, triggers, mechanisms and frequency-magnitude of extreme erosion-sedimentation events in southeastern Australia. This provided a framework for the project and enabled formulation of more focused research questions that were cognizant with the original objectives, as well as a research strategy which guided the remainder of the investigation. At the same time, selection of field sites and some preliminary data collection was undertaken to provide initial results and test the feasibility of the project aims i.e. were they realistic and achievable. The second stage involved the main data collection, analysis and interpretation, and formed the body of the project. Two field areas were chosen for closer investigation based on recommendations from SCA and from our previous work: (i) hillslopes in the Nattai catchment with sites along Blue Gum Creek and at the Tumbledown Landslide (Lower Nattai valley) and, (ii) upland swamps on the Woronora Plateau with sites at Drillhole Swamp, Swamp 18 and Flat Rock Swamp. At all sites, initial mapping and aerial photograph interpretation was undertaken, followed by fieldwork involving surveying, analysis of soils, assessment of geomorphic processes and collection of samples for dating. Additional analysis of historical records on wildfires, river sediment yield, discharge, rainfall and earthquakes was also undertaken. The third and final stage of the project focused on the outcomes and implications for water supply and water quality within SCA Special Areas. This involved evaluating the triggers of extreme erosion-sedimentation events, determining return intervals and establishing the relationships (coupling) between triggers.

Technical Reports and Publications

The primary outputs from this project are several technical reports written specifically for the SCA which are included in this volume. In addition numerous journal publications and conference abstracts were produced, as well as monthly summary reports for SCA detailing progress throughout the project. The technical reports and publications that arise directly from the project are listed below. A full list of publications including those involving colleagues from the CSIRO, University of Wales Swansea and University of Plymouth is appended at the end of the volume.

Technical Reports provided to the SCA

- Technical Report 1: Review of the hazards, triggers, mechanisms and frequency-magnitude of extreme erosion-sedimentation events in southeastern Australia with emphasis on post-fire erosion (January 2005)
- Technical Report 2: Upland swamp development and erosion on the Woronora Plateau during the Holocene (January 2006)
- Technical Report 3: Triggers of extreme erosion-sedimentation events on hillslopes in the Nattai catchment (January 2007)
- Technical Report 4: Research outcomes and implications for the Sydney Catchment Authority (February 2007)

Publications specific to this project

- Tomkins K.M., Humphreys G.S., Skeen H.J., Taylor G.M., Farwig V.J., Shakesby R.A., Doerr S.H., Wallbrink P., Blake W.H. and Chafer C.J. (2004) Deciphering a colluvial mantle: Nattai catchment. In: Singh B. (ed) *SuperSoil 2004: 3rd Australian and New Zealand Soils Conference*. 5–9 December 2004, University of Sydney, Australia.
- Tomkins K.M., Humphreys G.S., Shakesby R.A., Doerr S.H., Blake W.H. and Wallbrink P. (2004) Mass movement events in the south-west Sydney Basin during the Holocene. In: Roach I.C. (ed) *Regolith 2004*. CRC LEME Canberra, pp 365-369.
- Tomkins K.M., Humphreys G.S., Macris J. and Hesse P.P. (in press) Landslides in the Sydney Basin: Is there a seismic link? *Geoscience Australia Journal*.
- Taylor G.M. (2005) Landslides around Lake Burragorang: their characteristics, distribution and impact potential. Unpublished Honours thesis, Macquarie University.
- Tomkins K.M., Humphreys G.S., Wilkinson M.T., Fink D., Hesse P.P., Doerr S.H., Shakesby R.A., Wallbrink P.J. and Blake W.H. (2006) Contemporary versus long-term denudation along a passive plate margin: the role of extreme events. *Earth Surface Processes and Landforms*. In press.
- Tomkins K.M., Humphreys G.S., Gero A.F., Shakesby R.A., Doerr S.H., Wallbrink P.J. and Blake W.H. (subm) Post-wildfire hydrological response in an ENSO dominated environment Submitted to *Journal of Geophysical Research (Earth Surface)*, December 2006.

Knowledge transfer

Direct knowledge transfer between Macquarie University and the SCA was undertaken via presentations at annual and mid-year workshops as well as meetings with project managers. In addition, two field days were held for SCA staff including those from the SCA Science Branch and Catchment Offices. The first field day was held at the Blue Gum Creek sites in the Nattai catchment on 16 November 2004. This was in conjunction with the team from CSIRO led by Peter Wallbrink. The second was held at the upland swamps sites on the Woronora Plateau on the 9 December 2005. Details of these field days are documented in the monthly reports.