Australian and New Zealand Geomorphology Group

Program and Abstracts

13th Conference Queenstown Tasmania
10 – 15 February 2008

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Edited by
Tim Cohen and Ian Houshold

13th ANZGG Queenstown, Tasmania – Program

Sunday 10th February Registration in the foyer, 'Penghana', from 3pm

5:30 pm Welcome BBQ at 'Penghana'. Opening address by Darryl Gerrity, Mayor, West Coast Council, 6:30pm

Monday 11th February Conference sessions – Queenstown Memorial Hall, Orr St

8.00 – 8.30	***Registration – Queenstown Memorial Hall***	
8.30 – 8.45	***Welcome and introduction***	**Ian Houshold**
8.45 – 9.30	***Film "Seeing Change"***	**Kim McKenzie and John Chappell**
	Neotectontics and landscape evolution	
9.30 – 9.45	An overview of the neotectonics of Australia: the not-so-stable continent	**Dan Clark**
9.45 – 10.00	Local variability in landscape evolution, and the question of scale	**David Gibson**
10.00 – 10.15	Long term landscape evolution of the Western Australian Shield	**Brad Pillans**
10.15 – 10.30	Ancient landscapes of the western Canning Basin, north-western Australia: the significance of palaeovalleys in the modern landscape	**Adrian Fisher** and Pauline English
10.30 – 11.00	**Morning Tea**	
11.00 – 11.15	Late Cenozoic deformation of the Australian continent: evidence from the Eucla Basin.	**Lisa Worrall**
11.15 – 11.30	Evolution of the Drainage System of Western Tasmania.	**Eric A. Colhoun**
11.30 – 11.45	Application of *in-situ* cosmogenic nuclide analysis to landform evolution in Dartmoor, south-west Britain	**Joseph H. Hägg**, Micahel A. Summerfield, Cristoph Schnabel, William M. Phillips, and Stewart Freeman
11.45 – 12.00	Catchment erosion over the past 100,000yr in southeastern Australia: insights on how erosion and sediment transport respond to climate change	**A. Dosseto**, S. P. Turner, P. Hesse, K. Fryirs and K. Maher
12.00 – 12.15	Landscape evolution on a passive margin: Rates of valley incision and plateau lowering in the Sydney Basin using cosmogenic ^{10}Be	**Duanne White**, Kerrie Tomkins, Paul Hesse, Geoff Humphreys, David Fink
	Karst landscape development in a coastal environment during the Pleistocene, Naracoorte S.A	**Susan White** & John Webb
12:30 – 1.15	**Keynote address**	**Mark Quigley/ Mike Sandiford**
1.15 – 2.00	**Lunch**	

	Late Quaternary climates	
2.00 – 2.15	Alluvial evidence for major flow-regime changes during the Middle and Late Quaternary in eastern central Australia	**Gerald Nanson**, David Price, Brian Jones, Jerry Maroulis, Maria Coleman, Hugo Bowman, Tim Cohen, Tim Pietsch
2.15 – 3.00	Late Quaternary climate change in central Australia: mega-lake phases or extreme monsoonal events?	**Tim Cohen**, Gerald Nanson, Brian Jones, John Jansen, Josh Larsen
3.00 – 3.15	Some problems raised by the Late Pleistocene valley-fills in the semi-arid Flinders Ranges, South Australia	**Martin Williams**
3.15 – 3.30	A preliminary geospatial visualisation of a late Pleistocene fluvial wetland surface in the Flinders Ranges, South Australia	Peter Glasby and **Anthony O'Flaherty**
3.30 – 3.45	The late Quaternary palaeoenvironmental history of Lake George, New South Wales	**Fitzsimmons, K.E**. and Barrows, T.
3.45 – 4.15	**Afternoon tea**	
	Glacial and periglacial landscapes	
4.15 – 4.30	Landscape instability around the Last Glacial Maximum – geomorphic effects in southeastern Australia	**John Webb** and Brian Finlayson
4.30 – 4.45	Late Pleistocene glaciation of Mt Giluwe, Papua New Guinea	**Timothy Barrows**, Michael Prentice, Geoff Hope, L. Keith Fifield and Steve Tims
4.45 – 5.00	Cosmogenic nuclide d ating in the Denison Range, Southwestern Tasmania	**Matthew McMinn**, Kevin Kiernan & David Fink.
5.00 – 5.15	Pre-Last Glacial age for morphologically fresh moraines in the Western Arthur Range, southwest Tasmania.	**Kevin Kiernan**, David Grieg and David Fink
5.15 – 5.30	Relative age dating of the Wahiona moraines, Mt Ruapehu	**Erin Nolan**
7:30 –	**Trish Fanning, David Dunkerley and Brad Pillans do the honourable thing - Queenstown Memorial Hall**	

Tuesday 12th February

	Aeolian landscapes and the onset of aridity	
8.45 – 9.30	**Keynote address – the descent into aridity**	**John Chappell**
9.30 – 9.45	Dating of Australian longitudinal dunes using cosmogenic nuclides	**Toshiyuki Fujioka**, John Chappell, L.Keith Fifield and Ed Rhodes
9.45 – 10.00	Morphological diversity in the Australian continental dunefield: Results of a new mapping project and insights into dune formation	**Paul Hesse**
10.00 – 10.15	Linear dune and dunefield development: Complexities and implications for palaeoclimates	**Josh Larsen** Gerald Nanson, Tim Cohen, and Brian Jones
10.15 – 10.30	Identification of palaeo-drought episodes in the catchments of the Snowy Mountains Hydro Scheme and Murray-Darling Basin, Australia	**Samuel Marx,** Hamish McGowan, John Denholm
10.30 – 11.00	**Morning Tea**	
	Soils and geomorphology (A tribute to Geoff Humphreys)	
11.00 – 11.15	Relationships in Global Soil Distribution as Revealed by a World Soil Database	**Jonathan Gray** and Geoff S. Humphreys
11.15 – 11.30	The role of fire in landscape development, southeastern Australia	**Kerrie Tomkins** and Geoff S. Humphreys
11.30 – 11.45	Toward large scale simulation of surface armouring and weathering	**S. Cohen**, G.R. Willgoose and G.R. Hancock
11.45 – 12.00	Spectral remote-sensing techniques for regolith characterisation and mineral exploration in Queensland, Australia	**Matilda Thomas**, Thomas Cudahy and Mal Jones
12.00 – 12.15	Four faces of stratigraphic instability: divergent mechanisms of slope failure	**Mike Crozier**
12.15 – 12.30	Sediment tracing using rare earth elements (RRE), Main Range National Park, Queensland	**David Higgit**
12.30 – 1.30	**Lunch and Poster session**	
	Landscape management and Geoconservation	
1.30 – 1.45	People and sheep, wind and water: geomorphic processes and human impacts in Tierra del Fuego, Argentina, and consequences for the archaeological record.	**Patricia Fanning**, Monica Salemme, John Pickard, Fernando Santiago and Jimena Oria
1.45 – 2.00	Development of the Tasmanian River Condition Index – comparing apples with apples	**Alexandra Spink,** James Grove, Ian Houshold, Fiona Dyer

2.00 – 2.15	How to fit an Escalator into a Letterbox – Dividing Tasmanians rivers into categories useful to the measurement of condition	**James Grove**, Alexandra Spink, Ian Houshold, Fiona Dyer
2.15 – 2.45	Convergence of the waters: now is the time to plan for a national system of catchment-scale river-reserves.	**Ian Rutherfurd** and Ian Houshold
2.45 – 3.00	The original Lake Pedder: A *post-mortem* geomorphology and *pre-partum* prospects.	**Kevin Kiernan**
3.00 – 3.15	The Queensland regolith project: our progress and practises	**Michael Craig**, Matilda Thomas; Mal Jones, Joanne Morrison, Ian Robertson, Tessa Chamberlain, Ben Harmes, and Brad Pillans
3.15 – 3.30	Predicting Wind Erosion Hazard in Western Queensland, Australia	**Nicholas P. Webb**, Hamish A. McGowan, Stuart R. Phinn, John F. Leys, Grant H. McTainsh
3.30 – 4.00	**Afternoon Tea**	
	Landscape management and Geoconservation	
4.00 – 4.15	A revised map of Australia's physiographic regions: a hierarchical map unit approach to geoscience mapping	**Colin Pain**
4.15 – 4.30	Volcanic Geosites, and their use in Geoparks and geotourism, with examples from SE Australia	**E. B. Joyce**
4.30 – 4.45	Geomorphological impacts of armed conflict: Implications for assessment of environmental war crimes?	**Kevin Kiernan**
4.45 – 5.00	Linking the geomorphology, vegetation and soils on the Murray River floodplain for salinity management	**Vanessa Wong**, Jon Clarke and Colin Pain
5.00 – 5.15	Quaternary subalpine slope materials stability: a landslide/landslides on the Great Western Tiers, Tasmania.	**Deborah Hunter**
5.15 – 5.30	Mass movement on the great Western Tiers, Tasmania	**Andrew Hammond**, David Wilson and Peter McIntosh
5.45 – 6.30	**Australasian Fluvial Group Meeting**	
7:30 –	**Geomorphic trivia - Queenstown Memorial Hall**	

Wednesday 13th February – Mid-conference field trip to Mt Lyell mine, glacial deposits and King River Gorge, return 8.30 pm

9:30 – 1.30 Tour of the Mt Lyell mine workings and new tailings facilities

- History of the Mt Lyell operation
- Geology and glacial geomorphology of the Linda valley
- Geoheritage assessment and management
- Development of an environmental management system for mine drainage
- Management of tailings

Geoff Cordery - Environmental Systems Manager, Copper Mines of Tasmania
Dr Keith Corbett, - geologist
Dr Eric Colhoun – geomorphologist
John Halton - Mt Lyell Enviro–tours
Doug Hayden - Dougie's Mine Tours
Dr Kevin Kiernan - geomorphologist
Dr Lois Koehnken -Technical advice on water

1:30 – 2.45 Lunch, 'Penghana'

3.00 – 8.30 – Geomorphology and land management in the Queen and King River valleys – West Coast Wilderness Railway

- Neotectonics and landscape evolution
- Impacts of mining operations on fluvial systems
- Geomorphological monitoring programs and interactions with Hydro Tasmania operations
- Environmental rehabilitation trials – King River floodplain and delta

Geoff Cordery
Lois Koehnken
Ian Houshold

Thursday 14th February

	Coastal processes and sea level change	
8.45 – 9.00	Looking at estuarine processes in terms of attractors	**E. J. McLean** & J.B. Hinwood
9.00 – 9.15	Cross Sectional Form in Muddy Tidal Creeks	**Gareth Davies**
9.15 – 9.30	Reef-island evolution in the Mamanuca Island group, Fiji.	**David M. Kennedy** and Hamish W. McKoy
9.30 – 9.45	Deciphering Holocene sea-level change in New Zealand from detailed barrier stratigraphy acquired utilising ground-penetrating radar	**Amy J. Dougherty** and Scott L. Nichol
9.45 – 10.00	Late Quaternary geomorphology of the lower Manawatu floodplain and estuary	**Alastair Clement,** Craig Sloss, Ian Fuller
10.00 – 10.15	Changing sediment sources, deposition rates and human impact: Macquarie Harbour, western Tasmania.	**Paul Augustinus**
10.15 – 10.30	Latest results from the Huon Peninsula, PNG	**John Chappell**
10.30 – 11.00	**Morning tea**	
11.00 – 11.15	A nationally - consistent coastal landform map for Australia	**Chris Sharples**
11.15 – 11.30	Geomorphology of atolls and their vulnerability to climate change	**Colin D. Woodroffe**
11.30 – 12.30	**Keynote address and discussion**	**Bruce Thom**
12.30 – 1.30	**Lunch and Poster session**	
	River evolution	
1.30 – 1.45	Karstic morphology in quartzose rocks: Santana River basin at middle Paraíba do Sul river valley, Minas Gerais state, Brazil	**Uagoda, R**; Avelar, A.A. & Coelho Netto, A.L.
1.45 – 2.00	Fluvial Architecture of the Murray River at Chowilla, South Australia	**Jonathan D. A. Clarke**
2.00 – 2.15	River terrace sequences in the Widden Valley: relationships and processes	**Michael D. Cheetham**, Annabelle F. Keene, Richard T. Bush and Wayne D. Erskine
2.15 – 2.30	The evolution and stability of peat swamp channels, Barrington Tops, Autralia	**Rachel Nanson**
2.30 – 2.45	Geomorphology of the entrenched Murray River floodplain, Lindsay-Wallpolla Islands, Victoria	**Jonathan D. A. Clarke**
2.45 – 3.00	Fluvial grain-size trends in a sedimentary basin: The Lachlan River, Murray-Darling Basin	**Justine Kemp**
3.00 – 3.15	Using evolution and speciation of troglobitic fauna as a relative dating technique to determine the age of ancient palaeochannel deposits in the Pilbara region of Western Australia.	**Arthur Clarke**
3.15 – 3.45	**Afternoon tea**	

	Human disturbance and river management	
3.45 – 4.00	A response gradient of river adjustment and recovery across the upper Hunter catchment: Impacts of human disturbance since European settlement.	**Kirstie Fryirs**, Gary Brierley, Alexandra Spink
4.00 – 4.15	Don't fight the site: Geomorphic considerations in catchment-scale river rehabilitation planning	**Gary Brierley**, Kirstie Fryirs
4.15 – 4.30	Modelling within-reach variability in sediment remobilisation potential: an approach for targeting river rehabilitation efforts	**Jo Hoyle**, Andrew Brooks, John Spencer
6.00 – 7.00	**ANZGG AGM** ***Silver Hills***	
7.00 –	**Conference dinner** ***Silver Hills*** **Speaker – Patsy Crawford**	

Friday 15th February

	Tropical and dryland rivers	
8.45 – 9.00	Highly variable floodplain deposition in wet tropical streams throughout the late Holocene; Implications for sediment delivery to the GBR lagoon.	**S. Leonard** and J. Nott
9.00 – 9.15	Some components of the sediment budget in a large tropical river - Mitchell River, Gulf of Carpentaria.	**Andrew Brooks**, John Spencer, Jeffrey Shellberg, Jon Knight and Leo Lymburner
9.00 – 9.30	A review of factors controlling alluvial gully erosion and a proposal for quantifying changes in gully erosion rates in the Mitchell River, northern Queensland	**Jeffrey Shellberg**, Andrew Brooks, Jon Knight and John Spencer
9.30 – 9.45	Effect of an extreme storm event on catchment hydrology and sediment transport in the Alligator Rivers Region, Northern Territory	**M.J. Saynor**, G.W. Staben, D.R. Moliere, J Lowry & K.G. Evans
9.45 – 10.00	The long profile of the lower-Mekong River: Identifying major controls on pool morphology susceptible to river regulation and navigation improvement works	**Iwona Conlan**, Ian Rutherfurd, Brian Finlayson & Andrew Western
10.00 – 10.15	Links between floods, landslides, soil erosion and rates of floodplain accretion in the sugarcane belt of the Labasa River, Vanua Levu island, northern Fiji.	**J.P. Terry**, R. Lal, S. Garimella
10.15 – 10.30	Transmission losses in ephemeral dryland streams: the role of mud clogging in channel margin sediments	**David Dunkerley**
10.30 – 11.00	**Morning tea**	
	River Management: from theory to management	
11.00 – 11.45	**Keynote address**	**Gerald Nanson**
11.45 – 12.00	The delineation of valley margins as the basis for a valley confinement index using different resolution DEM data: implications for continental scale river classification approaches.	**John Spencer**, Andrew Brooks and Jon Knight
12.00 – 12.15	Assessment of flood variability in eastern Australia.	**Paul Rustomji**, Neil Bennett and Francis Chiew
12.15 – 12.30	More than rolling stones: Geomorphic response models for environmental flow assessments in southeast Australian rivers.	**Geoff Vietz** and Ross Hardie
12.30 – 1.30	**Lunch**	

	River Management	
1.30 – 1.45	Formation of pool-riffle sequences in a sand-bed stream of the upper Hunter	**Annabelle F. Keene**, Richard T. Bush, Michael D. Cheetham and Wayne D. Erskine
1.45 – 2.00	They bite back: geomorphic hazards when rehabilitating planform controlled sand bed streams	**Andrew Brooks**, Nicholas Cook and **David Outhet**
2.00 – 2.15	Natural Sequence Farming and Fluvial Geomorphology: dichotomy or misunderstanding?	**John Field** and Nathan Weber
2.15 – 2.30	Geomorphology and the Management of Melbourne's Urban Streams	**Sandra Brizga**
2.30 – 2.45	Influence of woody debris on channel hydraulics in the lower Avoca River	**P.J. Sandercock**, A. Allgaier, B. Abernethy, A. Brooks, Treadwell, R. Morden, S. Lang
2.45 – 3.00	Where did the River go? Physical interventions in the Latrobe River and their implications for predicting and managing for channel change	**Mark.R. Stacey**, Ross.E. Hardie
3.00 – 3.30	**Afternoon Tea**	
3.30 – 3.45	The Avon River: A road to recovery? Historic channel incision, present day flood response and future management	**Elisa.A. Zavadil** Ross.E. Hardie
3.45 – 4.00	Methods to assess bedload transport relevant for benthic invertebrate communities in mountain streams	**Arved Schwendel**, Russell G. Death & Ian C. Fuller
4.00 – 4.15	Sedimentation of the Avon River Pools downstream of Toodyay, Western Australia	**Ross N. Perrigo**, Jim Davies, Bernard Kelly
4.15 – 4.30	**… and another thing…Farewell and Post-conference field trip information**	**Ian Houshold and Tim Cohen**

PAPER ABSTRACTS
Thirteenth Conference – Queenstown, Western Tasmania
10^{th} – 15^{th} February 2008

Changing sediment sources, deposition rates and human impact: Macquarie Harbour, western Tasmania.

Paul Augustinus[1]

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Macquarie Harbour has been affected by European modification of the catchment commencing with the establishment of a penal colony on Sarah Island in 1820. However, major impacts commenced with the establishment of mines in nearby Queenstown with mine waste flowing into the King River, one of the major tributaries of the harbour. The King River delta grew dramatically from early 1893 to the cessation of mining in 1994, with an estimated ca 100 x 10^6 tonnes of mine tailings and smelter slag in the delta itself and possibly double that spread throughout the harbour. A Mackereth coring program was undertaken to examine the nature and distribution of the mine waste and rates and timing of addition at nine sites around the harbour. The up to 5.8 m long cores sediment were logged, magnetic susceptibility scans were undertaken and sediment geochemistry was quantified using XRF and ICP-MS/OES in an attempt to better understand mine waste distribution and changing nature due to varying sources over time.

Core chronologies were developed from 16 AMS ^{14}C ages, ^{210}Pb dating of five of the sediment records, and the first appearance of mine waste. We obtained high resolution late Holocene records of marine deposition and mine waste, with many of the cores span the past 1000 years. The mine waste is distinctive in colour and texture, well-laminated and the geochemical analyses indicate significant changes in sediment sources over the period of mine waste addition to the harbour with phases of addition of black, siliceous slag, and Cu, Zn and Pb-rich mine waste via the King River with the changes probably coincident with the development of different ore bodies in the Queenstown area. The most significant phase of metal influx to the harbour matches the expansion of open cut mining during the 1950s to 80s. The magnetic susceptibility, sedimentology and elemental composition of the Macquarie Harbour sediments clearly reflect the timing and nature of important anthropogenic activities in the catchment.

Late Pleistocene Glaciation of Mt Giluwe, Papua New Guinea

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[2] Department of Chemical, Earth, Atmospheric, and Physical Sciences and Center for the Environment, Plymouth State University, Plymouth, NH, 03264-1595 U.S.A.
[3] Department of Archaeology and Natural History, Research School of Pacific and Asian Studies, The Australian National University, Canberra, ACT 0200 Australia

The mountains on the island of New Guinea were the most extensively glaciated area in the Tropics during the Late Pleistocene. Mt Giluwe, an extinct volcano on the eastern side of island, was covered by an ice cap reaching down to ~3200 m in altitude. The altitude of the late Pleistocene snowline is the subject of debate, because temperature estimates based on a snowline ~1000 m below present strongly contrast with sea-surface temperature estimates in the western equatorial Pacific Ocean from the same time period. The problem is complicated by the absence of direct ages on the moraines, preventing full glacial maximum ice limits from being identified. To construct a glacial chronostratigraphy for the mountain, we applied exposure dating using the cosmogenic nuclide Cl-36 to potassium-rich basalt boulders. We find that the most extensive glaciation occurred before 100,000 years ago and that Oxygen Isotope Chronozone 4 and 2 moraines lie within these limits. Our assessment of the altitude of the snowline is similar to previous estimates, indicating that the temperature mismatch 'paradox' is real.

Tracing the impact of landuse change on soil organic carbon in a heavily eroded catchment, using carbon and nitrogen stable isotopes, Lake Tutira, New Zealand

Roderick Boys & Nick Preston

School of Geography, Environment and Earth Science, Victoria University of Wellington, New Zealand

Storage of Soil Organic Carbon (SOC) has high potential as a rapid climate change mitigation option. New Zealand provides the ideal opportunity to study the recent and reversible effects of land use change on terrestrial carbon. Lake Tutira (formed ~7000 years ago) has high sediment trap efficiency; cores taken from the lake have been used to establish a carbon budget for the catchment (Page *et al*., 2004). However, the dynamics of SOC distribution and attenuation within the catchment remain poorly understood. The SOC pool on vulnerable lithologies that have undergone land use change decreases as a function both of changes in vegetation and of associated soil erosion. In steepland catchments it is expected that buried soils will somewhat offset this loss by acting as a permanent or long-term sink for SOC.

Tracing carbon (C) and nitrogen (N) isotopic signatures, using gas chromatography mass spectrometry (GCMS), from sediment cores enables the quantification and interpretation of (a) changes in SOC storage in topsoils and buried soils, and (b) the effect of geomorphic processes on SOC storage. Additionally, ^{14}C ages, pollen analysis and grain size determination supplement the C and N stable isotope interpretation by adding temporal and sedimentological support for the geomorphic interpretation. Initial results indicate a ~2% decrease in SOC following conversion to pasture from native forest cover. Analyses of the Oporae Valley floor sediment cores indicate that there are buried soils present across the valley floor at depths ranging from 1.5 m to 2.5 m. Radiocarbon ages (e.g. 1294 ± 30yr BP at 2.7 m depth) indicate the length of time that these soils have been buried. These buried soils retain approximately half the SOC content, by comparison to contemporary undisturbed soils, where colluvial deposition has dominated, but may retain SOC equal to or higher than present day levels where fluvial processes are operating.

Reference

Page, M.J., Trustrum, N.A., Brackley, H. & Baisden, W.T. 2004. Erosion-related soil carbon fluxes in a pastoral steepland catchment, New Zealand. *Agriculture, Ecosystems & Environment* 103. 561-579.

Some components of the sediment budget in a large tropical river - Mitchell River, Gulf of Carpentaria.

Andrew Brooks, John Spencer, Jeffrey Shellberg, Jon Knight and Leo Lymburner

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Australian Centre for Tropical Freshwater Research, James Cook University, Townsville.

Recent interest in expanding development and exploiting the water resources of Northern Australia, has led to a new push to better understand river and landscape dynamics in Northern Australia, and how they might respond to increased development pressure. The general perception of Northern Australia (e.g. Woinarski, et al., 2007) is of a largely pristine landscape that to date has experienced little of the land and water degradation typical in southern Australia. While the magnitude of land use impacts and responses in northern Australia is undoubtedly less than in the Murray-Darling Basin, there is increasing evidence to suggest that grazing pressure and altered fire regimes, in some areas may have had greater impact on vegetation dynamics and erosion than previously appreciated. As a way of beginning to quantify key sediment sources and to start to understand changes in relative contributions associated with land use and other drivers, we have begun to construct a sediment budget for the Mitchell River, a 70 000km^2 catchment draining into the Gulf of Carpentaria.

We present some preliminary results from two key components of the sediment budget: alluvial gully erosion and channel erosion. A recent remote sensing based mapping program (Brooks et al. 2007; Knight et al. 2007) has identified more than 1600 km^2 of active alluvial gullying within the Mitchell fan, which has an estimated active front length of 49000 km. Preliminary measurements of gully activity suggests an average rate of retreat to be 0.22m per year. If these rates are a representative sample, and conservatively assuming an average gully front depth of 2m, this represents and annual sediment yield from alluvial gullying of 35MT pa. Estimates of minimum channel turnover, and hence bed material transport, were also determined using a remote sensing approach from Landsat archival data. The extent of bed area that changed from either water to sand bar and vice versa, or vegetated island to bare sand, was quantified between 1987 and 2005. Using some conservative assumptions about the depth of material reworked, an estimate of 15.5Mt annual bedload turnover was derived. This can be assumed to represent the minimum annual bedload transport rate in the lower Mitchell River. Whilst, very preliminary data, these initial components of the sediment budget will help us to better focus our ongoing research program towards further validating existing estimates, and filling key gaps in the budget.

References

Brooks, A., Spencer, J., and Knight, J. 2007. Alluvial gully erosion in Australia's tropical rivers: a conceptual model as a basis for a remote sensing mapping procedure. In Wilson, A.L. et al. (eds) *Proceedings of the 5th Australian Stream Management Conference:* 43-48.

Knight, J., Spencer, J., Brooks, A., and Phinn, S. 2007. Large area, high-resolution remote sensing based mapping of alluvial gully erosion in Australia's tropical rivers. In Wilson, A.L. et al. (eds) *Proceedings of the 5th Australian Stream Management Conference:* 199-204.

Woinarski, J. Mackey, B., Nix, H., Trail., B. 2007. *The nature of northern Australia*. ANU Press, Canberra. 128 pp.

They bite back: geomorphic hazards when rehabilitating planform controlled sand bed streams

Andrew Brooks[1], Nicholas Cook[2] and David Outhet[3]
[1]Griffith University, Nathan, QLD, Australia, [2]Newcastle, NSW, [3]Como West, NSW, Australia

Recent River Styles mapping has revealed that Planform Controlled Low Sinuosity Sand Style streams are often found in partly confined valley settings in the sandstone catchments on both sides of the Great Dividing Range in south eastern Australia. Their highly erodible bank and bed characteristics make them very fragile and give them high rates of geomorphic change. If disturbed or damaged, they are prone to high rates of lateral movement and can easily avulse. Vegetation plays a key geomorphic role, providing not only resilience but providing the impetus for geomorphic unit diversity. In this paper we compare the flood response of three examples of the Style: Wollombi Brook, Stockyard Creek and Widden Brook; all in the Hunter Valley of NSW, Australia.

We present very preliminary research results on the natural recovery of disturbed reaches and natural resilience to the large (second largest on record) June 2007 flood on Wollombi Brook in the Hunter valley. The largest on record was the 1949 flood which resulted in large scale channel change. A number of smaller events in the mid to late 1970's also resulted in significant channel adjustment. However, since the 1970's there has been a lack of channel adjusting flows, allowing native vegetation to colonise the bed and banks. There is a diverse range of vegetation regrowth in size, location and species. The stream now has a natural high resilience to floods which established within a relatively short time frame. This includes many reaches where stock exclusion was the only rehabilitation action. Recovery was helped by the relatively high sediment load (sand) and native seed carried by the stream. Instead of large scale channel change, early evidence shows that an effect of the June 2007 flood was an improvement in the channel/floodplain connections through channel bed sediment trapping by vegetation. The vegetation also appears to have created a hydraulic backwater effect, slowing velocities and raising water levels. This allowed the flood to fill all floodplain features such as backswamps and re-hydrate the alluvial aquifers.

However, we have found that not all examples of the Style have the ability to achieve a high level of recovery without some structural works to promote the process. These streams require custom design and construction methods to suit the geomorphic type. If done properly, they can quickly enhance natural recovery but not replace it. Results from observing the effects of the June 2007 flood on experimental log installations on Stockyard Creek show that accelerated natural recovery to a better condition for the Style can be achieved with the right type of works, vegetation and livestock exclusion.

Widden Brook was also recovering in a similar way to Wollombi Brook before the June 2007 flood. Photos show a similar native vegetation cover of in-channel benches and high bars. However, willows and very high bed controls were recently installed in the channel by people with good intentions but without any consideration for the geomorphic character of the stream. These were designed, apparently, to force Widden Brook into a Chain of Ponds Style with a discontinuous channel and swampy floodplains. Photographs taken after the June 2007 flood show that the high bed controls were breached but not before they caused extensive avulsions to occur. This is the natural response of the Planform Controlled Low Sinuosity Sand Style to channel blockage. This is evidence that reaches of the Style cannot be forced to Chain of Ponds and attempts to do so will result in failure of the works and major damage to the stream. In other words, they bite back.

Don’t fight the site: Geomorphic considerations in catchment-scale river rehabilitation planning

Gary Brierley[1] and Kirstie Fryirs[2]

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In the emerging era of river repair, increased concern has been expressed for the appropriateness and cost-effectiveness of our efforts to improve the health of river systems. In this manuscript, four geomorphic considerations that underpin the design and implementation of river rehabilitation programmes that ‘work with nature’ are outlined. First, the importance of appreciating the inherent diversity of river forms and processes is discussed. Second, the range of bed and bank processes that fashion the nature and rate of adjustment for different river types is highlighted, emphasizing their variable capacity for adjustment (i.e. their behavioural regime and their sensitivity to change). Third, river responses to human disturbance are conceptualised in terms of a river recovery diagram and a river evolution diagram. These tools frame human impacts upon river systems in light of the ‘natural’ variability of any given system. Finally, the importance of considering geomorphic river adjustments at the catchment scale is shown through appraisal of human-induced changes to the longitudinal connectivity of river systems. The application of these themes is demonstrated by reference to extensive catchment-scale analyses of geomorphic river character and behaviour and responses to human disturbance in the Bega and Upper Hunter Catchments in southeastern Australia. Rivers in Bega Catchment have been sensitive to change, with limited prospects for recovery. Prior to human disturbance, this system was haracterised by discontinuous watercourses, but it has been transformed into a continuous channel network. In the Upper Hunter Catchment, rivers have been more resilient to change, pronounced geomorphic adjustments have been relatively localized, and the system has retained its largely disconnected nature. Although the potential to recover towards a pre-disturbance geomorphic condition is greater than in Bega Catchment, prospects to improve river health are limited by other biophysical attributes (especially riparian vegetation cover, water quality, and the altered flow regime). In highlighting these reach- and catchment-scale considerations that underpin effective approaches to rehabilitation planning, emphasis is placed on the determination of practices that work with natural processes, rather than endeavouring to ‘fight the site’.

Geomorphology and the Management of Melbourne's Urban Streams

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The Melbourne metropolitan area extends across a diverse range of physiographic zones, including the steep mountainous terrain of the Dandenong Ranges (formed of Palaeozoic rhyolite and rhyodacite), outwash fans from the ranges, hills formed in Palaeozoic mudstones, siltstones and sandstones, Newer Volcanics basalt plains, flat to undulating "sand belt" terrain on Tertiary sediments, and floodplains of the major rivers and creeks. Natural stream characteristics and dynamics vary considerably across these zones. Pressures of historical and ongoing urban development are overlain on this complex natural template. They include changes in flow and sediment regimes and sediment supply, as well as direct modifications to the stream channels and floodplains. This paper discusses key geomorphic issues arising from urbanisation in the Melbourne metropolitan area and how geomorphological analysis has been used to inform stream restoration measures and planning for future urban development.

The active versus the fossil geomorphology of arid Australia

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According to classical climatic geomorphology, the suite of landforms generated under arid conditions includes playas, continental dunefields, gibber-mantled static regolith, weathering-limited rocky slopes and inselberg-like residual hills. The landscape of arid central Australia, being made up of all these landforms, appears to confirm the classical view. Yet, owing to global changes including the continent's drift-voyage north from sub-Antarctic latitudes, the climate of central Australia has changed profoundly over the last 50 million years, while any changes in the essential form of the ranges and residual hills may be virtually imperceptible – at least, if cosmogenic determinations of erosion rates, which are very slow, can be extrapolated back in time. Other than hydrologically-governed sedimentary landforms, such as playas and dunefields, the central Australian landscape, its gibber-strewn regolith, and even the characteristic red colour evolved under climates different from those of today and, over the last several million years, became largely inactive.

Radical ice-age ludes: latest insights from raised reefs at Huon Peninsula

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Research on marine sediments and ice cores indicates that the Late Quaternary ice-ages were punctuated, every few millennia, by climatic shifts as large and as rapid as the more pessimistic forecasts of present-day global greenhouse scenarios. These events included massive break-outs of ice into the north Atlantic, changes of ocean circulation and warming by several degrees in a few decades – at least, in the northern hemisphere. Yet, major questions remain about their essential anatomy, including their expression in the southern hemisphere, and the sources and magnitude of break-out ice, which some estimates place at equivalent to only a few metres of sea level rise but others put at 20-30 metres. Whether break-out leads or follows warming is similarly debated. Evaluation of the fine-scale sea level record preserved in raised coral reefs at Huon Peninsula, PNG, indicates that several ice break-outs were equivalent to over 15 metres of sea level rise and, while they may have commenced before a rapid warming event, the rise continued significantly after the event.

River terrace sequences in the Widden Valley: relationships and processes

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Floodplains are an active fluvial component vital to a river's equilibrium, sustainability and management. An understanding of floodplains and their relationship to abandoned floodplains (terraces) formed and eroded in the river's history is essential to ascertain the processes involved in that river's evolution. Rivers are often defined by the arrangement of a river in plan view, which understates the importance of channel-floodplain, terrace-floodplain and foothill-terrace relationships (Brierley and Fryirs, 2000). Terraces set back from and flanking the discontinuous floodplains are a dominant feature along Widden Brook in the Upper Hunter, NSW. It is these terraces and not bedrock that confines the channel. A cross-sectional analysis of foothill-terrace, terrace-terrace and terrace-floodplain relationships will add to Warner's (1972) classification of terrace types as well as Young and Nanson's (1982) explanation of terrace formation. There are three stepped, inset terraces confining the channel on the right bank. In contrast, there are only two terraces, one covered by colluvium, on the left bank. The lowest terrace in this sequence is unpaired and shows no similarity in topography or stratigraphy between the right and left bank. The middle terrace in the sequence appears to be both topographically and stratigraphically paired although colluvium covers the left bank example. The upper terrace is only found on the right bank and, on the left bank, has either been completely removed through erosion or covered by significant amounts of colluvium. Radiocarbon dating by AMS has shown the contemporary floodplain to be post-European settlement and is extremely dynamic whereas the terraces flanking them range from 1,440 ± 60 y BP on the lower terrace to 10,050 ± 260 y BP on the upper terrace. The paired nature of the older terraces when compared to the unpaired nature of younger terraces indicates a regional and uniform process of formation followed by more local and variable processes of recovery.

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An overview of the neotectonics of Australia: the not-so-stable continent

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The record of large earthquake occurrence in Australia's landscape provides an opportunity to better understand the long-term characteristics of stable continental region deformation. It also represents an important tool for extending the historic earthquake catalogue to a timeframe meaningful to intra-plate settings. In the last 5 years the interrogation of geological and geomorphological data sets, and consultation with earth scientists, has resulted in the identification of more than 200 fault scarps which are thought to have formed in the current Australian crustal stress regime. Only a handful of these have been quantitatively examined to determine seismic source parameters (e.g. timing of events, recurrence, magnitude). However, three important characteristics are revealed in the extant data: (1) recurrence of surface rupturing earthquakes on an individual fault is typical (i.e. active faults remain weak), (2) temporal clustering of events is apparent on many faults (i.e. large earthquake recurrence in 'active' phases might be much less than during 'inactive' phases), and (3) significantly larger events than have been seen in historic times (M_W >7.0) might be expected in the future, Australia-wide. These data have been combined with information such as the total displacement across faults in the current stress regime, fault length and distribution, and relationship of faults to contemporary seismicity, topography and landform to assess the response of the Australian crust to the imposed stresses. The primary finding is that response is heterogeneous and Australia may be divided into a number of 'neotectonic' domains which are distinguished by differing active fault characteristics.

Using evolution and speciation of troglobitic fauna as a relative dating technique to determine the age of ancient palaeochannel deposits in the Pilbara region of Western Australia.

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Following aridification of the Pilbara region of Western Australia, palaeochannel deposits of tropical rainforest and woodland river valleys have evolved as iron-rich mesas. A range of hygrophilous former forest-floor litter species has colonised the ancient palaeochannel deposits, migrating downwards and laterally following moisture. Many of these terrestrial species have developed troglomorphic characters in similarity to the troglobites in karst. Studies on the phylogeny of troglobitic schizomids and other troglobitic species in these mesa structures demonstrate that their speciation from surface relatives mirrors the evolution of these ancient river valley deposits.

Fluvial Architecture of the Murray River at Chowilla, South Australia

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Chowilla forms the extreme eastern part of the Murray River in South Australia. As one of the five "Icon" environmental sites along the Murray River, it has been extensively investigated by state and national agencies as part of wide ranging environmental studies for management of floodplain, riparian, and riverine health. It is perhaps the most studied floodplain along the Murray River. Therefore, it is ironic that the geomorphology of the floodplain has not been investigated in detail. High-resolution airborne lidar surveys allow detailed geomorphic mapping that is essential for the interpretation of geophysical surveys and regolith landform maps, and, in conjunction with these additional data, the preparation of more derived products such as recharge and flush zone maps and groundwater and salt budget models.

The Murray River at Chowilla occupies the Murray River Gorge, a valley incised through a Late Cainozoic succession consisting of the Blanchetown and Loxton-Parilla Formations. These are mantled by Pleistocene aeolian sands of the Woorinen Formation. The modern floodplain consists of three distinct generations of meander belt sediments with scroll bars and oxbow billabongs. These show distinct up and down-stream morphologies reflecting spill-over of sands during river floods. A conventional fine-grained floodplain is absent because the meander belt sediments extend across the full width of the floodplain within the confines of the gorge. However, older meander deposits are draped by floodplain silty clays with the thicknesses increasing to more than a metre on the oldest deposits. The oldest floodplain deposits also show distinctively longer meander wavelengths and wide channels than the modern channel, indicating a diminished flow over time.

Chowilla and Monoman Creeks are sinuous fixed-channel anastomosing channels, and are related to drainage during high water levels. These channels and the oxbow billabongs are mostly clay-lined. Distal to the river, several small clay pans abut the cliffs forming the edge of the trench, and are several metres lower than the rest of the floodplain. They form evaporation basins for water draining off the proximal floodplains along the fixed channels. Remnant high level terraces are present, and are inferred to be Late Pleistocene. The small size of the terraces makes it difficult to infer much about the depositional system that formed them. However, further upstream in the Lindsay-Wallpolla Islands reach of the river, similar terraces are mantled by aeolian silts and sands through which ghosts of channels and billabongs are visible in satellite imagery, suggesting an environment not too different from the modern one.

Drilling has shown that the River Murray Gorge at Chowilla is flat-floored and overlain by a coarse sand unit sometimes referred to as the Monoman Sand. This unit, which has no formal stratigraphic status, is inferred to represent a braided stream facies deposited during the earliest phase of Late-Pleistocene to Early Holocene aggregation. The top of this facies has a buried forest and palaeosol which may mark the transition from braided to meandering deposition that characterises the modern river. At Chowilla the inferred latest Pleisotocene to Holocene sediments are up to 40 m thick. Upstream the sediments thin markedly to less than 20 m in the Lindsay-Wallpolla region.

Geomorphology of the entrenched Murray River floodplain, Lindsay-Wallpolla Islands, Victoria

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The Murray River east of Mildura runs through a reach named after Lindsay and Wallpolla islands, formed by anastomoses or anabranches of the Murray River. The tract is one of the five "Icon" environmental sites along the Murray River and has been the site of artificial watering of the floodplain to offset the effects of drought and lack of natural flooding (MBDC 2006). The Murray River in the Lindsay-Wallpolla Islands reach runs though the Murray River Gorge, a valley incised through a Late Cainozoic succession consisting of the Blanchetown and, at the extreme western end, Loxton-Parilla Formations. These are mantled by Pleistocene aeolian sands of the Woorinen Formation. The Murray River Gorge here reaches its widest extent, 35-40 m, although it locally narrows to 12 km at Neds Corner and again to 3 km upstream of Wentworth.

High resolution airborne lidar surveys show that the modern floodplain consists of three distinct generations of meander belt sediments with scroll bars and oxbow billabongs. These show distinct up and down-stream morphologies reflecting spill-over of sands during river floods. A conventional fine-grained floodplain is absent because of the meander belt sediments extend across the full width of the floodplain within the confines of the gorge. However, older meander deposits are draped by floodplain silty clays with the thicknesses increasing to more than a metre on the oldest deposits. The oldest floodplain deposits also show distinctively longer meander wavelengths and wide channels than the modern channel, indicating a diminished flow over time.

An extensive terrace occurs along both sides of the Murray River Gorge. These are inferred to be of Pleistocene age. The terraces are mantled by aeolian silts and sands and have local outlying dunes of the Woorinen Formation. Ghosts of channels and billabongs are visible in satellite imagery suggesting an environment similar to from that which formed the modern floodplain.

Lindsay and Wallpolla Creeks are sinuous fixed-channel anastomosing channels. While these channels may partly follow abandoned channels of the Murray River, they are incised into the floodplain and are inferred to be related to drainage during high water levels. These channels and the oxbow billabongs from abandoned meander loops of the Murray River are clay-lined, with water flow either non-existent or very slow. It is these channels that are flooded during the artificial watering process.

Distal to the river are several clay pans with associated lunettes. The largest of these is Lake Victoria, followed by Lake Wallawalla. These abut the rise forming the edge of the gorge or against the terrace. In their natural state, they are several metres lower than the rest of the floodplain, forming evaporation basins for water draining off the proximal floodplains along the fixed channels. Engineering works have resulted in Lake Victoria being used for permanent water storage and Lake Wallawalla for temporary storage. These lakes are interpreted as modified meander loops of the Murray River.

Late Quaternary geomorphology of the lower Manawatu floodplain and estuary

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The Manawatu River responded to lowered base levels during the last glaciation by incising well below current sea level, such that during the post-glacial marine transgression (10-6.5 ka) rising sea levels inundated much of the lower valley forming an extensive proto-estuary. Unexposed, active faults manifesting growing folds protected the newly-formed estuary from marine incursions. Large volumes of sediment fed by the Manawatu River into the low-energy back-barrier environment landward of the anticline resulted in the coast prograding approximately 4 km seaward through the mid-to-late Holocene. Today the proto-estuary is overlain by alluvium and the most extensive transgressive dune field in New Zealand, which extends for 900 km^2 across the coastal plain. Three phases of dune development are identified as the Foxton (6.5-1.6 ka), Motuiti (1-0.5 ka) and Waitarere (<120 yrs). Further upstream, from the margin of the coastal plain, the Manawatu River flows in an increasingly distinct valley, inset between a series of cut and fill terraces. These river terraces all formed during the last glacial cycle and are inset below the Tokomaru Marine Terrace, which represents the coastline during the last interglacial (MIS 5e). Through its terraced reaches the river is characterised by a steep gradient, gravel bed and moderate sinuosity. The lower river is sand-bedded, flowing across a medium energy, lateral migration, scrolled / backswamp floodplain.

Large scale simulation of surface armouring and weathering

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Armouring is a process of surface coarsening caused by removal of fine material from the top layer. Soil armouring occurs when a mixture of fine and coarse particle is exposed to overland flow preferentially eroding the fine particles. This process eventually generates a surface with a size distribution which is equal or bigger than the transport threshold of the flow, reducing or preventing sediment entrainment.

Physical weathering is the breakdown of rock to smaller fragments by mechanical processes. This process influences the fine sediment availability and soil grading, and increases sediment transport. Sharmeen and Willgoose (2006) simulated the effect of time-varying surface armouring on sediment flux and erosion based on a complex physically-based model (i.e. ARMOUR). In order to reduce the computational requirements of the ARMOUR model we developed a new armouring-weathering simulation algorithm based on the Marko chain approach. This new model dramatically reduces run-time which allowed us to carry out a more detailed investigation of the armouring and weathering processes.

The results of a parametric study found strong numeric links between the area-slope relationships and soil grading. We will demonstrate the affect of weathering rate on equilibrium soil grading and show a quantitative link between topographic slopes and soil grading distribution. Finally we demonstrate this approach for two-dimensional simulations which will enable us to calculate the soil grading distribution in topographically complex environments.

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Late Quaternary climate change in central Australia: mega-lake phases or extreme monsoonal events?

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The Lake Eyre basin drains approximately one-seventh of the Australian continent and has terminal playas that record lake filling and drying episodes over the late Quaternary. These filling episodes ultimately record the magnitude of the Australian monsoon coupled with an additional westerly front component. The filling of Lake Eyre to 10 – 20 m above the current lake floor represents climatic conditions vastly different to today with varied rainfall/runoff/evaporation relationships with resultant massive water bodies (Nanson et al., 1998; De Vogel et al., 2004, Magee et al., 2004). Clarifying and consolidating the timing of lake filling episodes is therefore critical to unravelling the history of Late Quaternary climate change, a period when large-scale biophysical changes occurred across the Australian landmass.

A number of key questions remain for the terminal playas of the Lake Eyre basin. These include identifying the occurrence of beach ridges in adjacent lake basins at the same elevation and addressing whether they are the same age or not. This paper presents preliminary findings that will ultimately reshape our understanding of the filling of Lake Eyre and the middle-lakes system (Lakes Gregory, Blanche, Callabonna and Frome). Here we demonstrate that Lake Eyre filled to 10 – 12 m AHD in early Marine Isotope Stage[MIS] 5e (previously demonstrated by Magee et al., 2004) but a lack of dating precision at this age means that these results could also relate, in part, to high lake levels in MIS 6. More consistent dating shows the late to be full again in MIS 5c and that it filled to this equivalent level and possibly higher in late MIS 5a and MIS 4 (84 – 58 ka). Interestingly, the lake levels do not correspond well to evidence of extensive alluviation on river floodplains proximal to Lake Eyre. We use the grade of one of the major tributaries, Cooper Creek, and its alluvium to investigate whether the 'lake-full' conditions are indicative of long periods of enhanced monsoonal activity or whether they represent short-duration high magnitude extreme monsoonal events.

Using a combination of differential GPS, the SRTMv.3 digital elevation model (DEM) and single aliquot and single grain OSL we present some preliminary findings for Lake Callabonna. It would appear that the lake filled to 9 – 10 m AHD in mid MIS 3 and possibly again at the LGM, with recessional beach ridges present at lower levels. Adjacent lakes do share landforms at the same elevation, however to date we cannot confirm they are of the same age. The data also suggest that the middle lakes filled to nearly 4 m AHD in the late Holocene. This 'recent' filling of Lake Callabonna to approximately 4 times the depth of the 1974 filling episode presents an intriguing insight into the frequency of what would more than likely have been an extreme monsoonal event.

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Evolution of the Drainage System of Western Tasmania.

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Topographically southwest Tasmania consists of a complex of folded Precambrian and early Palaeozoic rocks. The area has been described as the ridge and valley province in contrast to the horizontal dolerite plateaux of central and eastern Tasmania. The term *ridge and valley province* is adapted from the strongly folded rocks of the central Appalachians where William Morris Davis deciphered landscape evolution through analysis of how the drainage network was related to underlying rock structures. Outside areas of late Cainozoic glaciation where drainage networks were deranged in western Tasmania analogy between the two regions is strong, and a classical interpretation of the long-term drainage evolution of the western Tasmanian landscape is possible.

175 million years ago the Tasmanian landscape was transformed by the intrusion of sills of Jurassic dolerite that cover central and eastern Tasmania, and formerly extended to the west coast. During the subsequent 100 million years when Gondwana was fragmenting proto-Tasmania was experiencing prolonged subaerial erosion that resulted in up to 8 km of late Mesozoic siliciclastic sediment being deposited off the west coast and 12 km in Bass Strait. During this long period of erosion the drainage network was largely developed.

The drainage network was initiated on a central axis of highland that extended from Cradle Mountain through the Central Highlands southwards to Mt King William. The rivers developed on a cover of Permian and Triassic sediments above the dolerite at an altitude of possibly 2-3 km. The major western rivers, the Arthur-Hellyer, Pieman-Mackintosh-Murchison, King and Gordon were developed from this axis towards the west coast as major consequent streams, that in detail became adjusted to the underlying geological structure as the landscape was eroded to produce extensive areas of trellised drainage patterns. Examination of the relations of the river patterns to topography and structure show many examples of subsequent streams, obsequent streams, river capture, underfit streams and wind gaps, features that are the essence of development of a superimposed drainage system.

However, in addition there are numerous geomorphological features that indicate tectonic uplift has taken place probably semi-continuously during development of the drainage system and certainly during the Cainozoic after separation of Tasmania from Antarctica. The characteristic features include: 1 deep antecedent gorges like the 900-m deep King Gorge through the West Coast Range, 2 deeply entrenched lower sections of all the main western rivers with un-entrenched valley sections further inland, notably the Gordon seaward of and above the Gordon Dam, and 3 long sections of deeply ingrown meanders that exhibit asymmetry of form. These features characteristic of uplift confirm that the drainage network is both superimposed on the geological structures and antecedent to much of the present topography.

The long profile of the lower-Mekong River: Identifying major controls on pool morphology susceptible to river regulation and navigation improvement works

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Deep pools along the Mekong River are critical habitat for fish. Regulation of the river by large dams is likely to alter flow, and sediment supply, in ways that could infill these pools. There are also plans to remove rapids to aid navigation. We are completing a study of the dynamics of water and sediment movement through pools in the Mekong in order to understand the impact of these planned changes on the pools. However, before we can understand the dynamics of particular pools, we need to understand the general distribution and morphology of pools along the entire river. What geological factors control the distribution and morphology of pools on the lower Mekong River?

Using a detailed long-profile digitised from a 1996 hydrographic surveys, we separated the bed-profile into long, intermediate and short wavelength components using a time-series analysis technique: empirical mode decomposition. In this way we identified pool-crossing units and downstream changes in their amplitude and wavelength.

At the regional scale, the Mekong long profile exhibits several discontinuities that correspond closely with abrupt changes in geology and planform morphology. Of particular interest are two elongated knick points where the River cuts across the edge of the large Khorat sedimentary basin. The narrow and incised bedrock channel, with deep and closely spaced pools in these zones suggests possible river capture/avulsion since the uplift and tilting of the Khorat Basin during the early-Tertiary and the more recent extrusion of the Bolaven volcanics.

Pool-crossing amplitude and wavelength change abruptly at major discontinuities in channel slope, geology and planform morphology. However, one-way analysis of variance showed no significant overall difference in median pool spacing between alluvial and bedrock-alluvial reaches and in fact, the alluvial reaches exhibited more variable (less periodic) pool spacing than did some bedrock reaches. This is contrary to our initial hypothesis that pool spacing is a simple function of boundary resistance so we would expect pools in bedrock reaches to be more closely spaced and less periodic than in alluvial reaches. Our results suggest that bedrock controls play an important roll in pool formation in what appear to be predominantly alluvial river reaches.

The majority of deep pools (30-90m) are associated with valley or in-channel bedrock constrictions, with stronger constrictions generally forming deeper pools. Any major programs to clear rapids for navigation purposes would therefore likely lead to a decrease in pool depth. The lower-Mekong carries a large sand and gravel bed load and since channel constrictions act as temporary bottlenecks for bed load, any river regulation that significantly decreased transport capacity of the flow in relation to sediment load would also likely lead to infilling.

The Queensland Regolith Project: Our Progress and Practices

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A collaborative regolith team from CRCLEME, GA, GSQ and CSIRO have commenced a commercially based contract with GSQ to generate a regolith map and regolith atlas for the whole of Queensland. The first project of this type concluded in June 2006 and involved mapping and characterising regolith for the whole of the Northern Territory.

These projects aim to produce a regolith-landform model for a large part of northern Australia including Queensland and contribute to the understanding of the physical background of processes and regolith materials of both arid environments and coastal regions. It also extends seamlessly the already established first-order framework for guiding geochemical prospecting for a wide range of minerals based on an improved understanding of Regolith from the Northern Territory to Queensland. The Northern Territory Regolith work began three years ago when the CRC led Regolith team began the task of documenting and describing the character, distribution and variability of the regolith throughout the Northern Territory. The value of extending such work into Queensland was quickly recognised. The Queensland Regolith Project began in July 2007 and ends in June 2008.

The main aim of these very large regolith projects is to establish regolith landforms maps at 1:2.5 million, based on an underlying 250k compilation and supported by regolith materials atlases describing how regolith materials vary, where they occur and what the broader identifying characteristics might be. Among the main activities carried out are trans-State and Territory regolith traverses, to set the scene for the more detailed investigations of the nature and distribution of regolith and associated landforms, and the study of major regolith terrains. The regolith team members also use the palaeomagnetic characteristics of regolith samples from the surface and mine exposures to establish when the oxidation events occur and fit this information into the emerging picture of major weathering periods across the continent.

In the case of the Northern Territory, the age range is 2 million to 295 million years (the Darwin foreshore and a road cutting near Tennant Creek, respectively). The team expects to define a similar chronology for Queensland. Early results suggest that the principle oxidation event may be early Tertiary. Some 60 samples are yet to be processed. Most of this new regolith information is contained in the maps and atlases. However, even greater regolith detail is contained in the respective supporting GISs. The NT Project GIS established the first comprehensive dataset of spatially located regolith information for any state or Territory in Australia. The Queensland project is now continuing this momentum. The fieldwork phase has already documented approximately 6000 site-specific descriptions of QLD regolith and landforms and some 300 major regolith materials will be characterised. These data will be an invaluable guide to generating a robust, well-calibrated interpretation of QLD's regolith character and its distribution.

Mapping and characterising regolith for an entire State or Territory within a two-year period is only possible by employing cutting-edge technologies, and customising commercial software packages to handle the massive data volumes that are required. Such short timelines for such large undertakings demand: our best logistics; thorough project scoping; extensive organisation; and detailed fieldwork planning. Finishing on time and within budget means, we must adjust and optimise our project plans, strategies and team efforts continuously throughout the project.

Four faces of stratigraphic instability: divergent mechanisms of slope failure

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One of the most potent pre-conditions for slope instability occurs in those landforms capped by competent, hard rock and underlain by incompetent, soft rock. In Otago, New Zealand, this condition is commonly represented by Miocene volcanic or indurated Miocene limestone overlying Eocene mudstone. Disruption of cap rock is consequent upon failure of the mudstone. The failure mechanism within the mudstone can be of three types: brittle rotational shear failure, plastic creep or viscous flow.

These failure mechanisms in turn lead to four movement mechanisms: rotational slide (slump), valley cambering, lateral spread, and block flow. Rotational slides and valley cambering are associated with cap rock topple, while viscous flow promotes slab and block transport. At some sites there is evidence for repetitive slump-flow- topple-slump cycle. While cap rock structure dictates some of the landslide features it is not clear what factors controls the type of failure mechanism within the mudstone.

Cross Sectional Form in Muddy Tidal Creeks

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Understanding the controls on channel cross sectional shape remains a difficult problem in Geomorphology. This study examines the applicability of some mechanistic models of channel cross sectional shape to tidal channels formed in cohesive mud.

Mechanistic models try to predict the evolution and equilibria of channel shape, by combining predictions of the distribution of velocity and shear stress over a cross section (based on mass and momentum conservation) with empirical or quasi-theoretical descriptions of sediment transport (Fagherazzi and Furbish, 2001; D'Alpos et al., 2006). These models predict the development of channels in a wide range of conditions. However, over longer time periods, the models predict channel cross sectional shapes that are deeper and narrower than most muddy channels for which we have field data.

This study proposes modifications to both the hydrodynamic and sedimentary components of the above models, based on existing experimental and field data, and some new observations. When compared with the previous approaches, the new model predicts the development of stable channel morphologies with dimensions closer to those observed in the field.

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Catchment erosion over the past 100,000yr in southeastern Australia: insights on how erosion and sediment transport respond to climate change

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Uranium isotopes can be used to determine the residence time of sediments in a catchment, i.e. how long they are stored in weathering profiles and transported through the catchment by rivers. We have measured uranium isotopes in sediments from palaeochannels of the Murrumbidgee River (Murray-Darling Basin, southeastern Australia) to quantify the variations of sediment residence time over the past 100,000 years.

Results indicate that sediments transported through the Murrumbidgee catchment during the Last Glacial Maximum resided for only a few 10,000 years in the catchment. This contrasts with modern and 100ka-old channel sediments where the residence time reaches values as high as 400,000-500,000 years. The variation in sediment residence time probably reflects changes in the type of landscape compartments that contribute to the river sediment budget: short residence time during LGM illustrates a dominant contribution of upstream hillslope erosion, whereas long residence time during interglacials reflects the re-working and mobilization of old sediments derived from the alluvial plain. These changes in landscape erosion could be related to changes in vegetation cover. This would suggest that the impact of climate change on catchment erosion is operating indirectly, *via* changes in vegetation cover and type.

Deciphering Holocene sea-level change in New Zealand from detailed barrier stratigraphy acquired utilising ground-penetrating radar

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One of the most heated topics within the context of global warming is sea-level and while much of the debate rages on about predicting the future it is surprising to most that there is similar uncertainty about what sea-level has done in the past. The most recent publication on sea-level change in New Zealand came out over 20 years ago which concluded that over the last 6.5ka a stillstand occurred but that further research is needed to determine fluctuations (Gibb, 1986). Ironically it is within this Holocene time period that the coastal features most vulnerable to future sea-level rise formed, such as sandy barriers. Within the accreting sands of prograding barriers past sea-level elevations are recorded. Existing studies of barrier evolution lack detail due to the their restriction to point source data, this study augments traditional coring techniques with Ground-Penetrating Radar (GPR) to acquire continuous cross-sectional records of the subsurface stratigraphy. The 3-D geophysical models of barrier architecture reveal large-scale features and facies boundaries previously undetected by coring alone. Since the elevation of beach and dune facies are sea-level sensitive this boundary has been used to map any change throughout four prograding barriers spread along the east coast of Northern New Zealand. The overall trend shows a 2 meter drop in sea-level starting from their inception ~4ka until ~1ka where it levels off and transitions into a slight rise. This sea-level curve records a mid-Holocene highstand similar to that published for the southeast coast of Australia (Sloss et al., in press). With better chronology in relation to detailed morphostratigraphic analysis this data set could contribute to the debate of smooth or oscillating sea-level (Baker and Haworth, 2000, Sloss et al., in press). Additionally, GPR shows this sea-level change within the context of barrier evolution thus providing better insight into predicting the response of barriers to future changes in sea-level.

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Transmission losses in ephemeral dryland streams: role of mud clogging in channel margin sediments

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Percolation of flood waters into the bed and banks of ephemeral streams provides one of the key mechanisms responsible for transmission loss. However, there are very few published estimates of the rates at which water can enter streambank sediments, and little is known about the variation in bank permeability with elevation above the bed and the resulting effects on transmission loss in floods of different magnitudes. This paper presents the results of 69 field determinations of bank infiltrability made on Fowlers Creek, an ephemeral dryland stream located in arid western New South Wales, Australia. Fowlers Creek carries high concentrations of suspended sediments, which are deposited as mud drapes on the bed, banks, and floodplain. Results demonstrate that infiltration rates are lowest at the base of the banks, and tend to increase steadily with elevation on the bank, even above the apparent upper limit of mud drapes. In parallel, the texture of the bank sediments (assessed from samples of the uppermost 10 cm) becomes coarser with elevation above the bed. This pattern is inferred to relate to the delivery of silts and clays into pore spaces in the bank sediments by percolating flood waters. The patterns of infiltration rate and sediment texture mapped in the field are reasoned to be the product of many clogging episodes in past flood events having different peak stage. The increase in infiltration rate and mean particle size up the banks reflects lower frequencies of submergence and clogging of the upper banks by large floods, and more frequent inundation and clogging of the lower banks by sub-bankfull flows. The stage-related changes in bank permeability provide a mechanism that can drive variations in transmission loss among floods having different peak stage and hydrograph shape.

People and sheep, wind and water: geomorphic processes and human impacts in Tierra del Fuego, Argentina, and consequences for the archaeological record

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Tierra del Fuego more often invokes visions of rain and snow, *Nothofagus* forests and peat bogs, and mountains and glaciers, than the widespread grasslands on rolling terrain that are characteristic of the northeast of the island. The geomorphic environments and history of human settlement of northeastern Tierra del Fuego, Argentina ($52^0$30'S – 54^0S), have many similarities with the semi-arid rangelands of western NSW, Australia (29^0S – $34^0$35'S). We present an overview of these similarities, and some initial observations on the consequences for the formation, preservation and visibility of the archaeological record. The area is dry (average annual rainfall ~ 250 mm), cold (average temperature $+6^0$), and extremely windy (monthly median > 25 km h^{-1}). Grassland vegetation is dense and practically continuous, except for patches of bare soil where aeolian deflation occurs. Gullying and mass movement (shallow slides and terracettes) are also evident, especially on steeper slopes. The earliest date for human occupation is ~ 11,880 y BP for bone at Tres Arroyos rockshelter (Massone 2004). Evidence for occupation (mostly shell middens, stone artefacts, and guanaco bones displaying anthropic marks) is also found at open sites located on aeolian and colluvial deposits near mid-Holocene to recent coastal shorelines and around lake basins. Within 100 years of European settlement in the early nineteenth century, the indigenous population was wiped out, by disease, disturbance of traditional food sources, and professional head-hunting. Hunting and gathering was replaced by sheep grazing, introduced to the northern part of the island in 1878 (Lothrop 1928).

Surface disturbance by sheep in this windy environment appears to have resulted in erosion of topsoils, formation of shallow deflation basins elongated in the downwind (easterly) direction, and accumulation of windblown material to form a distinctive pale grey layer of variable thickness (typically < 1 m) over the former organic-rich topsoil. OCR dating from 3 coastal locations indicates topsoil burial commenced around 170-200 y BP, when sheep were introduced (Favier Dubois 2003, 2007). The process continues today, with trapping of sand- and silt-sized sediments within grasses downwind of the deflation surfaces, forming lee-side deposits of variable thickness and area depending on the size of the upwind source area. Although the sediments differ in particle size, colour, etc., the deposits are essentially identical to those in Australia termed PEM ("post-European material"). We suggest that similar processes have occurred in both locations following European colonisation and introduction of sedentary grazing. Aeolian deflation and accumulation are not, however, just contemporary processes. Deposits up to 20 m deep and with multiple buried paleosols are exposed above cliffs on the southern shores of several lake basins in northern Tierra del Fuego. These point to episodic aeolian accumulation during the Holocene, (and earlier?), with the source areas probably either dry lake beds and/or glacio-fluvial outwash plains. Aeolian deflation and accumulation have several important consequences for the archaeological record of former hunter-gatherer populations. Stone artefacts and bones at open sites are exposed by deflation and concentrated lower in the landscape, forming a palimpsest deposit. In Tierra del Fuego the constant, and at times violent, westerly winds blow small, lightweight and platy materials downwind for many metres, and sometimes even upslope of their original position. Materials disturbed by wind and water erosion (gullying) are also redistributed downslope and sometimes reburied. At some sites, revegetation of deflated basins by grasses and herbs covers the conflated archaeological materials as the new vegetation traps wind-blown sediment. This further complicates the archaeological record, so that results based on traditional approaches relying on stratified deposits may be difficult to interpret. Instead, the geomorphic framework for recording and interpreting conflated surface archaeological deposits in western NSW developed by WNSWAP (Fanning *et al*. 2007) may be more appropriate.

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Natural Sequence Farming and Fluvial Geomorphology: dichotomy or misunderstanding?

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The media events leading to the emergence of Peter Andrews as a guru of sustainable land management has left many in the traditional science areas of hydrology and fluvial geomorphology with distinct feelings of disillusionment, frustration and even anger. There are issues of language and vocabulary, personality, management paradigms, and knowledge of landscape functioning.

The language used on both sides of the argument ranges from overly simplistic, anecdotal and ill fitting analogies to narrow and difficult technical jargon. Also much of the language is deep with meaning and the opposing sides in any argument do not necessarily understand the other side’s usage, no matter all the subtle and implied meanings. The personalities that have come to bear on the discussions have ended up in confrontation, which in turn, cannot be blamed solely on either point of view. The management paradigms underlying the proposed regimes range from the engineering approach of design for the 100 + year flood, with high levels of technology and sizeable investment to produce “set and forget” constuction on the one hand and compared to the approach of construction with low levels of technology and investment and resultant low levels of stability and high maintenance until vegetation becomes the major stabilising influence.There is also a major problem of reinstatement of the channel with little regard for the catchment (ie controlling runoff and thereby channel flows without revegetation of the catchment) and attempting to reinstate a chain of ponds while the catchment remains cleared with very high runoff, short and steep hydrographs producing “gully rakers” regularly causing erosion.

The transposition of a technology (for example: leaky weirs to reduce water velocity) arguably said to work in one landscape (porous, very sandy, uniform to gradational, high organic matter floodplain soils of the upper Hunter) to other quite diverse landscapes (for example: acidic, duplex, high clay, low porosity, low organic matter soils on the tablelands of NSW: or the high clay gradational, shrink swell dominated, alkaline clay soils of the western slopes of NSW) is also very problematic. On the other hand, we see general agreement with the ideas that reinstating chains of ponds is a worthwhile goal; that in stream structures need to be part of the implementation; and that broad regional revegetation must be a part of the overall catchment plan.

Ancient landscapes of the western Canning Basin, north-western Australia: the significance of palaeovalleys in the modern landscape

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Geoscience Australia is currently acquiring airborne electromagnetic (AEM) data over a large survey area in the Paterson Orogen and onlapping Canning Basin in north-western Australia. The survey is part of the Government's Onshore Energy Security Program, and was designed to encourage mineral exploration in the region. It will also contribute to a National Water Commission funded project being led by Geoscience Australia to investigate groundwater resources in palaeovalleys across the arid and semi-arid inland. In order to interpret the AEM data a conceptual model of the regions near-surface geology and long-term landscape evolution is being developed from existing information (literature, geological maps, drill-holes, satellite imagery and geophysical data).

An important component of the region's landscape evolution has been the development and preservation of different palaeodrainage networks. Glacial valleys of the Late Carboniferous – Early Permian are preserved in the uplands, and are also known to extend under the cover of the Great Sandy Desert (Playford, 2001). In contrast, the position of playa lakes and large calcrete bodies within the desert also reveals a younger Cainozoic palaeovalley network that is fluvial in origin and tectonically driven in response to the break-up of Gondwana (Van de Graaff *et al.*, 1977). Similar overlapping palaeovalley networks have been observed in several other basins around Australia, such as the Eucla Basin, where the relationship between Late Carboniferous – Early Permian glaciogenic troughs and more prevalent Cainozoic fluvial palaeovalleys has also been observed (Hou, *et al.*, 2001).

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The late Quaternary palaeoenvironmental history of Lake George, New South Wales

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Lake George, the largest lake basin in the southern highlands of New South Wales, provides one of the most complete records of Quaternary sedimentation in southeast Australia. Despite its significance as an archive, there is only a limited chronology to place existing geomorphic and palaeoenvironmental information in the context of other more fragmentary records from this part of the continent. Our study presents an optically stimulated luminescence (OSL) dating chronology of the various landscape features associated with the lake.

Although the lake is currently ephemeral, sediments within the basin preserve evidence of both permanent and dry lake conditions in the past (Coventry and Walker 1977). Cross bedded gravels exposed in a quarry in the southern part of the lake basin indicate the existence in the past of a substantial water body with water depth in excess of 20 m. Sediments exposed within an incised creek bed at the northern end of the lake record multiple periods of lake filling. These units are associated with nearby aeolian dunes and two embankments that mark the 37 m and 18 m lake depth shorelines. The creek sequence is overlain by a thin veneer of alluvial sediments and aeolian dust derived from the exposed basin surface late in the Holocene. We reconstruct past lake levels based on the sedimentology of the dated units, and relate these to climate change in the region during the Late Quaternary.

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A response gradient of river adjustment and recovery across the upper Hunter catchment: Impacts of human disturbance since European settlement.

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Most analyses of river adjustment have focused on parts of catchments where metamorphosis has occurred. This provides a non-representative view of river responses to human-disturbance post-European settlement. Although many rivers have been subjected to systematic land use change and disturbance, significant within-catchment variability is evident in the form, extent and consequences of adjustment. This study documents the catchment-wide distribution of river adjustment across the 4,200 km^2 upper Hunter catchment, NSW in the period since European settlement. The spatial distribution and timing of differing forms of lateral, vertical and wholesale river adjustment are analysed. A non-uniform, localized pattern of adjustment is noted. Less than 20% of river courses have experienced metamorphosis. This reflects the predominance of bedrock-controlled rivers which have limited capacity to adjust and are resilient to change. The type and pattern of rivers, influenced largely by valley setting, is a key determinant of the fragmented pattern of river adjustment in the upper Hunter catchment. Phases of reach-scale geomorphic adjustment to initial human disturbance are characterised as a response gradient. In general terms, primary responses involving, for example, cutoffs or straightening, were followed by secondary responses such as channel expansion. These secondary responses occurred between 50-70 years after initial disturbance. This has been followed by a tertiary phase of river recovery, denoted as a transition from predominantly erosional to predominantly depositional geomorphic processes such as channel contraction. These tertiary responses occurred around 70-120 years after initial disturbance, and are ongoing. This study has broader application for the study of river responses to human-disturbance in southeastern Australia and highlights the significant lag times involved in river recovery from initial disturbance.

Dating of Australian longitudinal dunes using cosmogenic nuclides

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Desert dune-fields are a major feature of arid Australia, but their formation and evolution histories are not well known owing to the lack of suitable dating methods. Development of luminescence dating (TL and OSL) has shown that the Australian dunes have apparently developed in episodic at glacial periods (e.g., Nanson et al., 1992). Luminescence dating, however, has difficulties to examine earlier episodes of dune activities, because 1) the method is of limited use in age up to 300 ka and 2) luminescence ages tend to represent only the latest episode of dune activities, where the previous luminescence signals are most likely bleached during later activities when sands are re-exposed to sunlight. In this study, we utilise cosmogenic nuclides (^{10}Be and ^{26}Al) to first investigate the timing of the earliest dune activity in Australia. In a simplest case, when a sand grain is buried after exposed to cosmic rays at the surface for a certain period of time, the nuclide accumulated during the initial exposure period decreases in amount depending on its half-life and burial time (Granger and Muzikar, 2001). Measuring two nuclides in a sample therefore allows us to solve two unknowns, i.e., burial time and initial exposure time. In case of ^{10}Be ($t_{1/2}$ = 1.5 Ma) and ^{26}Al (0.7 Ma) pair, up to 5 Ma of burial time can be measured. Total 66 dune-core samples (20 for cosmogenic and 46 for OSL) were collected from nine drill-holes at five dune ridges in the west Simpson Desert. Palaeosol horizons that contain soft haematitic nodules were identified during drilling. Finite OSL ages from top and the second dune layers range 16-88 ka and 79-132 ka, respectively, implying that the sands in these layers were likely mobilised during the last and penultimate glacial periods. In lower two layers, all OSL ages are saturated, whereas burial ages calculated from measured ^{10}Be and ^{26}Al, assuming simple burial model as above, indicate average ages of 0.7±0.1 Ma and 1.2±0.1 Ma for the third and the lowest dune layers, respectively. Further, more realistic dune formation model is examined by assuming repeating episodes of sand accumulation and deflation. The result of this latter model calculation indicates that the initiation of dune activity in the sampling area (west Simpson Desert) likely dates back to ~1 Ma. This does not contradict with our previous result that less intense desertification began earlier: neighbouring stony deserts began to form at the onset of Quaternary ice ages 4-2 Ma (Fujioka et al., 2005). Our present result suggests that aridity deepened and the dune-fields began to form in central Australia when ice-age cycles increased in amplitude and their dominant periods switched from 40 ka to 100 ka, around 1 Ma.

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Local variability in landscape evolution, and the question of scale

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There are many references in the literature to estimates of the age of a landscape, the rate at which it has developed, or the shape of palaeolandscapes. Many are based either on ages of deposition (e.g. fossil age) or time since burial (e.g. optically stimulated luminescence dating) of sediments, or elapsed time since crystallisation of igneous flows and pyroclastics (e.g. various forms of isotopic dating) that form parts of the landscape. Others rely on the measurement of cosmogenic isotopes generated in the near surface environment, or the measurement of palaeotemperatures by geothermometers such as analysis of apatite fission tracks. These diverse methods of dating have various accuracies (some researchers will contend that the accuracy figures for some techniques are in fact inaccurate, especially if the data do not fit their models), and the inferred rates of deposition or denudation derived from these dates also may depend on assumptions (for example assumed geothermal gradient).

However, the derived rates of landscape development are true only for the location of the sample. Further assumptions need to be made to extend the age or rate of development of a landscape away from the sample locations. For example, basalt overlying fluvial sediment on ridges adjacent to the Clyde River at Brooman in SE NSW (Spry et al. 1999) has been dated by K-Ar methods at ~28 Ma. The basalt flowed down the Clyde palaeovalley, and the sub-basaltic sediment is the alluvial fill of the palaeovalley. The base of the basalt is ~80 m above river level, so an average net incision rate of ~3m/Ma since the time just prior to basalt extrusion is indicated for the river channel. The basalt is up to 40 m thick, so an average incision rate of >4 m/Ma is indicated since the basalt was extruded. However, at locations where the basalt is preserved, the amount of erosion is clearly lower, perhaps only a few metres at the highest preserved points of the basalt (although this is purely speculation), giving an erosion rate of perhaps <0.5 m/Ma. In addition, the modern Clyde valley is generally broad, with relatively low slopes near the river in many areas. However, the nature of the palaeovalley sediments suggests that the 28 Ma palaeo Clyde was flanked by steeper slopes. If this is the case, average erosion rates since 28 Ma in areas away from the palaeo and modern valley axes may be much greater than 4 m/Ma. Thus there is a mosaic of rates of landscape development within a small area, and one figure cannot describe the rate of landscape change over a distance of several kilometres across the modern valley profile. At a more regional scale, a weighted average rate of development might be appropriate, if all the mosaic rates were known. However, as most of the local rates are in fact not known, the regional rate can only be a very inaccurate guesstimate.

As a first step towards assessing the scale of variability of landscape development rates, over 1000 K-Ar ages of igneous rocks <100 Ma in eastern Australia have been compiled, along with laboratory data (Gibson 2007). The report and data are available through links to CRCLEME Open File Report 193 at http://www.crcleme.org.au/Pubs/OFRSindex.html.

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A preliminary geospatial visualisation of a late Pleistocene fluvial wetland surface in the Flinders Ranges, South Australia

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Within the Flinders Ranges of South Australia, best known for its long sequence of Neoproterozoic and Cambrian strata, there are also late Pleistocene fluvial sediments that have been the subject of recent investigation (Williams et al., 2001, Williams et al., 2006; Glasby et al., 2007). In this study we use geospatial technologies for data acquisition and build a 3-dimensional palaeo surface representing the uppermost sediments of a late Pleistocene fluvial wetland system. Given the level of spatial accuracy employed, preliminary results indicate a continuous plane and sloping consistently down from east to west, suggesting that the remnants are still largely consistent with the original surface. An earlier study by Williams et al. (2001) showed that a series of cut and fill events followed depostion of the main formation. The use of geographical information systems for 2D and 3D analysis and visualisation in this study proved relevant to the interpretation of the landscape as it does raise issues of spatial data accuracy. We discuss the applicability of this initial attempt to help elucidate the aggradation and broader landscape evolution of the area. Suggested improvements to our data collection methods and inclusion of AMS radiocarbon and OSL ages of middle and upper sedimentary units for future work are also discussed.

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Relationships in Global Soil Distribution as Revealed by a World Soil Database

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This project used the ISRIC WISE Global database to develop broad quantitative relationships between the environmental factors of topography, parent material and climate and a range of key soil properties (primarily pH, sum of bases, organic carbon and clay content) and World Reference Base (WRB) soil types. Five different analytical approaches were used in the analysis, involving combinations of linear regression, decision tree tools and categorical mean and median analysis. The strengths of the relationships are only moderate at best, with R^2 values generally 0.2 to 0.4. The results were broadly supported by similar analyses of databases from Australia and the United States, although some differences are apparent.

The predictive relationships can provide useful first approximations of soil character under different environmental conditions and could be applied in quantitative soil modelling and mapping programs. They have the potential for widespread application as they should be universally applicable, are based on readily available data and do not require sophisticated quantitative modelling techniques. Preliminary testing revealed only moderate predictive success rates, approximately 45% for soil properties and 58% for WRB soil types. Although all approaches gave similar predictions, with over 90% equivalence, the most effective was the categorical analysis with median values.

The relationships revealed in the study can assist in our understanding of soil formation and soil distribution. Most relationships are in accord with accepted pedological thinking and support the state factor model of soil formation, but some anomalies are observed and deserve further examination. The results reveal the dominant influence of climate and parent material in controlling the distribution of many soil properties, however the influence of topography is less clear on the properties examined. The strong influence of present day climate, apparently even in older soils, supports recent studies (eg, Wilkinson & Humphreys 2005) that many soils are younger than previously thought.

How to fit an Escalator into a Letterbox – Dividing Tasmanians rivers into categories useful to the measurement of condition

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The creation of Fluvial Landscape Mosaics (FLM's), proposed for use in the Tasmanian River Condition Index (TRCI), is a new approach used to predict similarity between the geomorphic character of river systems. They are based on a top down rather than bottom up approach. Fourteen essentially independent inputs (topograpic, lithostructural and climatic), each having a significant control on fluvial processes, were integrated with the mapped extent of pre-existing geomorphic controls (such as glacial, periglacial and peatland systems), in a multivariate GIS framework. Four hundred regions of similarity (environmental domains) were defined, then amalgamated according to similar combinations of domains across the landscape. This provided a spatial analysis of similarity of the physical controls on fluvial systems over time.

The FLM's provide a spatial description of pre-European factors that influence stream development. Within the mosaics streams have smaller scale attributes which may be classified through accepted methods of characterisation, such as the River Styles approach. These River Types may be predicted from the information provided by the FLM's, such as gorges or anastomosing streams, then tested through field mapping and analysis. The scale at which river Types may be described is presently a grey area depending on available remotely sensed imagery and practical field measurements. The possibility of using TasWide Styles to distinguish and categorise Types across the state is currently being explored. In the TRCI the Types may be used to stratify the sampling of the State, allowing the identification of references reaches which will provide a set of benchmark sites for comparison of condition.

Assessment of condition may be achieved through measurement of a suite of reach-scale indices, including width-depth ratio, sinuosity, bank erosion, bedload.calibre etc in order to score degraded reaches with reference to benchmark reaches.

Application of *in-situ* cosmogenic nuclide analysis to landform evolution in Dartmoor, south-west Britain

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Located beyond the southern limit of glaciation in Britain, the upland granitic terrain of Dartmoor, south-west England, has been exposed to long intervals of intense periglacial activity during the Pleistocene. This region has been significant in debates about appropriate models of long-term landscape change, most notably two-phase (Linton, 1955) versus single-phase (Palmer & Nielson, 1962) models of landform evolution, and the development of tors. However, given the previous lack of quantitative techniques capable of constraining denudation and specific process rates, and thereby testing developmental models for these features, there remains much uncertainty in the interpretation of the classic landforms of the region. This study measures concentrations of the cosmogenic nuclide ^{10}Be produced in-situ in quartz within the upper few metres of the Earth surface. These reflect the history of near-surface exposure to cosmic radiation of sampled material, and allow for the interpretation of exposure age and/or erosion rates of the land surface. This research utilises these cosmogenic nuclide values to evaluate geomorphological processes and investigate key aspects of landform development. These include the formation of tors in non-glaciated regions, the development of regolith and blockslopes under periglacial conditions, and the derivation of catchment-averaged denudation rates. This study provides the first quantitative measurement of erosion on tor surfaces in Dartmoor, with typical rates of 15-40 mm ka^{-1}. These are relatively high and comparable to other components of the landscape. In addition, there is no clear relationship of cosmogenic nuclide concentration to tor dimensions. It is shown that the tors are dynamic landforms and simple, single-phase development is an inappropriate model. Catchment-averaged denudation rates are derived and these long term rates of 20-95 mm ka^{-1} are significantly higher than modern, short-term values. Finally, downslope transport in a palaeo-periglacial blockslope is investigated using ^{10}Be concentrations. This variety of landforms and scale of investigation facilitates an integrated approach to the understanding of catchment-scale erosional dynamics. In addition, the complex nature of landform development that is evident in the area provides challenges to the application of in-situ cosmogenic nuclides and highlights both the potential and limitations of the technique.

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Mass movement on the Great Western tiers, Tasmania

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Tasmania's Great Western Tiers, colloquially termed "The Tiers", is an escarpment or collection of mountain bluffs, some reaching over 1200m asl, that demarcate the agriculturally important valleys of eastern Tasmania from the elevated, rocky Central Plateau. The Tiers stretch from Western Bluff near Mole Creek Township to Millers Bluff, which is approximately 25km from Campbell Town.

Rocks of the upper escarpment commonly comprise of the more resistant Jurassic aged dolerite. Below the upper escarpment slopes are steep, often benched or stepped that reflect the differential erosion and hardness of the underlying rocks, mainly Permian and Triassic aged sedimentary rocks. Thick scree deposits commonly mantle the slopes and talus is found at the base of cliffs. Many of the slopes are deeply dissected by the headwaters of major rivers and streams, some of which drain from the Central Plateau, but most drain the escarpment slopes.

Vegetation on The Tiers ranges from dry sclerophyll woodlands and wet sclerophyll forests on the slopes and lower parts of the Central Plateau to alpine complexes and coniferous forest patches on higher parts of the Plateau. Today, the main land uses on The Tiers are conservation reserves, forestry (native species and plantations), agriculture (mainly grazing) and water catchment areas. Our research is focused on the lower slopes of The Tiers that are harvested for timber by both the state and private forestry sectors.

Forest planners are faced with a number of environmental challenges extracting timber and during post-harvest forest re-establishment. These challenges include: visual landscapes, soil erosion, water quality, geoconservation, biodiversity, mass movement and karst issues.

This study utilises a multi-criteria GIS approach to identify vulnerable geomorphic settings, lithologies and soils within The Tiers. To date, over 70 mass movement occurrences have been identified and recorded (Sloan, 1996: Perera, 1992; this study). The intent is to produce risk maps for forest planners to best manage resources in a working forest environment.

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Morphological diversity in the Australian continental dunefield: Results of a new mapping project and insights into dune formation

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Despite recent major advances in the modelling of dune initiation, formation and maintenance there remains a large gap in our understanding of how many observed sand dune morphologies come to be. There is some consensus on the primary role of wind regime and sand supply in determining the occurrence of several types of 'free' dunes (transverse, longitudinal, star) but a high degree of uncertainty about the role of other factors, including vegetation, composition and substrate. In addition, recently the conservative behaviour of dune morphology in response to major Quaternary climate changes has become apparent from new chronological studies of sand dunes in Australia. However, recent research in the US southwest has proposed extreme sensitivity of dune formation and morphology to late Quaternary climate changes. Improved mapping of the Australian dunefield (based on satellite imagery) has the potential to shed some light both on the range of dune morphologies (not previously assessed) and their broad environmental associations.

Some major patterns of the distribution of different dune types (Wasson et al, 1988) are confirmed by the new mapping. However the variety of dune morphologies is much greater than is represented in previous maps of the Australian dunefield (or any other). There is a very large diversity of longitudinal dune forms, network dunes and mound dunes. Some explanation of this diversity comes from the continental wind system and some from effects related to topographic setting and some is still obscure.

While recent dating studies have shown the incredible persistence (resilience?) of longitudinal sand dune forms there are also isolated areas in which superimposed dune systems or re-oriented dunes occur. These appear to record areas in which dominant wind patterns have changed substantially at times in the late Quaternary.

Modelling within-reach variability in sediment remobilisation potential: an approach for targeting river rehabilitation efforts

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It is now widely accepted that anthropogenic disturbance to riparian zones, river channels and catchments in Australia, as in many new world countries, has substantially altered channel morphodynamics and increased sediment loads in rivers. The need to rehabilitate these river systems and reduce sediment loads is widely recognised, with substantial resources now being directed by all levels of government towards the implementation of rehabilitation measures. Given the scale of the problem and the level of resources available to undertake rehabilitation works, there is an increasing need to better target on-ground efforts and optimise the benefits of scarce rehabilitation resources in achieving stated environmental and management goals. To date, various tools, such as SedNet, have been developed to help prioritise rehabilitation efforts at the catchment scale, but this is often at a resolution that is too coarse to be translated directly to on-ground rehabilitation works. In this investigation we present a high-resolution reach-scale modelling approach, using the widely available USACE quasi-2D model HEC-GeoRAS, to help identify priority areas for revegetation and in-stream works within a 10km reach of the upper Hunter River in NSW. We believe this is the scale at which most works programs will be designed and implemented by environmental managers. Central to the modelling process is the use of airborne LiDAR data, from which a 1m pixel resolution DEM of the channel is developed, as well as a detailed representation of the in-channel vegetation roughness. We demonstrate an approach for translating the LiDAR vegetation layer into spatially distributed Manning’s roughness layer. Results from this study highlight substantial spatial variability in erosion and deposition potential within the reach, both at the sub-reach and geomorphic unit scales, emphasising the need for highly targeted rehabilitation strategies that account for this variability. A conceptual prioritisation model is presented whereby ‘relative need for rehabilitation’ (incorporating the hydraulic modelling results, knowledge of local geological controls, and ecological considerations), is compared with other work that assesses relative ‘likelihood of rehabilitation success’, in order to help identify priority areas for revegetation and in-stream works.

Quaternary subalpine slope materials stability: a landslide/landslides on the Great Western Tiers, Tasmania

Deborah Hunter

The Great Western Tiers escarpment of the Central Plateau horst dominates the skyline of much of northern Tasmania. Slope deposits of Jurassic dolerite and sedimentary origin mantle underlying Triassic rocks on the upper to mid-slopes. The stepped (tiered) appearance of the escarpment is due to differential erosion of the underlying, horizontally bedded sedimentary rocks. In places, the erosion-resistant Ross sandstone outcrops as cliffs. Elsewhere, the slope mantles appear to have stabilised under forest cover since the early Holocene.

The cause of a debris avalanche landslide on the eastern escarpment of the Central Plateau, northern Tasmania was investigated by field survey, laboratory techniques and research. The study was undertaken because little detailed work had been conducted on landslides outside urban settings in Tasmania. It was found record-breaking rainfalls had triggered the mass movement after prolonged saturation of underlying clays following land use change in the catchment. It was considered that where mantles cover Ross sandstone on the escarpment, their stability is conditional on the maintenance of the local hydrological regime.

Volcanic Geosites, and their use in Geoparks and geotourism, with examples from SE Australia

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Landforms due to volcanism have been constructed during all phase of the earth's history, and subjected through time to erosional processes which have modified the original landforms.

Volcanic features are in large part constructional but sit on earlier landscapes which have often influenced cone-building, ash deposits and lava flows, for example existing valleys may often control lava flows. A system of classification of landforms due to volcanic processes provides a starting point for any discussion of volcanic Geosites and Geomorphosites (Joyce in press), and this needs to be followed by a further classification of the effects of erosional processes through time.

The heritage values of Geosites include their relation to the history of the geological sciences, to human history, and to art and literature. Both sets of values should be used when planning management of volcanic Geosites, and management must also be based on a good understanding of current erosional processes, and in some areas the possibility of future volcanic activity.

The proposed *Kanawinka Global Geopark* is part of the Newer Volcanic Province of SE Australia. Significant geological features and sites have been documented over many years (Joyce 2006), including the internationally significant lava caves. The indigenous heritage of the area includes a complex of Aboriginal fish and eel traps and the remains of stone houses in the stony rise flow landscapes of the Mount Eccles volcano. Historic "bluestone" (basalt) houses, bridges, churches, other town buildings and many striking stonewalls record European post-contact settlement. These cultural features, supported by a detailed geological and geomorphological story, help make the area an ideal candidate for nomination as a Geopark (Joyce 2007).

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Formation of pool-riffle sequences in a sand-bed stream of the upper Hunter

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A series of 12 structures was built along 6 km of the 600 km^2 Widden Brook in the Hunter Valley, NSW to trap sandy bedload as part of a river rehabilitation project implemented under Natural Sequence Farming. Stock-proof fencing of the riparian corridor was also carried out. The combination of in-stream structures and riparian revegetation has successfully sequestered large volumes of sand over the last 6 years, causing a substantial reduction in downstream sand supply.

Channel response to sand sequestration over the first 500 m of river downstream of the last structure has included over 1 m of bed degradation, channel contraction to less than half of the initial channel width, formation of marginal in-channel benches, reformation of a well-defined, rhythmically-spaced pool-riffle sequence and creation of a partially gravel-armoured bed surface. The recently colonised riparian vegetation has increased bank resistance and stabilised sand deposits. Sand storage in the treated reach has starved the river immediately downstream, inducing bed erosion and the size-selective transport of sand and fine gravel. Rarely mobilised coarse gravel has formed a lag deposit which is the armour layer.

A large flood in June 2007 has mobilised much of the stored sand and caused bed lowering, erosion of in-channel benches and channel widening. Large wood buried over the last 200 years by the influx of massive amounts of sand has now been re-exposed, creating log steps which dissipate stream power by forming step pools. Residual pool depths at cease-to-flow now store four times the volume of water that was present before the start of river rehabilitation. The stability of these pool-riffle sequences is examined.

Fluvial grain-size trends in a sedimentary basin:
The Lachlan River, Murray-Darling Basin

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One trend common to river of all types and physiographic settings is a decrease in the average grain size of river bed sediment in a downstream direction. In gravel bed rivers, this trend is commonly attributed to either abrasion or to selective transport, or both, the relative importance of each process in a reach depending its position in the catchment. Recently other studies have suggested that the rate of basin subsidence and the sediment supply rate may also be important controls on the rate of downstream fining. The rivers that drain into the Murray-Darling basin present an unusual situation in that they decrease in size downstream, transporting mostly gravel and sand in their upper alluvial reaches that grades downstream to fine sand and silt. Abrasion rates are typically low in sand and mixed sand-gravel bed rivers, however in streams that decline in magnitude, downstream decline in bed calibre should be enhanced, as downstream decrease in slope is combined with a reduction in depth, producing a much larger decline in shear stresses and increasing the potential for selective transport. This study examines the changing downstream trends in grain-size in the Lachlan River, using grain size data from Pleistocene and Holocene alluvium. The multiple grain size sediment transport model, MIDAS, is used to explore the sensitivity of downstream fining trends to differences in sediment flux and discharge.

Reef-island evolution in the Mamanuca Island group, Fiji.

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The morphology and evolution of small reef islands has been widely researched, however many of the models developed to explain their deposition have considered the island as s separate entity to their surrounding reefs. This means that the sediment linkages between the reef crest and island beach are overlooked. A lack of knowledge on these linkages between the reef crest and islands, means that precise predictions on how these systems will respond to climatic and environmental change are impossible. The Mamanuca Island Group, Fiji, contains many small islands and reefs that have formed in a broad lagoon on the western side of the Viti Levu. These islands occur on patch reefs, which lack a distinct seaward zonation and have no lagoon. They therefore represent an ideal location to investigate reef-island sediment connectivity and its role in the evolution of small islands.

Ten reef islands were surveyed in January 2006, and the biosedimentary zones mapped. 107 surface samples were collected from the island surface and subsurface with 17 radiometric ages being obtained. The islands range in size from 0.04-4.68 ha and adopt four main forms; unvegetated subtidal gravel cays, unvegetated sand cays above MSL, fully vegetated sand cays, and one high basaltic island. Sediment is primarily medium-coarse sand dominated by coral, *Halimeda*, coralline algae and foraminifera. Little zonation is apparent across the reef crests and there appears to be a high degree of linkage between the reef crest and island. This is supported by radiocarbon dating which indicates contemporary transport to the islands, which appear to have only started developing in the last 2000 years. The islands within the group are therefore geomorphically young and still linked with the surrounding reef carbonate factory and are therefore highly susceptible to sea level change.

The original Lake Pedder:
A *post-mortem* geomorphology and *pre-partum* prospects.

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The significance of the original Lake Pedder for its inspirational, scenic, recreational and wilderness values provoked considerable controversy prior to its inundation beneath the artificial Huon-Serpentine reservoir as part of the Middle Gordon hydro-electric development in the early 1970s, and there is an on-going campaign for restoration of the original lake. No geomorphological studies into the original lake Pedder were undertaken prior to its inundation. Recent reconnaissance studies based on the very limited literature of the time, analysis of pre-flooding photographs and maps, and new fieldwork around the margins of the artificial reservoir, confirms that this it is a site of great geomorphological interest and geoconservation significance. Lake Pedder was formed through partial impoundment of the upper Serpentine River by glacigenic sediment. Several phases of glaciation are evident about the present reservoir level but evidence of the key older phases of glaciation most significant in original formation of the lake is presently inaccessible beneath the reservoir surface. In terms of its genesis and character, Lake Pedder appears to be unusual if not unique in the world geomorphological literature. In addition to being a landform in its own right it was also a nested set of component landforms that included beach systems that were more extensively developed than in any other freshwater system in Australia and smaller phenomena such as ferro-manganese concretions of a very unusual kind. Lake Pedder was also part of a wider landform assemblage that included the adjacent mountains, glacial, fluvial and other landforms to which the original lake was genetically related, and which, under the integrity provisions of the World Heritage Convention Operational Guidelines, ought properly be protected as an integrated set rather than their present partial coverage. Investigations into the condition of the original landforms beneath the reservoir surface and the condition of the perimeter of the present reservoir have confirmed that all key landforms remain intact notwithstanding some erosion around parts of the reservoir perimeter, and a federal parliamentary enquiry into restoration of the original lake has concluded that the restoration project is technically feasible. Pressure to pursue this goal continues in a context of increasing environmental awareness and knowledge of what has been lost, the inability from the outset to maintain full supply level in the main Gordon River reservoir despite the input from the Huon-Serpentine impoundment, and growing recognition of the hazards inherent in Tasmania continuing to place most of its electricity-generation eggs in the same drought-prone hydro-electric basket at a time of accelerated climatic drying.

Pre-Last Glacial age for morphologically fresh moraines in the Western Arthur Range, southwest Tasmania.

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Paired $^{10}Be/^{26}Al$ dating of boulders from two moraine complexes that have previously been interpreted as dating from the LGM indicates that both predate the Last Glacial cycle. The dates obtained are older than any previously obtained from southwestern Tasmania but are consistent with the very heavy weathering of the oldest glacial sediments in some other nearby mountains. The topographic position of the dated moraines implies that during the global LGM only very small glaciers could have existed in the Western Arthur Range and that the ELA of these glaciers must have been significantly higher than has previously been suggested. Nevertheless, the ELA was significantly lower in the Western Arthur Range during the LGM than in other ranges further to the north-east, consistent with earlier suggestions that glacial snowlines rose north-eastwards across Tasmania, broadly parallel to the present-day precipitation gradient.

Linear dune and dunefield development: Complexities and implications for palaeoclimates

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Linear dunes are important landscape features because their development is typically slow and relatively stable compared to other dune types. Given this prolonged development, questions relating to their morphodynamics are essentially Quaternary questions as well, and any geomorphic investigation requires detailed chronology of dune development. We use a number of case studies, as well as a detailed chronological analysis of a single dune in the Strzelecki Desert, to investigate the timing and rate of development of linear dunes. Our results suggest that although there may be some variation in the net accretion rates of individual dunes in Australia over time, the rates are essentially linear, and variations from this are not statistically significant. On the other hand, linear dunes from the Kalahari display a wide range of both linear and non-linear accretion rates. It is also interesting to note that in both the Strzelecki and Kalahari deserts, dunes in close proximity, and even the same linear dune can have differing net accretion rates. We suggest this wide range of net accretion rates emphasises the importance of local processes, such as sediment supply, in controlling dune sedimentation and morphology, and that regional scale processes exert less control. Because of their Quaternary development, linear dunes have also been a popular proxy for palaeoclimatic conditions such as wind direction and aridity. A comparison of Australian and African dunefield chronologies with established palaeoclimate records such as CO_2, SST's, and ice core $\delta^{18}O$ reveals little to no relationship over time, and supports our suggestion that local, rather than regional or global processes control linear dune development.

Highly variable floodplain deposition in wet tropical streams throughout the late Holocene: Implications for sediment delivery to the GBR lagoon.

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Current stream management practises in the Wet Tropics World Heritage Area of North Eastern Queensland are focused on reducing sediment loads to the Great Barrier Reef (GBR) Lagoon and assume sediment delivery is constant over space and time. This study examines the long term natural variability of sediment delivery from two representative Wet Tropics river catchments by investigating the evolutionary sequence of valley fills using Optically Stimulated Luminescence dating techniques and detailed sediment analysis.

The Daintree and Mulgrave River catchments in the northern and central sections of the Wet Tropics are defined by late Pleistocene terraces that confine the contemporary floodplains. These terraces were formed by rivers whose capacity was either substantially reduced or sediment supply from slopes was much greater than today. The active Holocene floodplains are dominated by vertically accreting modern sediment sequences (< 400 years). The modernity of these sedimentary sequences suggest that rapid cut and fill processes have dominated where entire sections of floodplain have been stripped and reformed in a matter of centuries. This further suggests that large volumes of sediment can be transported to the GBR lagoon over relatively short time spans. It is likely therefore that the natural variability of sediment delivery to the GBR is much greater than that suggested to have occurred due to human landuse practises over the past 150 years. These results have substantial implications for management of stream catchments in this region.

Identification of palaeo-drought episodes in the catchments of the Snowy Mountains Hydro Scheme and Murray-Darling Basin, Australia

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Periods of prolonged drought are an intrinsic feature of the Australian landscape (McKeon et al., 2004) and have major environmental, societal and economic effects. These droughts may be the result of inter-annual to multi-decadal variability in regional weather patterns that are the result of teleconnections such as the El Niño Southern Oscillation (ENSO) that operates on a 3 to 7 year cycle and/or the Pacific Decadal Oscillation that changes phase every 20-50 years (Power et al., 1999). This natural variability may in turn be superimposed on millennial scale variability in climate. Accordingly, the instrument record which spans approximately 100 years in most locations is often too short to confirm the cyclic nature of droughts and longer term trends in precipitation. This information is required to more accurately predict future climate variability and the possible impacts of global warming so that better informed natural resource management planning occurs.

In this study we develop a dust deposition chronology extracted from alpine peat deposits in the Snowy Mountains, New South Wales to serve as proxy for drought in the catchments of the Snowy Hydro Scheme. This is possible because the occurrence of dust storms in Australia is inherently linked to the degree of aridity (McTainsh et al., 1989). Results show variability in dust deposition through time, indicating that the climate of southeast Australia including the Murray-Darling Basin (MDB) has experienced marked changes in aridity over the last 7000 years. In the past 2500 years the basin experienced a ~1500 year period characterised by pronounced swings in climate including severe droughts, while the MDB has become more arid over the last 300 years. This is recorded as an increased trend in dust deposition preserved in the peat and suggests that the severity of future inter-annual to multi-decadal droughts may increase as part of this longer term trend of increased aridity in southeastern Australia. The effects of this natural increase in drought severity may be made worst by the predicted impacts of climate change due to global warming

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Looking at estuarine processes in terms of attractors

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Recent advances in measurement and the introduction of long-term instrumentation in estuaries has allowed data mining of hydrodynamic data to play an increasingly important role in estuarine studies. While records are not long enough to permit statistical analyses, they do provide better calibration and some different approaches to short-term modeling of estuarine change in response to variations in the forcing. One of these new approaches has been in the identification of "attractors" which help to explain the form and processes operating within estuaries.

Some researchers have asserted that estuarine systems are inherently chaotic and prediction of future states therefore unlikely. However, as Phillips (1999) concedes, this may not be the case over longer time scales. Further, the concept of self-organization is perhaps, best illustrated by the applicability of Roy's evolutionary model (Roy, 1984) to a range of estuaries along the SE coast of Australia; while the detail of the evolutionary path is missing, the gradual system modification towards the end point of the particular estuary type is generally agreed. This can be viewed as a g*lobal attractor*. At smaller spatial and temporal scales it is possible to identify a number of *local attractors* which will produce variations in system adjustment but whose centroid essentially lies along, or near, the path of the global attractor. Abrupt changes in external conditions may push the system towards a new state but the longer-term regime of sediment supply and river flow, tides and waves will essentially "average" the morphological fluctuations over the evolutionary time scale.

This paper reviews the above concepts using available data for Lake Conjola, a medium sized barrier estuary on the NSW south coast. Previous studies, survey data and available methods of data mining developed to take advantage of continuous monitoring of water level in the estuarine channel are reviewed and combined with the results from models of estuarine hydrodynamics. Global and local attractors are identified and evaluated for potential inclusion in hydrodynamically-based evolutionary modeling.

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Cosmogenic Nuclide Dating in the Denison Range, Southwestern Tasmania

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Eight cosmogenic isotope exposure-age dates ranging from 14.2±1.1 to 15.8±1.1 kyrs BP have been obtained from a series of moraines that have previously been interpreted as being of LGM age on morphostratigraphic and weathering evidence. The most extensive of the dated LGM advances extended onto earlier moraines from which dates of 108±6.7 and 116.6±7.4 ka BP were obtained. The weathered condition of boulders on the most distal moraines makes reliable dating difficult, but ages of 193.8±12.8 and 77.9±5.4 ka BP were obtained from two boulders close to the foot of the range. Although an advance at 19-20 kyrs BP that was more extensive than any subsequent ice cover has been widely recorded elsewhere in Tasmania, no evidence of an advance at this time was obtained from the Denison Range despite careful dating of all key moraines. That no evidence was obtained of advances earlier during the Last Glacial cycle is also interesting given that, at nearby Mt Field, weathering evidence, uranium-series dating of speleothems overlying glaciofluvial gravels in karst caves, and exposure-age dating of moraines, have suggested that advances more extensive than any during MIS 2 occurred during MIS 3 or MIS 4, or possibly both.

Alluvial evidence for major flow-regime changes during the Middle and Late Quaternary in eastern central Australia

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As a low gradient arid region spanning the tropics to the temperate zone, the Lake Eyre basin has undergone gentle Neogene crustal warping leading to substantial alluvial deposition, thereby forming repositories of evidence for palaeoclimatic and palaeohydrological changes from the late Tertiary to the Holocene. Auger holes and bank exposures at five locations along the lower 500 km of Cooper Creek, a major contributor to Lake Eyre in the eastern part of the basin, yielded 80 luminescence dates that have established a chronology of multiple episodes of enhanced flow regime from about 750 ka to the Holocene. Mean bankfull discharges on Cooper Creek upstream of the Innamincka Dome at 250-230 ka are estimated to have been 5 to 7 times larger than those of today, however, substantially less reworking has occurred during and after oxygen isotope stage (OIS) 5 than before. Lower Cooper Creek appears to have similarly declined. In the Tirari Desert adjacent to Lake Eyre there is evidence of widespread alluvial activity perhaps during but certainly before the Middle Pleistocene yet the river became laterally restricted in OIS 7 to 5. While the Quaternary has been characterised by a dramatic oscillating wet-dry climate, since oxygen isotope stage OIS 7 or 6 there has been a general decline in the magnitude of the episodes of wetness to which the eastern part of central Australia has periodically returned. During the last full glacial cycle, Cooper Creek's periods of greatest runoff and sand transport were not during the last interglacial maximum of OIS 5e (132-122 ka) but later in OIS 5 when sea levels and global temperatures were substantially below those of 5e or today. Fluvial activity returned in OIS 4 and 3, but not to the extent of mid and late OIS 5; strongly seasonal but still powerful flows transported sand and fed source bordering dunes in OIS 5 and 3. This chronology of fluvial activity in the late Quaternary coincides with that for rivers of southeastern Australia and suggests that the wet phases in eastern central Australia have not been governed as much by the northern monsoon as by conditions in the western Pacific close to the east coast both north and south. Flow confinement within the Innamincka Dome has locally amplified Cooper Creek's energy, and here evidence exists for short but high-magnitude episodes of flow during the Last Glacial Maximum and in the early to middle Holocene, conditions that were capable of forming large palaeochannels but that were not long-lived enough to rework the river's extensive floodplains elsewhere along its length.

Least action principle, equilibrium states, iterative adjustment and the stability of alluvial channels

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The energy based least action principle (LAP) has proven to be very successful for explaining natural phenomena in both classical and modern physics. This presentation briefly reviews its historical development and details how, in three ways, it governs the behaviour and stability of alluvial rivers. First, LAP embodies the special stationary equilibrium state of motion and so its incorporation with the principle of energy conservation explains why so many optimising hypotheses have been proposed in fluvial geomorphology. Second, the variational approach underlying LAP provides a more straightforward and simpler fuzzy-object orientated method for solving river regime problems than do the various complex Newtonian formulations. Third, it is shown that in fluvial systems with surplus energy, the surplus can be expended with slope and/or channel geometry adjustments, with the degree of channel geometry adjustment quantified by the dimensionless numbers F for depth dominated adjustment and H for width/depth dominated adjustment. Different planforms are preferred at different energy levels with H providing a quantitative measure of the flow's efficiency for moving sediment. In rivers with insufficient energy, the interactions of endogenous and exogenous factors are shown to be capable, in certain circumstances, of achieving a stationary equilibrium condition which acts as the attractor state. Importantly this study describes how iterative changes enable systems to achieve stable equilibrium by directing otherwise random system changes in the most probable direction.

The evolution and stability of peat swamp channels, Barrington Tops, Australia

Rachel Nanson

Earthtech

Geomorphology, geochronology and hydrology were used to assess the development of two channeled swamps on the Barrington Tops plateau. Channel stage-data demonstrate regular water exchanges between the contemporary channels and adjacent swamp watertables, indicating a dynamic but stable hydrological relationship between them. Stratigraphic data indicate the incision of Edwards Swamp at ~1200 BP and 800 BP along Edwards Creek and the Barrington River, respectively, and the incision of Polblue Swamp at ~1000 BP. Two swamp units are identified: the upper floodplain, comprised entirely of peat, and the inset floodplain, underlain by interbedded peat and fluvial sediments. Radiocarbon dating indicates rapid vertical growth of the inset floodplain on the Barrington River from ~800 BP to ~530 BP, following incision. Bankfull stage-height is remarkably consistent along the length of each swamp channel, is achieved many times in a year and limits swamp floodplain growth rates and height by controlling swamp water-table height and hence the growth rates of swamp vegetation. These data suggest the likely control of channel dimensions on inset swamp unit height and the co-evolution of the inset alluvial swamp and channel reaches. Furthermore, these results suggest that peatlands can continue to operate as regional carbon and water stores following incision.

Relative Age dating of the Wahianoa moraines, Mt Ruapehu

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Mt Ruapehu is the only location in the North Island to still be glaciated and is one of only a few that has been glaciated at all. This presentation will present findings from my Masters thesis on Relative age dating of the Wahianoa moraines. The main focus of my thesis was to try and determine the approximate age of the Wahianoa moraines using lichenometry and Schmidt hammer. In addition, the paleo-ELA of the moraines was estimated using the frequently used climate reconstruction techniques. The overall outcome of these methods was to try and place the formation of the Wahianoa moraines within the New Zealand glacial timescale and hopefully try to gain a further understanding of the glaciation of Mt Ruapehu.

A revised map of Australia's Physiographic Regions: a hierarchical map unit approach to geoscience mapping

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Following a long tradition of maps of physiography in the United States of America and Europe (e.g. Fenneman 1917, Lobeck 1922), Gentilli and Fairbridge (1951), with help from Lobeck, prepared a "Physiographic Diagram of Australia". This was followed by a landform map (Loffler and Ruxton 1969), and then a map of Physiographic Regions by Jennings and Mabbutt (1977).
Whereas in the United States physiographic regions are used as a basis for both geological mapping and natural resource management, in Australia they have not been used for these or any other purposes. Recently, however, a revised map of the Jennings and Mabbutt Physiographic Regions of Australia has been prepared for the Australian Soil Resources Information System (ASRIS). The revision was carried out by digitising the original map and then overlaying it on the Shuttle Radar Terrain Model (SRTM), which has a resolution of 90 m. The first step was to adjust the original boundaries to more closely reflect the landforms as depicted on the SRTM. This initial revision was then passed to state agencies for revision in light of more detailed information held at the state level. The final revision will be level 2 of the 6-level ASRIS hierarchy.

This paper will introduce the new map of physiographic regions, plus other national data sets including Groundwater Flow Systems, the ASRIS hierarchy, and other matters relating to scale, mapping and land unit characterisation.

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Joe Jennings: Father of modern Australian geomorphology

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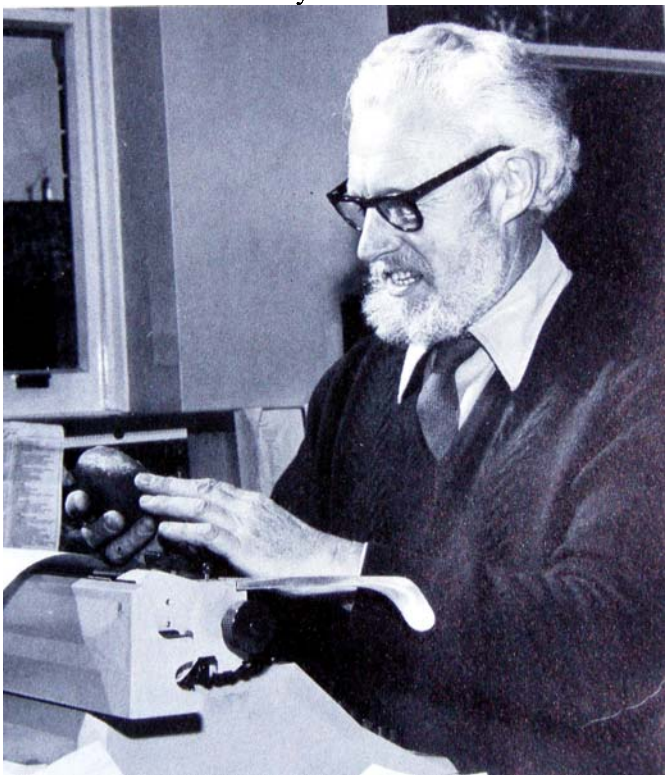
Joseph Newell Jennings (Joe, to everyone who knew him) was the after-dinner speaker at the first ANZGG meeting held at Robertson in 1982 and his remarkable legacy lives on through his many academic descendents that attend the biennial ANZGG meetings. He was appointed to the Geography Department at ANU in 1953, and over the next three decades he had a profound and lasting effect on Australian geomorphology. Although best remembered as a karst geomorphologist, Joe had wide-ranging research interests and boundless enthusiasm for the entire discipline of geomorphology - see obituary and publication list in Spate & Spate (1985). Nowhere is this better evidenced than in the PhD students he supervised (with year of completion in brackets), including Eric Bird (1959), Nel Caine (1966), Ian Douglas (1966), Martin Williams (1969), Jim Bowler (1970), Bud Frank (1972), John Chappell (1973), Colin Pain (1973), Ross Coventry (1973), Chris Whitaker (1976), Joyce Lundberg (1976) and David Gillieson (1982). As a PhD student of John Chappell, and therefore an academic grandson of Joe, I was privileged to know Joe in the late 1970's and early 1980's at ANU. For this presentation I have constructed a "family tree" of Joe's academic descendents.



Joe "in the office" [Frontispiece in Davies & Williams (1978)]

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Long term landscape evolution of the Western Australian Shield

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The antiquity of Australian landscapes has long been postulated. Almost 100 years ago Jutson (1914, p. 92) observed that "the land surface of Western Australia is one of the oldest land surfaces on the globe, and that it has not been below the sea for many geological ages". In doing so, Jutson cited the complete lack of younger marine strata overlying the Precambrian shield, other than in coastal areas, as "strong negative evidence" for his conclusion. Jutson's reasoning was that if the sea had covered a significant proportion of the shield, then it was highly improbable that some remnants of marine strata were not preserved at inland locations. Indeed, Jutson's broad conclusion is entirely consistent with modern paleogeographical reconstructions (e.g. BMR Palaeogeographic Group 1990) indicating that parts of the Australian continent, including the Yilgarn Craton, have been subaerially exposed for hundreds of millions of years.

Recent advances in dating regolith on the Western Australian Shield provide ample evidence of ancient regolith and landforms, some with ages extending back to the late Carboniferous (Pillans 2007). However, their persistence at or near the surface is inconsistent with long-term denudation rate estimates based on cosmogenic nuclides, sediment budgets and apatite fission-track thermochronology (Kohn et al. 2002; Weber et al. 2005). Burial and exhumation are suggested as significant preservation factors, along with prolonged tectonic stability and a shift to a more arid climate in the Cenozoic.

Based on apatite fission-track thermochronology, Weber et al. (2005) derived a model for the denudation history of the northern Yilgarn Craton. The essential elements of their model are surface exposure and weathering during the Late Carboniferous, followed by rapid burial by a ~3 km cover of Permian sediments, and then slow exhumation until re-exposure in the Late Cretaceous. Such a model is consistent with the preservation of Permo-Carboniferous regolith and landforms. The thick Permian cover also explains the lack of Archean-age detrital zircons in Late Paleozoic and younger sediments of the adjacent Perth Basin (Sircombe and Freeman 1999).

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Sedimentation of the Avon River Pools downstream of Toodyay, Western Australia

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The Avon River is one of the most recognised and valued environmental resources in Western Australia. The Avon River features a braided river morphology with 26 major pools as it flows over 260 km through the Wheatbelt Region towards Perth. Today, the river faces issues of sedimentation, salinity, reduced habitat and water quality concerns. The river is saline for much of its course as a consequence of primary and secondary salinity.

Significant clearing of the catchment associated with the introduction of agriculture has occurred since the arrival of Europeans in the 19th century. Catchment clearing accelerated sediment delivery to the river particularly during the early 20th century. The Avon River Training Scheme (1956-1973) was initiated to reduce the risk of urban flooding and salt water inundation of farmland. It involved removing all vegetation from the channel by bulldozing along a 40 m wide channel. This river training mobilised the sediment stored in the channel, some of which was associated with catchment erosion following land clearing.

Managing the movement of sediment throughout the Avon River system is a considerable challenge for the Department of Water which has responsibility for river management in Western Australia. In 1996 an initial survey was commissioned to assess the condition of the Avon River pools. This survey identified that all of the pools had been degraded with a number of the upstream pools completely filled with sediment.

A further survey for the Department was undertaken in 2007 to examine the downstream pools Jimperding, Long, Cobbler, Boongarup and Walyunga. The bathymetry of these pools was surveyed for comparison with the 1996 survey and to establish baseline data for future studies. This paper outlines the key outcomes of this survey including analysis of the pool bathymetry, discussion of the sedimentation processes; and recommendations and management options. The results are discussed in the context that opportunities exist to extract the sediment for commercial use however; a wider management plan is needed to maintain the morphological and ecological integrity of the pools.

This is an Avon Catchment Council project delivered by the Department of Water and funded with investment from the State and Australian Governments through the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality.

Geomorphic and geodynamic implications of Australian neotectonics

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Australia's unique landscapes provide insights into the interactions between mild intraplate tectonism, mantle dynamics, climate change and surface processes. Patterns of topography and geology have much to reveal about the tilting, buckling, and breaking of the continent. By combining field geology with emerging dating techniques (cosmogenic nuclides, optically stimulated luminescence, U-Th), quantitative measures of how neotectonism, climate change and anomalous weather phenomenon have conspired to shape Australia's landscapes emerge. We discuss the outcomes and limitations of these datasets, and raise strategies for future tectonic geomorphology research in Australia.

Assessment of flood variability in eastern Australia.

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Flood variability is a hydrologic characteristic that has been associated with large magnitude changes to river channel morphology in eastern Australia and elsewhere. Flood variability also influences variability in ecologic processes and the pattern of fish species distribution in freshwater environments, as well as the opening regime of many estuaries. Using three measures of flood variability, namely (1) the Flash Flood Magnitude Index, (2) flood quantile ratios and (3) power-law scaling, an inter-basin comparison of flood variability is presented for catchments east of Australia's Great Dividing Range. Uncertainty in each measure is quantified using bootstrap resampling. Due to the use of the annual maximum flood series and the weight placed on low magnitude flood peaks (or even non-floods), the Flash Flood Magnitude Index is argued to be a poorer measure of flood variability than the flood quantile ratio or power-law scaling approaches. Regions of low flood variability east of the Great Dividing Range include far north Queensland, the Tweed to Richmond River basins of northern New South Wales and catchments in east Gippsland in Victoria. Higher flood variability occurs in Queensland south of the Herbert River, in the Hunter River basin along the central New South Wales coast and in the Snowy River basin.

Convergence of the waters: now is the time to plan for a national system of catchment-scale river-reserves

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Now is a good time for earth-scientists to argue for the protection and conservation of Australian geomorphic systems in catchment-scale reserves. Generations of earth-scientists have done a remarkable job of preserving extraordinary geological features and 'type' examples of geological phenomena Many spectacular river systems are preserved in national parks, and World-Heritage areas. These areas tend to be self-selected on the basis that they were poor sites for grazing or cropping, although some have proven to be good sites for uranium mines or hydro-power schemes. Many of the easy sites have been, but we could all identify other systems that are worthy of protection. They have not been protected because their value is idiosyncratically geomorphic, or their value has only emerged with recent scholarship, or they are already used for grazing or other economic uses. Examples could be some of the great estuarine systems of the dry-tropics, the anastomosing systems of the channel country, or the palaeochannels of WA. Personally, we are particularly enthusiastic about the remnant chain-of-ponds systems that are 'endangered landforms'.

As you may have noticed (particularly if you have teenage children), not everybody shares our abstract love of the landscape. The geological freak-show argument does not always succeed with policy makers. This is particularly the case because the systems we want to protect today are not virgin terrain, unsuitable for production, they are contested landscapes full of people, cows and sheep. But we now have two new strings to our bow that will help us to forge an argument for some form of protection: ecosystem services, and economic-hysteresis of restoration. In the last decade, over a billion dollars has been spent on stream restoration in Australia. Despite an uneasy collaboration between biologists and earth-scientists, this endeavour has essentially been justified on ecological grounds. Geomorphology provides a skeleton on which the real meat is hung. Catchments also provide physical services that keep that meat fresh, such as floods, sediment, and nutrients. Anybody involved in the stream restoration conceit quickly learns how hopeless we are at rebuilding many natural systems. We quickly conclude that it is much better to preserve the system (and its functions) than to attempt to fix it.

We present data showing that trying to 'repair' such natural systems typically costs two orders of magnitude more than the cost of degrading the system in the first-place. This is the hysteresis of restoration, and it is often driven by geomorphic energy gradients. The big change that has happened in recent decades is that degrading those services is not longer just a shame, it is becoming an offense. Most of the largest restoration projects in the world (such as the Kissimmee River in the USA) are actually forced on proponents after they degraded stream systems. The implication of this is that preserving our favourite places will not happen just because we value them for out esoteric reasons, but it will happen because we all now know how much it would cost us to try to repair these systems. In short, because people are scared to degrade streams, and because they want them to continue to provide 'services', the arguments for preservation are easier to make. We present examples of recent projects that are successfully protecting reasonably large geomorphic systems. There is an unprecedented opportunity for geomorphologists to pull out the shopping list of landscapes (think catchments) that we can protect. This seems an appropriate task for the ANZGG.

Influence of woody debris on channel hydraulics in the lower Avoca River

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The Avoca River is a distributary stream system located in north east Victoria. While in its upper parts flows remain within a relatively confined valley, in its lower parts the river anastomises with flow conveyed via one or more anabranches across a low-angle alluvial plain. Community concerns over heightened woody debris loadings and the potential for accumulations to exacerbate overbank flows prompted an investigation of the role of woody debris along the lower Avoca River.

Riparian vegetation and woody debris forms a significant component of the Avoca River environment, creating its own set of geomorphic features such as pools, bars, anabranch channels and bank attached-bars. In some reaches woody debris has accumulated to the extent that it now forms as barrier across the channel. While woody debris do have in influence in reducing channel capacity, its overall influence is minor. Construction of flood levees, flow abstractions and historical drainage works are considered to exert a greater influence.

Woody debris loading is not considered to be abnormally high, and it is likely that perceptions of heightened woody debris loadings over the past decade are due to the fact that prior to this there was an active removal program. The number of blockages may have also increased in the past decade due to the recent drought, causing the death of trees and shedding of branches. During lower flows these pieces of woody debris float downstream and get caught at blockages, typically behind larger trees that have fallen across the channel. Due to their current dryness, these accumulations are clearly able to float, and in all likelihood will be redistributed in a flood.

Effect of an extreme storm event on catchment hydrology and sediment transport in the Alligator Rivers Region, Northern Territory

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The highest annual rainfall of 2600 mm was recorded during the 2006/07 wet season at Jabiru airport, which lies within the Alligator Rivers Region, Northern Territory. A total of 1940 mm of rain fell in February and March 2007, with 785 mm recorded over a three day period between 28 February and 2 March 2007 (the largest three-day rainfall recorded in the Top End). Maximum rainfall intensities during this period exceeded a 1:100 y storm event for durations between six and 72-hours. Magela Creek, a major left-bank tributary of East Alligator River, experienced the highest flood levels since recording began in 1971 as a result of this extraordinary rainfall event. Several gauging stations within the catchment were completely submerged by floodwaters. Peak flood height along the main Magela Creek channel exceeded the previous maximum recorded flood height by more than 25%. There was also extremely high flood levels on the East Alligator River resulting in large amounts of sediment movement, scour and fill. As a result of extensive sediment deposition below the lower gorge section of the river, local tour boats have since been unable to access large sections of the river channel.

In the upper part of the Magela Creek catchment some 15 to 20 landslips were also observed to have occurred during this intense storm event. These landslips occurred on well vegetated, exhumed Oenpelli Dolerite surfaces that are surrounded by the Mamadwerre Sandstone (previously known as the Kombolgie sandstone). These landslips could potentially supply sediment to Magela Creek during future wet seasons. The number and extent of the landslips were mapped using remote sensing imagery and object-based classification techniques. These maps were combined with field measurements and erosion models to determine the possible stream sediment contribution of these features to the Magela Creek catchment. This work provides information on the contribution of mass movement processes to erosion/denudation rates of the Alligator Rivers Region landscape presently being measured. This will lead to an improved understanding of catchment sediment sources and how mass movement and sediment remobilisation contribute to stream sediment loads. With the Magela Creek catchment currently being monitored to assess the impact on stream sediment loads by mine-related activities at ERA Ranger mine, this information will provide greater confidence in impact assessment against currently observed background erosion/denudation rates.

Methods to assess bedload transport relevant for benthic invertebrate communities in mountain streams

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Disturbance by the effects of bedload transport is one of the most important factors contributing to the composition of benthic stream invertebrate communities. Scouring and deposition of sediment lead to a change in habitat as well as displacement and mortality of individuals. The response of each species also varies with the distinct aspects of bedload transport. This research will investigate the stability of the river bed using four different methods, accounting for discrete features of bedload transport at a range of scales, and relate this to the diversity of benthic invertebrate communities at 12 mountain stream sites in the Lower North Island of New Zealand. In this paper we present the techniques to assess bed (in)stability.

The first method employs high resolution Digital Elevation Models (DEMs), derived from repeat surveys of the channel using RTK-dGPS. DEM differencing will assess changes in larger scale patterns of scour and fill within study reaches. In order to detect the actual movement of embedded substrate material 5 stones of three size fractions have been marked in situ with electronic RFID-tags. The travelled distance, regularly monitored with a mobile detector, acts as an indicator of bed stability. The third method (Duncan et al. 1999) is based on the Shields and the DuBoys equations but is corrected for the conditions encountered in mountain streams: heterogeneous substrates, small relative depths and high water surface slopes. It calculates the percentage of bed in motion at bankfull stage. Finally the Pfankuch-Index (Pfankuch 1975) gives a visual, subjective evaluation of the channel stability which has been proven to be well correlated with biologic data in other studies.

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A nationally - consistent coastal landform map for Australia

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Global climate change and sea level rise have provided the impetus for the realisation of a detailed and consistently classified coastal geomorphic map of the whole Australian continental coastline. Such a map is needed in the first instance for coastal vulnerability assessment, so as to allow Australia-wide identification of shores more and less sensitive to physical instabilities including erosion and slumping. The Commonwealth Department of Climate Change has funded Geoscience Australia to produce the map within a short time frame, and the project work has been undertaken by a team of spatial science and geomorphic specialists at the University of Tasmania.

The map is based on the extraction, compilation and re-classification of existing geomorphic, geological and physical habitat map data that was previously captured for a wide variety of purposes, in a range of formats, classifications and scales. Building on formats developed for precursor coastal mapping in Tasmania, the data has been captured in a line-map format dubbed a 'Smartline', and reclassified using a descriptive fabric- and form-based classification system. The digital (GIS) line map represents the coast (e.g., HWM), and is tagged with multiple attributes describing the types of landforms present along the coast to both seawards and landwards. The line mapping achieves a high degree of detail in the along-shore direction; being segmented where-ever any significant change in any of the mapped attributes occurs.

Whilst the Smartline format has some limitations in comparison to polygon mapping, it also has distinct advantages of its own including allowing both rapid compilation and efficient analysis of detailed map data for long coasts. In the present project, a range of sensitive (potentially unstable) landform types are being identified and mapped out using queries on the geomorphic attributes of the line map, however the same national dataset is suitable for many other purposes including geomorphic research, oil spill response planning and coastal natural asset inventory compilation.

A review of factors controlling alluvial gully erosion and a proposal for quantifying changes in gully erosion rates in the Mitchell River, northern Queensland

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Recent research (Brooks et al. 2007; Knight et al. 2007) has quantified the aerial extent and distribution of alluvial gullies across numerous rivers draining into the Gulf of Carpentaria, including the Mitchell River. While some preliminary observations of erosion processes and recent rates have been made (Brooks et al. this conference), the exact mechanisms initiating and driving alluvial gully erosion remain obscure and no data exist on changes in erosion rates over the historic past or Quaternary period. The aim of this talk is to provide an overview of potential mechanisms driving and resisting alluvial gully erosion and propose techniques for quantifying past erosion rates.

The driving forces of alluvial gully erosion include the relative relief and slope between the floodplain and local river channel (potential energy) and the inundation hydrology across the floodplain perirheic zone (kinetic energy). The resisting forces include soil texture and cohesion, soil chemistry and dispersion potential, and grass and tree vegetation cover. Base level lowering associated with alluvial fan evolution appears to be the ultimate controller of gully erosion, while it is hypothesised that altered land use (cattle grazing, fire regimes) have accelerated gully erosion through changes in resistance.

Erosion at the gully head is a combined result of direct precipitation, overland flow, and basal sapping of shallow groundwater, resulting in both carving and fluting of the surface face and mass failure of blocks from depth. Mass failure within a soil profile is a result of soil particle dispersion at depth presumed to be associated with high cation exchange capacity and concentrations of sodium. Above this failure plane, soils often contain iron mottles due to seasonal wetting and drying and resistance to leaching. Following headward retreat of the gully face and removal via solution or suspension of the soil matrix material, ferricrete and calcrete pisoliths often form lag deposits on gully floors due to permanent oxidation and precipitation to form duricrusts. The time of the formation of these pisoliths are potentially datable via the uranium decay series. Dating pisoliths distributed across a gully floor, in addition to dating trees surviving or establishing after gully erosion, could provide a detailed chronology of gully position and erosion rates over time. This methodology could then be compared to measured rates of erosion from historic air photos or recent surveys.

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The Delineation of Valley Margins as the basis for a valley confinement index using different resolution DEM data: implications for continental scale river classification approaches.

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The development of a biophysical classification of Australia's tropical rivers is a key part of the "Tropical Rivers and Coastal Knowledge" (TRaCK) program. Valley confinement is a primary determinant of river geomorphology (Brierley & Fryirs 2005, pp134), and hence the delineation of the valley margin and hence confinement is a critical component of a geomorphic river classification procedure. Given the vast area encompassing the Australian tropics and the scale of the landscape, a remote sensing and GIS approach is the only viable approach to landscape classification in this region. Here, we present a method for the delineation of valley margins from digital elevation models (DEMs), from which a valley confinement index can be derived. The approach differs from the existing Multi-resolution Valley Bottom Flatness (MrVBF) approach of Gallant and Dowling (1993) which seems to be of limited use in very low relief landscapes. Given the low relief of the landscape in many northern Australian rivers, one of the major impediments to developing a good geomorphic classification is the lack of existing data on valley confinement or flood inundation extent. Hence a major focus of this project is the development of an approach for extracting valley confinement information from available data.

At present the best resolution DEM across the entire landscape is the 90m SRTM (shuttle radar topography mission) DEM - which is freely available from NASA. However, a 30m DEM from the same data is nominally available over large areas as well. Topographic data that has been collected over many decades is available from Geoscience Australia in a digital format, including stream lines. DEMs are raster datasets and the stream lines are vector datasets. This method is developed around the integrated use of vector and raster data to delineate valley margins. A set of algorithms were developed to determine the approximate position of the valley margins corresponding to a stream line. Further information can be derived following the delineation of valley margins, such as proximity of channel to valley margin and downstream patterns of confinement.

Analyses of DEMs and mapped landscape features are always limited by the resolution of the data being analysed. Here, we present data on valley confinement using a range of different resolution data, and highlight the limits of resolution of the various data sources in a range of landscape settings.

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Development of the Tasmanian River Condition Index: comparing apples with apples

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Most river health or condition assessments focus on single or multiple components of ecosystem function and process. The scale of such assessments has been site or reach specific, with some providing a catchment context. However, very few offer an integrative 'whole of ecosystem' approach that incorporates scientific disciplines across spatial and temporal scales. The Tasmanian River Condition Index adopted an ecosystem approach, which integrates biophysical components within firstly, defined fluvial landscape mosaics and secondly, the Conservation of Freshwater Ecosystem Values database. The mosaics and database provide the spatial context and setting, with the aim of presenting comparable and contextual assessments of river condition state-wide. This paper focuses on the physical form component, one of five sub-indices used to assess condition. Each of the five sub-indices is an independent assessment of condition presented as a numeric score. Each sub-index is built on a separate and impartial method that is appropriate for the scientific discipline. When the five sub-index scores are combined, they provide an overall score for a defined reach or sub-catchment. For the physical form component, a characterisation and reference approach is undertaken, which utilises the existing fluvial landscape mosaics and a previously developed river characterisation framework to allow comparison of assessed sites against established reference sites. The Tasmanian River Condition Index provides a uniform approach to identifying values and threats, setting strategic objectives and determining resource condition targets.

Where did the River go?
Physical interventions in the Latrobe River and their implications for predicting and managing for channel change

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The lower Latrobe River (Victoria, Australia) has been subject to a history of physical interventions that rival that for any other major rural river in Victoria. Since European settlement the lower Latrobe River catchment and its tributaries have been extensively channelised, cleared of floodplain vegetation, diverted, regulated, de-snagged, mined with open cuts and subject to various other anthropogenic changes (Erskine *et al*, 1990). In particular the planform of the river has been severely modified - indeed between 1924 and 1978 the sinuosity of a 5km natural length of the lower Latrobe River decreased from 2.53 to 1.06, a 58% reduction (Erskine *et al*, 1990). However in spite of these interventions the lower Latrobe River, excluding the constructed reaches, has maintained a surprisingly intact form. Most recently the Latrobe River was inadvertently captured by an open cut coal pit.

The Latrobe River flows southeast from the Great Dividing Range to a major online storage at Lake Narracan. The reach below Lake Narracan is referred to as the lower Latrobe River. The lower Latrobe River follows an easterly alignment and discharges to Lake Wellington and the Gippsland Lakes. Major tributaries to the lower Latrobe River include the Morwell, Tyres and Thomson Rivers. A geomorphic investigation of the Latrobe River at its tributaries was undertaken in 1990 (Erskine *et al*, 1990). That investigation compiled an extensive history of the Latrobe River. However, since then the Latrobe River has been subject to considerable further physical interventions including an upstream translocation of the Morwell River confluence to enable mine development and ongoing power station operations. This translocation has resulted in an increase in the flow regime in the reach of the Latrobe River that had the greatest reduction in channel length associated with past meander cut offs.

Early on the morning of Wednesday 14th November 2007 a landslide at the Yallourn open cut coal mine operated by Tru Energy added yet another chapter to the history of the Latrobe River. The entire Latrobe River flow was instantaneously captured during the landslide. Interestingly, the landslide occurred in the same reach impacted by the translocation of the Morwell River confluence and the greatest reduction in channel length. In the days that followed the landside and capture of the Latrobe River a diversion channel was constructed around the site of the landslide and the Latrobe River flows were reconnected to the downstream reach. The Latrobe River will be subject to channel change in response to ongoing channel evolution processes, exacerbated by past meander cutoffs, flow regulation, translocation of the Morwell River confluence and the most recent emergency diversion construction. Predicting and managing for these changes provides a challenge to geomorphologists and waterway managers.

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Links between floods, landslides, soil erosion and rates of floodplain accretion in the sugarcane belt of the Labasa River, Vanua Levu island, northern Fiji.

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The Labasa River basin on Vanua Levu island in northern Fiji is commercially important for sugarcane farming, which provides much revenue and sustains the economy for a large proportion of the local population. The ^{137}Cs (caesium-137) method was used to investigate medium-term rates of sediment deposition on the floodplain of the Labasa River. Alluvium was sampled at three riverbank sites in depth-increments of 3 cm. Measured net vertical accretion rates, based on analysis of profiles of ^{137}Cs activity, average 2.7 cm y^{-1}. Some variation in sedimentation was observed between sampling sites (1.1–6.0 cm y^{-1}, Figure 1), with the greatest rate recorded on top of a natural levée and the lowest rate near a minor tributary junction with the main river channel. Overall, the high rates of floodplain accretion on Vanua Levu are comparable with measurements made in recent decades on other islands across the tropical Pacific.

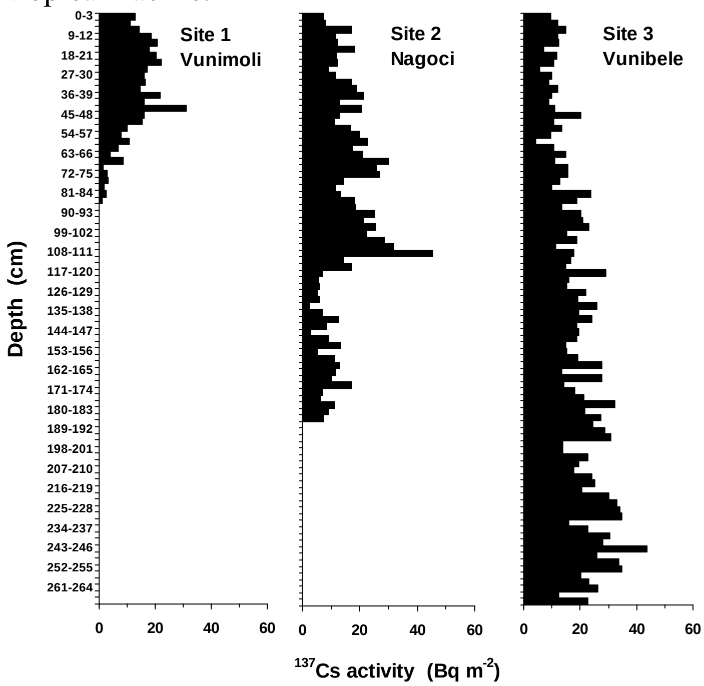

Figure 1. Vertical distribution of ^{137}Cs in floodplain alluvium in the Labasa River.

The Relevance of Coastal Geomorphology in Contemporary Planning and Management

Bruce Thom
Wentworth Group of Concerned Scientists

As much as we would like to think our science is of use to decision makers, I have periodically encountered a number of obstacles. Over the last decade I have been very fortunate in working with a range of government and non-government groups who have asked questions that relate to coastal geomorphology. I have watched with considerable joy and occasional frustration at how many colleagues in Australia and elsewhere have attempted to engage with those who think they need geomorphic expertise. There are often problems of communication. Professionals with different backgrounds have a range of expectations of geomorphologists that may not be easy to resolve. Non-professionals in politics, the development industry or environmental groups will expect us to deliver answers in a language that supports a particular position and when we cannot then they see weakness in our science, not strength. I have great faith in our discipline to be "useful". As we work across a range of temporal and spatial scales with many different and increasingly powerful technologies, our capacity to deliver should increase. The issue is whether we have the patience and skill to work out ways to influence policies, management practices, planning rules, and political and legal argument. This may not suit everyone who is an active researcher, but there must be some of us who try.

Spectral remote-sensing techniques for regolith characterisation and mineral exploration in Queensland, Australia

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Spectral remote sensing techniques provide a powerful source of information that can be integrated with other datasets to understand both regolith materials and underlying bedrock. In several examples in Queensland, bedrock signatures can be delineated in areas previously mapped as areas of extensive cover sediments 'Cz' which means that in addition to being able to make mineral classifications that characterise transported materials, it is also possible to find new windows of basement geology in areas previously mapped as cover. This has great applications for mapping geomorphic processes, understanding mineral dispersion pathways and targeting surface sampling for mineral exploration.

A comprehensive spectral geology study was developed as part of a joint venture to collect and process new hyperspectral data in Queensland, as part of the Queensland Government's "Smart Exploration Program". Advanced Spaceborne Thermal Emission and Reflective Radiometer (ASTER) satellite imagery data were used to complement state-wide Landsat mosaics, all provided by Geoscience Australia, and used as a base layer to guide field sampling for the all-of-Queensland Regolith-Landform map (Craig 2008, this volume). The multi-organisation research team included Geoscience Australia, the Geological Survey of Queensland, the Predictive Mineral Discovery CRC, CSIRO, James Cook University and CRC LEME.

Regolith-landform mapping has two main components, the regolith unit, which is a description of the terrestrial material; such as a "red-brown cracking clay" and the landform unit; such as a "depositional plain". These two descriptive components are brought together in an interpretive whole, the "regolith-landform unit" to describe the landscape and its materials. Significant regolith information can be gained through interpreting the spectral response of the land surface from remote imagery, particularly in the short-wave infra-red, where a great deal of mineralogical information is available. Materials which can be mapped include clays; and iron/aluminium oxyhydroxides, with specific information being obtainable from higher resolution methods such as HyMap, on mineral composition, abundance and physicochemistries (disorder and chemistry), allowing differentiation between weathering products such as kaolinite, illite and smectite; and hematite, goethite and gibbsite.

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The role of fire in landscape development, southeastern Australia

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Wildfires are a common disturbance in the eucalypt forests of southeastern Australia, with substantially increased runoff and erosion in the post-fire recovery period often thought to be a predictable geomorphic response. Here we test this notion using data from the Nattai catchment, south-west of Sydney, following wildfires in 2001-02 and earlier.

Despite causing significant destruction of vegetation and giving the perception of extreme erosion, wildfires alone appear to account for only a small proportion of landscape denudation (< 5 % or < 0.54 mm kyr^{-1}). Instead, erosion after fires is highly dependent on the timing, magnitude and characteristics of rainfall events in the short post-fire recovery window. These are difficult to predict due to variability in weather patterns affecting southeastern Australia, which are independent of the timing of wildfires and other broad-scale climate drivers such as the El Niño-Southern Oscillation. Geomorphically effective rainfall events, which trigger significant rainsplash and slopewash of material from hillslopes into the stream network, are typified by heavy, sustained falls with return intervals of one year or longer. These events do not always occur in the post-fire recovery period, especially in the initial months after fire when surface erodibility is greatest. Wildfires appear to play an important role in facilitating transport of low density material (i.e. ash and charcoal) and fine sediment from hillslopes during minor rainfall-runoff events. Transport of the coarser, sandy sediment after fires is less likely unless coupled with heavy rainfall, but the likelihood of this occurring decreases with time after fire and vegetation recovery.

A landslide origin for the Waiho Loop Moraine at Franz Josef, South Westland, New Zealand; geomorphorphic and climatic implications.

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The Waiho Loop moraine in South Island, New Zealand has been widely interpreted to reflect a climatic deterioration during the end of the last ice age. It has been used as *prima facie* evidence for the inter-hemispheric synchronicity of climate change and has been inferred to imply a major late glacial cooling in New Zealand and the wider Southern Hemisphere. Recent work by Tim Barrows has challenged the timing assumption and attributed a Holocene age to the feature. Here we present proof that the Waiho Loop is not caused by a climatic event at all but instead represents the product of a major landslide onto the Franz Josef glacier. All other moraines in the lower Waiho Valley are predominantly composed of locally derived high grade schist and are made up of rounded materials. The other moraines comprise fan head systems with small dump features capping outwash whereas the Loop is an arucate terminal ridge. The Waiho Loop is dominantly composed of slightly metamorphosed sandstones sourced from a restricted part of the glacier catchment at least 13 km upstream of the Loop and these more angular materials were carried to Waiho Loop supra-glacially. In addition, the Waiho Loop readvance is not recognised in the adjacent Fox glacier system. The Alpine fault trace crosses the valley and we conclude that the moraine is the by-product of a large landslide most likely of co-seismic origin. The elimination of the Waiho Loop as a climatic feature removes key evidence for a late glacial cooling in New Zealand and by inference the Southern Hemisphere mid-latitudes.

Karstic Morphology in quartzose rocks:: Santana River basin at middle Paraíba do Sul river valley, Minas Gerais state, Brazil.

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This paper focuses the landscape morphology in area of the tectonic compartment of the Andrelândia Group (Minas Gerais state) which is inserted in the Ribeira Mobile belt, south of the São Francisco craton, comprinsing tectonic compartments trending NE-SW: the major regional structure (the mega-synform of Paraiba do Sul) is related to the compressive/ductile event of the Brazilian Orogeny and includes metasedimentary rocks of Pre-Cambrian age. Current geological-geomorphological studies have been carried in the lower tectonic compartment of Andrelândia Group (metasedimentary sequence: quartizites, philites, schists and gneisses).

The study area is limited by the Santana river basin (245 km^2) which drains southwesterly to Preto river, the main tributary of the regional Paraíba do Sul river. The biotite-quartz-feldspat-granada rich gneiss rocks show well marked metamorphic foliation and grain size between 2-5mm. Two litotipes of quartzite are found: a pure quatzite with 95% of homogeneus coarse quartz grains (3-8 mm) with angular surface and poorly defined foliation is overlaying the gneiss rock; it changes gradually to a heterogeneous quartzite with fine grains (1-3mm) of quartz and feldspars associated to muscovite with turmaline traces and it shows well defined foliation. Extensive recumbent folding with sub-horizontal dipping and foliation together with subvertical joints favor water infiltration and hence exfiltration in the mid-lower hillslopes. Water percolation seems to favor quartz, feldspar and muscovite dissolution nearby the contact between the finer/heterogeneous and the coarse/homogeneous quartzite providing conditions for bloc collapsing and cave development.

Variable karst forms were observed within an area of 42 km^2 in the mid-Santana river valley including: 44 caves, 91 dolines, 02 sinkholes, 02 towers (*mogotes*), and many others karstic features with cannyons and karrens (*lapiés*). Most dolines are located in the hilltops seem to be closed related with the origing of hanging topographic hollows (unchanneled or channeled valleys): dolines show sediment fills of variable thickness with organic layers; similar statigraphy is found in the hanging hollows.

More than rolling stones: Geomorphic response models for environmental flow assessments in southeast Australian rivers.

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This paper reviews the geomorphic objectives and response models used in environmental flow assessments in Australia. In particular we focus on the geomorphic response models, which relate physical characteristics of the channel and sediments to components of the flow regime. Classical literature in geomorphology tends to focus on large-scale channel change, and often does not provide the specificity in geomorphic response required by environmental flow assessments.

The geomorphic response models adopted by practitioners for environmental flow assessments vary widely. Much of this variability can be attributed to different geographic contexts and geomorphic processes. However this variability can also be attributed to the experience of the practitioners and the availability of suitable response models. Many of the response models are not suited to the approach adopted for environmental flow assessments. Similarly many of the environmental flow assessment methods do not suit systems subject to ongoing geomorphic development and change.

We review the geomorphic response models commonly used in environmental flow assessments in Victoria and identify the importance of targeted geomorphic objective setting and the use of suitable models. We also discuss the role of geomorphology in environmental flow assessments, for clarifying the context of current channel morphology within short to medium-term channel evolution.

Landscape instability around the Last Glacial Maximum – geomorphic effects in southeastern Australia

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During the LGM southeastern Australia experienced a cooler, drier climate. The most extreme conditions occurred over a short-lived period (~3 ka) around 23 ka, preceding the minimum in Southern Ocean sea surface temperatures and maximum in global ice volume at 17-20 ka, but coinciding with the minimum in high latitude summer insolation and the maximum in dust flux. At this time reduced vegetation cover due to the colder and drier conditions, coupled with brief but intense storms that generated high-energy flood events, caused landscape instability, and previous research (Gardner et al. 2006) has recorded increased eolian and alluvial fan activity of this age along the southeastern Australian coast.

However, the geomorphic effects of this phase of instability appear to be much more widespread than previously realised. First order valleys throughout the Southeastern Highlands are characterised by angled cross-section profiles, due to several meters of sediment infill of the valley floors; this infill is now being incised. The incision has often been attributed to the effect of post-settlement clearing, but both fill and incision are present in highland areas that have never been cleared. Preliminary radiocarbon dating of charcoal from the incised sediment gave an age of ~20ka, suggesting that the sediment fill was deposited during the very dry, cold period around 23 ka, when the soil on the hillsides was mobilised due to reduced vegetation cover and intense storm activity.

Furthermore, examination of radiometric images of the Southeastern Highlands shows the presence of extensive alluvial fans, identified by the distinctive radiometric signature of their surface soils. The size of these fans is much greater than would be expected from the present climatic conditions. Although the fans are at present undated, their lack of dissection indicates that they are very young, and they could be plausibly attributed to the landscape instability at ~23 ka.

Interestingly, pollen records from southeastern Australia do not record extreme conditions around 23 ka, perhaps because they were so short-lived.

If the valley fills and alluvial fans of the Southeastern Highlands did in fact all form around 23 ka, they record a brief period of cold and aridity that removed much of the vegetation cover from the landscape and left a widespread geomorphic imprint across southeastern Australia.

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Predicting Wind Erosion Hazard in Western Queensland, Australia

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Developing our understanding of the extent of areas susceptible to wind erosion is critical for the effective management of wind erosion in agricultural lands, and in developing our understanding of the mechanisms driving spatial and temporal variability in mineral dust emissions. Despite this, research that explicitly addresses wind erosion hazard mapping is scarce. This is surprising given both the significance of mineral aerosols in climate forcing and the focus of aeolian research into methods to control wind erosion in marginal farming lands. Previously employed survey methods tend to provide snapshots of erosion hazard which reflect the climate-state at the time of survey (i.e. drought), and may not account for spatial and temporal variability in erosion controls. The development of models forces us to critically assess our understanding of the factors driving spatio-temporal variability in wind erosion, while providing a tool for learning more about how this dynamic process operates throughout desert landscapes.

We present AUSLEM (Australian Land Erodibility Model), a spatially explicit model for predicting land susceptibility to wind erosion in Australia. The model uses inputs of soil and vegetation conditions and runs at a 5x5 km spatial resolution on a daily time-step. The system was implemented to predict land erodibility in western Queensland from 1980 to 2006. Results show that land erodibility is both spatially and temporally dynamic throughout western Queensland, with patterns of change reflecting the response of the landscape to variations in rainfall and management. The model was validated by comparing trajectories of mean annual model output with trends in wind speed and dust event frequencies recorded at meteorological stations. Agreement between model output trajectories and trends in dust event frequencies was found to be highly dependent on dust event types recorded at stations and their representativeness of local wind erosion activity. Good agreement was found at half of the validation sites. The model was found to perform well at scales > 100x100 km, but the absence of a scheme to account for the temporal evolution of soil surface conditions (i.e. crusting) was found to significantly affect performance at smaller spatial scales.

Karst landscape development in a coastal environment during the Pleistocene, Naracoorte S.A

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Naracoorte is an area of atypical intensive karst in the Gambier Karst Province of the Lower Southeast of South Australia and a substantial part of southwestern Victoria. These intensive karst areas are characterised by dolines, uvalas, blind valleys and underground cave development ranging from simple single passages to complex mazes. The caves contain dated speleothems and a range of fossiliferous clastic sediments that accumulated through pitfall entrances during the Middle Pleistocene. The overall landscape history of the Naracoorte area during the Pliocene/ Pleistocene shows that speleogenesis was controlled by oscillating sealevel, coastal deposition and tectonic movements on the Kanawinka Fault. The development of the Naracoorte karst is constrained by the age of the enclosing Gambier Limestone (Oligo-Miocene), and post-dates the maximum sea-level transgression at ~7 Ma. The following Pliocene-Pleistocene regression deposited a series of subparallel calcareous beach dune ridges, progressively younging seaward. The East Naracoorte Range is older than 720 ka and was probably deposited between 900 ka and 1.1 Ma (Banerjee et al., 2003; Huntley and Prescott, 2001). The composite West Naracoorte Range has proved difficult to date reliably (Banerjee et al., 2003), but is probably between 780 and 880 ka (Huntley and Prescott, 2001, Banerjee et al., 2003). Cave formation probably occurred in a relatively narrow window of time between uplift along the Kanawinka Fault in the late Pliocene, and draining of the caves as a result of the lowering of the water table as the sea level fell at ~800-900 ka during deposition of the West Naracoorte Range. The main period of cave development probably began during deposition of the East Naracoorte Range at ~1.1 Ma, as prior to this the cave area was flooded by the sea, and no cave formation could occur. Sea levels can be estimated from the position of the coastal strand-line dunes. The caves may have initially formed along the freshwater/seawater interface extending inland from the East Naracoorte Range, and were subsequently enlarged by groundwater flow as sealevel fell between 1.1 Ma and 800ka. Because the water table was not stable for any substantial period of time, only two preferential development of passages developed at ~70 m and ~61 m above present sea level. The upper cave level (~70 m ASL) developed first, possibly at ~1 Ma. The lower level (at ~61 m ASL) developed later as water tables dropped when sea levels lowered. The four superimposed dunes of the West Naracoorte Range show that sea level dropped in the Naracoorte area between 880 ka and 780 ka but did not retreat to the southwest until some time later. Naracoorte cave passages were partially, then completely drained as the water table fell; the solutional notching on the cave walls reflects this progressive fall in water level. Most collapse probably occurred progressively as water drained from the passages. These caves have probably not been completely flooded since they were finally drained, because sea level has not risen again to the base of the West Naracoorte Range during the Pleistocene and the ground water is therefore too far below the caves. Localised flooding of passages from surface runoff has occurred since the final draining of the passages. The cyclical wet and dry conditions over the last 500 ka (Ayliffe et al., 1998) caused some cave modification, including the development of solution pipes and the deposition of clastic sediments. From the latest mid Pleistocene until the Last Glacial Maximum (LGM) the glacial maxima were periods of relative aridity, when aeolian sediment mobilisation and deposition occurred and cave clastic sediments were deposited. The wetter periods were times of speleothem deposition, localised minor flooding and solution pipe development. Minor modification of the caves, such as collapse, speleothem deposition and sediment reworking by surface water sinking underground, continues to the present day.

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Some problems raised by the Late Pleistocene valley-fills in the semi-arid Flinders Ranges, South Australia

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The Flinders Ranges are located in the geographical centre of South Australia and come under the influence of both tropical summer rainfall and temperate winter rainfall. Mean annual precipitation reflects altitude, aspect and latitude, ranging from less than 200 mm in the east and far north to over 400 mm on the higher ridges. Winter rains (June-August) tend to be prolonged and gentle rains from westerly air masses, while summer rains (December-February) are often brief but intense convectional downpours or more enduring rain from tropical northerly air masses. Annual evaporation exceeds 2,000 mm, well in excess of total rainfall. Apart from a few perennial streams fed from groundwater springs, there are no permanent ponds or wetlands within the ranges. The Ranges consist of quartzites, limestones and shales that were originally deposited as marine and fluvial sands and clays during the Neo-Proterozoic and Cambrian. These sediments were metamorphosed, folded and faulted during the Pan-African event ~550 Ma ago. Episodic Cainozoic uplift and weathering resulted in the present rugged relief. Present erosion rates determined from cosmogenic isotopes amount to 10-20 m/Ma and Late Pleistocene faults and earthquake-induced landslides have been mapped and dated along the western margin of the ranges. There are scattered remnants of Mesozoic and Cainozoic deposits flanking the ranges but within the massif proper the most widespread Cainozoic deposits are the fine-grained Late Pleistocene valley-fills which accumulated from ~ 35 ka until ~ 15 ka (Williams et al., 2001, 2006; Williams and Nitschke, 2005). Such valley-fills are not accumulating today. They consist of six major depositional facies, with silty clay as the dominant lithology. Any coherent interpretation of the valley-fills needs to explain each of the facies. The clays contain the shells of ostracods (very small crustaceans) and aquatic mollusca, including some species and genera that are new to science. They also contain tufa deposits (soft limestone precipitated in former springs) and hard nodules of calcium carbonate precipitated within the profiles of former soils. The clays themselves contain variable proportions of organic carbon.

Among the problems raised by these deposits are the respective former roles of winter and summer rainfall, the influence of lower glacial temperatures and evaporation, the contributions from loess, the effect of past variations in atmospheric carbon dioxide on plant cover, the abrupt nature of post-depositional incision, evidence for episodic LGM flooding, the entrapment and reworking of loess slope mantles, and the influence of higher regional ground-water levels.

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Linking the geomorphology, vegetation and soils on the Murray River floodplain for salinity management

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The Murray River floodplain supports a number of competing land uses, including significant areas of national parks and state forests alongside both irrigated and dryland agriculture, horticulture and croplands. As part of a multi-disciplinary study, associations between geomorphology, soils, regolith and vegetation were integrated to answer land management questions related to salt mobilisation, irrigation practices and the overall influence of salt on floodplain health.

The Murray River floodplain downstream of Wakool Junction consists of three discrete floodplain meander belts (Fm1, Fm2 and Fm3 units) and an alluvial terrace inset into the Murray River Gorge. The modern floodplain (Fm1) is characterised by neutral to slightly acidic sandy soils of low salinity. Open forests of River Red Gums (*Eucalyptus camadulensis*) with minimal understorey dominate this unit. The older floodplain units (Fm2 and Fm3) generally support low open woodlands of salt-tolerant Black Box (*E. largiflorens*), with occasional River Red Gums occurring in drainage depressions. Isolated trees of Mallee eucalypts (*Eucalyptus* spp.) and Black Box with a Saltbush (*Atriplex* spp.) shrubland are typically found on the Fm3 unit while the vegetation on the terrace unit is predominantly Saltbush (*Atriplex* sp.) shrubland.

The Fm2, Fm3 and terrace units are characterised by heavy-textured soils which increase in pH with increasing distance from the main river channel. These clay soils are sodic, which seal on wetting and are higher in salinity than those found on the Fm1 unit, suggesting that limited flushing of salts occurs. Fining of sediments also occurs with increasing distance from the main channel, which limits recharge on the older floodplain units. The terraces are capped by relict sand dunes, resulting in higher rates of localised recharge, forming perched watertables above the floodplain clays. Due to river regulation, a large number of channels are now abandoned and lined by cracking clays which also seal on wetting, and are therefore unlikely to be areas of high recharge. Active channels and those which receive environmental water allocations sustain communities of River Red Gums, or Black Box along the smaller and drier channels.

The area outside of the Murray River Gorge, classified as the uplands unit, is characterised by well-drained loamy sands and sandy loams, with moderate amounts of carbonate in the intermediate dunes. This unit has largely been cleared for agriculture or horticulture, with significant areas subject to irrigation and are therefore potentially areas of high localised recharge. The integration of the geomorphology, vegetation and soils on the Murray River floodplain has been a key component in the estimation of recharge rates for salinity and land management.

Geomorphology of atolls and their vulnerability to climate change

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Many aspects of both natural and socio-economic systems on the coast are threatened by climate change, as emphasised in the IPCC Fourth Assessment. However, there is a widening perception that sea-level rise threatens low-lying reef islands, and that those on the rim of atolls are especially vulnerable. Geomorphological studies of atolls indicate that they have evolved as a consequence of past changes of climate and sea level and this paper examines their morphology and natural resilience in the context of these past changes.

Surveyed cross-sections across reef islands from both Indian and Pacific Ocean atolls are reviewed and island morphology and sedimentology described together with evidence for the manner in which these islands have accreted. The sea-level history of such islands, and the extent to which they may have experienced former episodes of sea-level rise remains contentious. However, the geological evolution of reef islands has resulted in a legacy by which landforms of differing resistance have been formed, such that individual islands differ in their vulnerability to future erosion and inundation (Woodroffe, 2007).

Geomorphological studies reinforce the concept that islands may be resilient in the face of individual events, but there is a need to develop new tools to assess vulnerability to ensure that atoll communities are well prepared to adapt to the impacts that climate change will have on their islands.

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Late Cenozoic deformation of the Australian continent: evidence from the Eucla Basin.

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The discovery of the Jacinth, Ambrosia and Tripitaka heavy mineral sands deposits by Iluka Resources in South Australia established the Eucla Basin as a highly prospective heavy minerals sands province. The Eucla Basin, which is located on Australia's southern margin (Figure 1), was inundated by a number of marine transgressions during the Cenozoic. Successful exploration of the basin margin in South Australia required careful reconstruction of the palaeogeography and palaeo-sedimentology of prospective Cenozoic coastlines. Extension of these reconstructions along the basin margin into Western Australia has been hampered by significant late Cenozoic deformation. In this presentation evidence for late Cenozoic deformation of the basin is reviewed against explanatory models for late Cenozoic deformation of the Australia continent as whole.

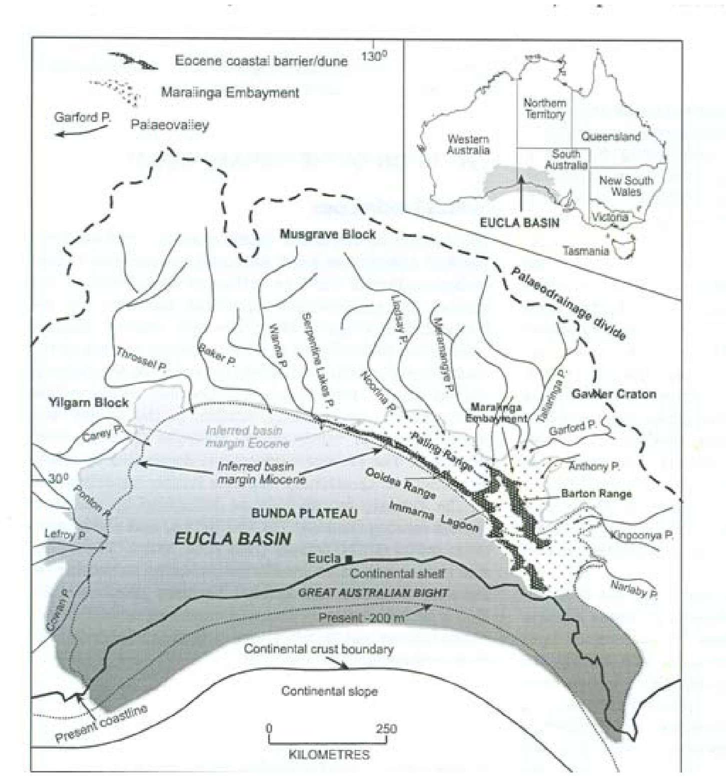

Figure1. Location of the Eucla Basin. After Hou *et al* 2003.

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Landscape evolution on a passive margin: Rates of valley incision and plateau lowering in the Sydney Basin using cosmogenic ^{10}Be.

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Recent studies in the Sydney Basin have indicated that short term (~100 a) catchment average erosion rates are up to an order of magnitude less than those determined on longer timescales (>10 ka). In geomorphic terms, this means that historical observations of landscape-modifying processes may not necessarily be relevant when scaled up over longer timescales, and thus theories of landscape evolution based on observations of modern day processes may not apply.

To counter this problem we investigated the rates of sediment production in various portions of the landscape in the Sydney Basin on longer timescales using cosmogenic ^{10}Be. Our primary approach for this technique is to investigate how catchment average erosion rates vary along a single drainage line within the Nattai River catchment. Catchments with areas ranging from 1.5 and 600 km^2 were sampled. These span a range of landscape elements from the upland plateaux, past the major escarpments to the major valley floors. This allowed us to observe if any major changes occur in the rate of sediment production along the length of the drainage system, and thus the various importance of these landscape elements in the overall rate of denudation in the catchment. In addition, the distribution of bedrock with unique grainsizes in this catchment has allowed us to selectively measure sediment derived from below the major escarpments, and more accurately determine the rate of valley incision in this region.

This information is used to develop models of landscape evolution in the Sydney Basin, and discuss the wider implications for landscape evolution on uplifted passive margins. The implications of the long-term erosion record on the management of these catchments are also discussed, particularly those catchments that contain infrastructure which could be affected by low frequency-high magnitude erosion events (e.g. large floods or landslides) such as major reservoirs like Lake Burragorang, which constitutes ~80% of the water supply for the greater Sydney region.

The Avon River: A road to recovery?
Historic channel incision, present day flood response and future management

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The year 2007 has presented a series of challenges for the West Gippsland Catchment Management Authority in Victoria, Australia. After a decade of drought, and an interminable wait for decent rain, the region was hit by widespread bush fires during summer… And when rain finally came in June 2007, it resulted in a major flood event for the Latrobe, Thomson, Macalister and Avon Rivers.

The Avon River flows south from the Great Dividing Range to Lake Wellington and the Gippsland Lakes. Much of the river has undergone historic channel incision, a common phenomenon in waterways across Victoria following European settlement. This incision process has been associated with considerable channel widening, bed degradation, lateral migration, cutoffs, and ongoing instabilities since the 1940s (Erskine *et al*, 1990; Brizga and Finlayson, 2000). In the 1930s – 1980s, physical interventions were undertaken to manage the impacts associated with the incision. These interventions included concrete methods of bank protection and groynes. Sand extraction was also undertaken from 1940 through to the late 1990s.

By the late 1980s it was recognised that the Avon River channel had enlarged to the point where in-channel stream powers had reduced and the potential existed for intervention to encourage channel recovery. Subsequent management works through the early 1990s concentrated on increasing channel roughness (though vegetation establishment) and encouraging thalweg sinuosity. These works included permeable alignment training, silt fences, and grade control structures, coupled with substantial re-vegetation efforts.

We conducted a geomorphic assessment of the Avon system before and after the June 2007 flooding. The majority of reaches were observed to be in Phase IV or V of the incision cycle, and predominantly in a phase of geomorphic recovery (Zavadil and Hardie, 2007). The dominant physical response to the flooding was sediment deposition, with only localised cases of channel widening and erosion. The majority of in-channel vegetation colonising the gravels survived the flood flows, stabilising the bed and encouraging deposition. The future robustness of the system will require a phasing out of 4WD access to the channel bed, and continued investment into native vegetation establishment to encourage sediment deposition, development of the inset floodplain, and long term stability of the system.

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POSTER ABSTRACTS
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Potential Effects of Climate Change on the Alluvial Fans South of Kekerengu, South Island, New Zealand

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Alluvial fans are a common landscape form in New Zealand's South Island. On the coast south of Kekerengu there are good examples of alluvial fans. The stability of these fans is important as main a road and railway line between Picton and Christchurch passes these fans closely. If the fans are active or are dormant and become active then they could present a hazard to the highway and railway line and people who use them. Climate is a controlling factor on fan stability. Climate changes are predicted in the future for New Zealand. This could bring a drier weather with heavier rainfalls to the east coast of the South Island. This type of climate change could affect the stability of the fans and become a potential hazard to the state highway and railway line. The aim of this study is to morphologically map the alluvial fans on the coast at Kekerengu, South Island, New Zealand, and assess whether they are currently active, relict or dormant. It will then determine the likely effects of climate change on these fans.

Active fans show currently generating processes and are still forming. They have sparse or absent vegetation. Relict fans are considered to have definitively stopped forming and their formation is considered to relate to a prior climatic or geomorphic regime. They have not changed their form for a large amount of time. Their scarps are smooth and the slopes are completely revegetated. Dormant fans are at a stage in-between active and relict. They are currently inactive but show evidence of past activity and have the potential to recover again and become active. Dormant fans are also partly revegetated with younger vegetation than the surrounding areas. Loose sediment can be transported more easily in heavy rainfalls and dormant fans may be reactivated. Fans already active may have higher sediment loads and therefore extend quicker. There is also potential for new fans to start forming over old fans. Climatic changes may enhance these changes. Aerial photographs enable morphological maps to be produced and allow changes and the stability of the fans within the twentieth century to be noted. Field work also provides an indication of this. Vegetation age assessments determine the stability of the fans by showing how long vegetation has been on the fan. In the catchment a survey shows how much loose sediment is being stored and is available to potentially move onto the fans.

Tropical floodplain hydrology and erosion processes: critical knowledge gaps and potential constraints on development in Northern Australia.

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The current severe drought in southern Australia, and the increasing appreciation that this pattern may become the norm due to global climate change, has resulted in a chorus of proposals to significantly increase land and water resource development in northern Australia. Arable land is almost entirely concentrated within floodplains in the seasonally wet tropics, yet this part of the landscape is subject to regular inundation across vast areas as well as gully, or badland, erosion on a scale that is unimaginable in southern Australia. These two factors alone potentially represent fundamental constraints on development in this region. Initial investigations (Brooks et al.,2007 and Knight et al., 2007) indicate that gullies on floodplains are currently acting as the major sediment sources to some tropical rivers, and there are fundamental questions regarding the extent to which further development pressure will accelerate erosion from these areas. Our capacity to accurately predict the extent of floodplain inundation, and hence the processes driving floodplain materials budgets is severely constrained; partially by a lack of high resolution 3D floodplain terrain models, but more importantly, by our poor understanding of the hydrological mechanisms responsible for floodplain inundation and materials transfer. Traditional hydrologic and hydraulic floodplain inundation models that assume a dry floodplain as a starting point, where overbank flooding is largely derived from the main channel, are likely to significantly underestimate floodplain inundation in the tropics. In large floodplain systems, such as the Mitchell River (FP area ~23000km^2), discharge generated from the floodplain itself can represent a substantial proportion of total overbank discharge, much of it never making its way into the primary channel network. This situation is exacerbated when the major discharge forming events are associated with cyclonic depressions that propagate inland from the basin outlet, thereby saturating the floodplain before discharge is even generated within the upper catchment.

In this poster a conceptual model posed by Mertes (1997, 2000) provides a basis to explain hydrologic processese in large floodplain systems in northern Australia. Remote sensing and ground survey data are used to highlight aspects of the complex hydrology and sediment budget processes within the Mitchell River in the Gulf of Carpentaria. It is apparent that local sources of inundation are likely to be critical components of the floodplain water budget in northern Australia. These data highlight the major challenges for the development of intensive agriculture on tropical floodplains.

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Aeolian and fluvial interactions and the development of linear and source-bordering dunes in the Strzelecki desert, Australia

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The lower Cooper Creek exits the Innamincka dome into the Strzelecki desert to form a low-gradient fan characterised by a suite of alluvial landforms that have evolved through a long history of fluvial and aeolian interaction. Linear dunes with a north-south trend are dissected by the path of the lower Cooper Creek as it meanders towards its final destination at Lake Eyre. Many of the these linear dunes are often sourced out of indurated east-west trending but denuded sand bodies that are interpreted to represent source-bordering dunes. Here we present the basic chrono-stratigraphic relationships between the fluvial and aeolian units. We demonstrate through an extensive thermoluminescence (TL) and optically-stimulated luminescence (OSL) chronology that the basal core of these linear dunes are up to OIS 7 in age but typically fall within OIS 5e or OIS 4. These basal sands are interpreted to have been sourced from adjacent fluvial sand bodies that are buried by the contemporary muddy floodplain. These fluvial sand units also date from OIS 6, 5e and 5b, OIS 4 and the LGM and represent distinctly different hydrological conditions than at present. Unlike the mud-dominated floodplain of today these sand units represent more competent rivers transporting abundant bedload. We suggest that source-bordering sands were blown northward out of the river channels in the initial phase of linear dune development. Vertical accretion of the source-bordering dunes continued throughout OIS 3 with the onset of linear dune extension occurring from the LGM onwards being sourced from an LGM channel. The current configuration of linear dunes on the Cooper fan represents minor linear extension (< 15 km) since ~ 16 ka. This demonstrates that the Strzelecki desert is characterised by both relict and contemporary aeolian landforms. Furthermore, it indicates that long distance transport of sand has played only a minor role in the formation of linear dunes on the Cooper fan. We suggest that a wind-rift extension model is the dominant mode of dune formation in this section of the Strzelecki desert with the bulk of sediment sourced from adjacent swales and the upwind source-bordering dunes.

Sedimentary and palaeoecological indicators of geomorphic and hydrologic change in Deep Lagoon, Macquarie Marshes, Central Northern New South Wales

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Deep Lagoon is a shallow ephemeral waterbody situated on the south western periphery of the Southern Macquarie Marshes at Buckiinguy, in central northern New South Wales. The upper 60 cm of sediment is relatively homogenous but subtle evidence in the stratigraphy reveals an altered geomorphic and hydrologic regime at 30cm below the surface. The sequence of aquatic microinvertebrate and macroplant fossils contained in the sediment, adds important ecological detail to the geomorphic and hydrologic history of Deep Lagoon.

Sedimentary evidence from the broader Buckiinguy wetland complex indicates two phases of deposition, the upper unit comprised of fine silt and the lower unit of medium silt and fine sand (Ralph 2001). Geochronological data in the form of ^{210}Pb and AMS ^{14}C suggest a cessation or an extremely reduced period of sediment deposition occurred between these two units. The altered sedimentation regime is attributed to the avulsion of a new distributary channel of the Macquarie River, the Buckiinguy Break, and the establishment of floodout splay marsh conditions in the early 20th century (Ralph 2001).

Deep Lagoon shows evidence of the same sedimentary history as the broader Buckiinguy complex. The distribution of microinvertebrates and macroplant fossils in the sediment confirms the existence of two geomorphic and hydrologic phases, interceded by a transitional phase at 30cm below the surface. Prior to the avulsion at Buckiinguy the floodplain was less consistently inundated, open to a flashier, flood dominated hydrologic regime. In the post avulsion phase the geomorphic evolution of the floodout splay determined a more proximal hydrologic source and Deep Lagoon developed on the distal floodplain as a more consistently inundated, eutrophic, open water environment.

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Geomorphology of the middle Goulburn River floodplain; how much has its valley changed since the settlers arrived?

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Sediment deposition along floodplains occurs during overbank events, which are important for fluvial health. It is recognized that two of the most evident effects of regulation are the alteration of the magnitude and frequency of the flows that travel downstream from the dam together with a reduction on the sediment load that is transported by the river channel. Flood frequency analysis reveals that there were approximately three times as many overbank flooding events on the Goulburn River floodplain downstream of Eildon Lake during the pre-Eildon dam period (from 1916-1951) compared to the post-Eildon dam period (1953-2007).

A one-metre grid resolution Digital Elevation Model (with a vertical and horizontal accuracy of $\pm$ 10cm and +20 cm respectively) shows the anabranching nature of the Goulburn River valley and its floodplain geomorphic features. Historical maps and aerial photographs made possible to identify the sequential geomorphic changes that occurred during the post-European period since the middle 1860s.

The sediment and flow regime of this river has also changed through multiple human causes. Sediment mining, land clearing for grazing and cultivation, the geomorphological shaping of the river floodplain by the various overbank floods registered during the last century and stream regulation all have had an effect on flow and sediment regimes.

Results from sediment coring analyses and further estimation of sediment deposition rates will be used to describe the magnitude of change in sediment accumulation during the last 150 years along the river floodplain. A hydraulic model will be used to investigate the historical sediment dynamics of the middle Goulburn valley.

Palaeoenvironmental reconstruction of the Castlepoint Formation, Castlepoint, New Zealand: a sequence stratigraphic framework

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Castlepoint, in the Wairarapa region of the North Island of New Zealand, is the location of a well-exposed marine sequence deposited in the upper Pliocene and/or lower Pleistocene. The richly fossiliferous Castlepoint Formation comprises sandstone and coquina limestone that represents sea-level oscillations under the Milankovitch paradigm. The aim of this research is to establish a sequence stratigraphic framework for the Castlepoint Formation, to enhance our knowledge of its geological history and add to the current understanding of Plio-Pleistocene inner shelf sediments.

While such exposed sequences are relatively uncommon in a global context, Plio-Pleistocene sedimentary cyclicity is well represented in New Zealand, most notably in the Wanganui and Hawkes Bay basins. Cyclicity in the Castlepoint succession is less obvious, but is still of importance on a local, regional and global scale. Four complete and two partial cyclothems are identified, with additional minor fluctuations within these cyclothems. The assignment of systems tracts is based largely upon faunal assemblages, primarily molluscan, as well as the sedimentological characteristics of the units. Oxygen isotope analyses on brachiopod specimens confirm the palaeoclimatic conditions and the brachiopod species, *Neothyris castlepointi*, is described for the first time.

In contrast to the laterally extensive Wanganui and Hawkes Bay successions, the Castlepoint strata represent deposition under higher energy conditions on a narrower continental shelf, thus extending cyclothem recognition into coarser grained carbonate-rich inner shelf deposits affected by high wave-energy, especially during storms.

Connectivity of landslides within the Waipaoa Catchment, North Island, New Zealand.

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The Margins Source to Sink Programme addresses the dynamics of sediment delivery from generation at source to deposition on the continental shelf. It aims to unravel the complex geomorphic response of sediment delivery, especially in relation to changes in the system which generate sediment pulses, these being climate change, human land-use changes, and tectonics (relating to both volcanic and seismic activity).

This study comprises a small component of the Margins Programme, relating to connectivity between hill-slope and channels within the Waipaoa Catchment. It addresses hill-slope channel coupling with respect to landslides, which are a dominant source of the catchment's sediment. Landslides, although the ultimate source of sediment, are not always the mechanism by which sediment enters the fluvial network. It is also vital to consider rates of gullying, sheet erosion and riparian erosion. Reconstruction of the rates of these processes through time enables a clear understanding of the behaviour of the terrestrial sediment flux.

Sediment generation and removal from small sub-catchments is shown in GIS, mapping connectivity using slope angle and the distance to the channel to determine hill-slope channel coupling. This model is used as an overlay to determine both the percentage of sediment generated from landslides that is removed from the primary slope and the importance of secondary processes in the eventual removal of this sediment.

Geomorphic controls on regional scale Australian dust emissions: investigating aeolain and fluvial interactions in arid landscapes.

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The concept of sediment availability as a major control on dust emissions within arid environments is of growing interest in aeolian geomorphology. Theoretical models suggest that during arid phases the geomorphic features which supply dust to the airstream may become exhausted of wind erodible sediments (Bullard and McTainsh, 2003). As a result, major dust source areas tend to be associated with fluvial depocentres in arid and semi-arid settings, where periodic flood inundation events re-supply the system with fine erodible sediments (Prospero et al., 2002). Previous research has suggested that aeolian-fluvial interactions are an important mechanism controlling dust emissions from Australia's principal dust source regions, the Lake Eyre and Murray-Darling Basins (Bullard and McTainsh, 2003; McTainsh, 1998).

Field studies on the Diamantina River floodplain have indicated that aeolian and fluvial systems are linked at annual time scales (McTainsh et al., 1999; McTainsh et al., 2002). In this study we seek to characterise the nature of this linkage and how it may affect dust emissions from eastern Australia. In particular we examine the role of fluvial processes in aeolian sediment supply/exhaustion cycles and the temporal scales over which these processes operate.
This is achieved using an 11 year time series of weekly dust emissions (Marx et al., 2005) which is compared with records of river flow, vegetation cover and soil moisture in the Lake Eyre Basin.

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Bioturbation and its contribution to soil flux at Blue Gum Creek, near Sydney

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Bioturbation is one of the most important concepts to feature in pedologic research in recent years (e.g. Paton *et al.* 1995) and its contribution to post-fire soil erosion is a prominent theme that has developed in contemporary studies of wildfire-affected environments (e.g. Shakesby *et al.* 2007). Blue Gum Creek in Nattai National Park was last burned in Sydney's Christmas 2001 fires. A subsequent investigation into post-fire soil erosion here has included an assessment of bioturbation and its impacts.

A unique 5-year dataset of rates of surface mounding by ants and small mammals has been obtained from 20 seasonal measurements of 33 permanent plots. The results contribute to the much-needed quantification of bioturbation generally. Preliminary analysis suggests that bioturbation does indeed have a significant impact on post-fire soil erosion, and demonstrates that bioturbation can vary considerably both temporally (e.g. with season) and spatially (e.g. with slope position) within a landscape.

Associated measurements of downslope biotic soil flux have also been made at Blue Gum Creek, having only been studied previously in relation to Californian pocket gophers and treefall (e.g. Gabet *et al.* 2003). This has involved determining the quantity of soil transferred and its displacement distance for 100 ant mounds and 100 small mammal scrapes. Preliminary results suggest that the vast majority of biotic soil flux at Blue Gum Creek is in a downslope direction and that such flux is important in a geomorphic context. However, the relationship between the displacement distance and slope angle is insignificant, which is not consistent with the conclusions of the Californian studies.

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Hydrological Controls on the Formation of the Macquarie Marshes

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Channel breakdown is the complete or partial collapse of a river channel due to reductions in geomorphic thresholds of a river system. The Macquarie River, NSW, exhibits a form of channel breakdown approximately two thirds downstream from the headwaters at the confluence of the Campbells and Fish Rivers. The geomorphic thresholds of river systems greatly influence the geomorphology of the channel.

Twenty cross section sites with flow data of flood recurrence intervals from gauges along the Macquarie River were collected to determine that there is a downstream decrease of the intrinsic thresholds of slope and discharge. The data gathered is consistent with the hypothesis that the Macquarie River breaks down due to a decrease in discharge.

Marsh areas occur because of a hydrological breakdown in sensitive zones within the channel, leading to distributary formation and dissipation of flow. The causes for channel breakdown in ephemeral streams and inland draining rivers are their location in the lowland regions on flat plains, no tributary inputs, high losses to evaporation and distributary channel networks (Yonge and Hesse, in press). In some cases, such as the Macquarie Marshes, intermediate floodout type zones are initiated, then downstream tributaries form and flow leads into a re-channelized trunk stream, before repetition of this cycle.

The decrease in discharge leads to a change in channel geometry and channel capacity, which contribute to channel breakdown. However, the re-channelization of the Macquarie River post Macquarie Marshes is an indication that it is not solely decreases in discharge and slope that lead to channel change. The contribution of other factors, such as suspended sediment load and channel transport capacity may contribute to the formation of the marshes. Continuing research will determine the complete picture of channel breakdown of the Macquarie River. The decrease in discharge has been demonstrated as one factor of channel breakdown of the Macquarie River.

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Yonge, D. Hesse, P. (in press 2007) Geomorphic Environments, Drainage Breakdown and Channel and Floodplain Evolution on the Lower Macquarie River, Central Western New South Wales. In: J. Clark and C. Pain (Editors), *Australian Cainozoic Cratonic Basins.* Special Publication. International Association of Sedimentology.

The geomorphology of Farewell Spit and its sensitivity to sea-level rise

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Situated on the north-western tip of the South Island, Farewell Spit is a transgressive dunefield barrier extending 30km from Cape Farewell, enclosing the north-western part of Golden Bay. This coastline experiences the highest tidal range in New Zealand (up to ~5m) and during perigean cycles low-lying areas of the sand spit are inundated.

The short and long term geomorphic stability of Farewell Spit and its potential response to projected sea level rise is the focus of this study. Barriers respond to sea level rise through inland migration, their morphology altering with extensive reworking of sediment due to wave energy reaching further inland. Thus an important issue for coastal management is predicting the potential impacts on barrier coasts to changes in environmental boundary conditions and coastal processes.

GIS analysis of aerial photos of the Spit covering a 54 year time frame has shown a great deal of movement of such features as vegetation, dunes and The Shellbanks within this short period. Extensive surveying of low-lying areas identifies those at high risk of becoming more frequently inundated, leading to major erosion or permanent breaching of the Spit. The latter could induce flow-on effects into Golden Bay which is not currently geomorphically accustomed to a higher energy wave regime.

The medium to long term stability of the Spit is investigated through detailed grain size analysis of core transects across stable dunes and tidal flats. This supports past interpretations of sediment transport mechanisms within the Spit system and associated tidal flats and identifies past evidence of significant barrier movement. Optically Stimulated Luminescence dating of stable dunes across the length of the Spit and ^{14}C analysis of shells within a tidal flat core develops a chronology of the Spit's evolution.

This research is the first detailed study on this landform's evolution and will provide quantitative data which will allow for a predicative model to be developed on how the Spit may respond to future sea-level variability. It will therefore result in more accurate management decisions for this internationally recognised landform and the Golden Bay area.

Landscape history controls vegetation ecology: Formation of mid-creek floodouts in western NSW

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In the Western Catchment of NSW management focus is on large rivers, yet more than half the catchment is watered by small dry creeks. They contribute economically to the grazing and tourist industries, by supplying stock and station watering points, and by forming part of the tourist landscape. Dense vegetation along creek banks and at many floodouts underpins local ecosystems.

Floodouts are places where creek channels diminish and disappear, leaving a channel-free watercourse across which floodwaters travel as sheetflow. In western NSW, mid-creek floodouts ("intermediate floodouts", Tooth 1999) are usually found at tributary junctions. They formed during major flow events: sediments and organics were dumped in the flow path as floodwaters left the confines of smaller lower-order valleys.

NSW floodouts are maintained by a geomorphological/ecological feedback (Wakelin-King and Webb 2007). The slope change and absence of channels, first formed by the wedge of flood sediment, encourages later flows to spread out, slow down, infiltrate, and drop sediments, seeds, and organics. The damp, organic-rich environment favours the survival of vegetation. Dense vegetation makes a rough, crowded surface which discourages erosion / channel formation and encourages slow, shallow sheetflow. Thus, the land shape promotes the vegetation and the vegetation sustains the land shape. Because of their efficiency in trapping floodwaters, floodouts are important drought refugia. If erosion allows a channel to establish through the floodout, the cycle reverses and the area becomes unproductive.

Geomorphology is an underused tool in rangeland management. In this context, process information indicates 1) prevention of downslope linear erosion should be a primary management goal in floodouts, and 2) floodouts are ecologically equivalent to riparian zones and should be defined as such in e.g. Landcare funding criteria.

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ANZGG Inc.

Annual General Meeting

Thursday 14th February 2007, 6 pm
Queenstown, Tasmania, Australia

Agenda

• Opening and welcome	Trish Fanning (President)
• Apologies	Jacky Croke (Secretary)
• Minutes of General Meeting Held at Monash University, Melbourne, February 2007, & Matters Arising	Jacky Croke
• Financial Reports for Year Ended 30 September 2007 (incl. Budget 2008/09)	Sandra Brizga (acting Treasurer)
• Conferences - Next ANZGG Conference: date, location, organizing committee	Trish Fanning
• Election of ANZGG executive 2008-2010	Trish Fanning
• Other Business: o ANZIAG Conference July 2009, Melbourne	Brian Finlayson (Chair, LOC)

Australian and New Zealand Geomorphology Group Inc.
Annual General Meeting

Held at:	School of Geography and Environmental Science, Menzies Building, Monash University
On:	28th February 2007, commencing at 1315.
Present:	Patricia Fanning (Chair), David Dunkerley, Sandra Brizga (telephone), Meredith Orr, Jonno Brown, Shobhit Chandra, Rob Ferguson, Brian Finlayson (telephone)
Apologies	
Minutes of previous AGM and Business Arising	The minutes of the AGM held at Taipa Bay, New Zealand, 16th February 2006, were accepted without amendment.
Financial Report for the year ended 30th September 2006	Sandra Brizga tabled the Financial Statement for the ANZGG for the financial year 1 October 2005 to 30 September 2006. It was noted that the proceeds of the Taipa Bay conference had still not been transferred to Australia; Trish Fanning agreed to follow this up with Paul Augustinas, the conference convenor. Sandra Brizga requested that a cheque for $36 be raised to pay the annual fee for incorporation to Consumer Affairs Victoria. Trish Fanning reported that the International Association of Geomorphologists had agreed to waive annual dues for 2006 – 2009 inclusive in view of the commitment of the ANZGG to hosting the next international conference in July 2009. The IAG requests in return that the ANZGG provides a report annually of activities leading up to the conference. *It was resolved* to accept the Financial Statement for the 05-06 financial year. Proposed: Trish Fanning Seconded: David Dunkerley Carried unanimously. Sandra Brizga agreed to sign the statement and forward it to CAV, along with the fee.

Next ANZGG Conference	The next ANZGG conference will be held from 11th to 15th February 2008 in Queenstown, Tasmania. The organisers are Ian Houshold and Tim Cohen. Preparations are will in hand and the first circular has been posted on the ANZGG web site. For noting.
ANZIAG 2009 conference	Brian Finlayson reported on developments to date. A PCO (Tour Hosts, based in Sydney) has been engaged following a full tender process, and negotiations are currently under way in preparation for signing of a contract and a profit/loss sharing agreement, and to draft a conference budget and timeline. *It was agreed* amongst members of the LOC present to hold the next teleconference meeting of the LOC at 2pm on Friday 23rd March 2007. For noting.
Closure:	There being no further business the meeting was declared closed at 1410. *Next AGM*: February 2008 at Queenstown, Tasmania.

Abstract added post-conference

Gordon River Fluvial Geomorphic Monitoring

Dax Noble, Hydro Tasmania Consulting

Background - study aims and objectives

The Gordon River is located in the Tasmanian Wilderness World Heritage Area (TWWHA) in South West Tasmania. The hydrology of the middle Gordon River was initially altered in 1974 when the river was dammed to create Lake Gordon. Initial power generation was commissioned in 1977 (turbine 1), 1979 (turbine 2) and 1988 (turbine 3). The damming of the Gordon River resulted in alterations to the magnitude, duration, frequency, timing of flows and rates of water level rise and fall throughout the middle Gordon River, all of which contribute to important ecological processes.

Connection of the Tasmanian power grid to the National Electricity Market (NEM) meant that further alterations to the hydrology in some of Tasmania's rivers would occur. The Basslink connection would cause a change in the operation of the Gordon River from a predominantly 'base-load' controlled system to 'hydro-peaking'. The base-load under normal reservoir discharge has a consistent volume of water discharged for longer durations, however, hydro-peaking contrasts this as there is greater variation in discharge followed by rapid drops in water level - causing a peaking effect in discharge volume.

As a result of predicted alterations to river hydrology within a World Heritage Area a joint state (Tasmania and Victoria) and commonwealth advisory panel was formed to assess the potential impacts and associated monitoring requirements. The Tasmanian Government then adopted these prescriptions into Hydro Tasmania's (HT) special water licence. As part of the special license requirements HT was required to complete a series of investigations.

The Basslink IIAS[1] investigations (1999-2001) in the Gordon River were multi-disciplinary studies, including hydrology, geomorphology, vegetation, in-stream macroinvertebrates, river based mammals, karst and fish. The results of these investigations provided insights into how the Gordon River has responded, and continues to respond, to the present regulated flow regime of the river. Subsequent ongoing monitoring for the Basslink Monitoring Program (2001-07) has provided additional information about the processes acting on the river. Four years of pre hydropeaking baseline data have been collected, and six years of post Basslink implementation data will be collected for comparison with the baseline data. 2006 was the first post-Basslink year of monitoring, and monitoring will continue until 2012.

Hydro Tasmania has measured a pre-Basslink baseline that characterises the existing modified environment between the tailrace and Franklin confluence (middle Gordon River). Part of the investigations involves study of the fluvial geomorphology throughout the middle Gordon and biannual monitoring (March and October) of changes post-Basslink. Geomorphic baseline assessments and monitoring were completed prior to commencement of trading into the National Electricity Market.

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[1] Basslink Integrated Impact Assessment Statement: Potential Effects of Changes to Hydro Power Generation

The fluvial geomorphic study is one aspect of the Basslink monitoring program and will be the focus for the remainder of discussion. The fluvial geomorphic monitoring includes the measurement of 200 erosion pins and 25 scour chains located at 48 monitoring sites in the middle Gordon River twice a year, photo-monitoring of an additional 54 sites once a year, and analysis of piezometer results. Due to the scale of the fluvial geomorphic monitoring (aside from the program as a whole) only one aspect has been selected for discussion, erosion pin monitoring.

Environmental Considerations
In the study area, bank materials consist of bedrock (60%), cobbles (5%), sandy alluvium (35%), or combinations. The largest concentration of sandy alluvial banks is found in a 3 km reach between the mouth of the Albert River and the Gordon River Splits, designated as "Zone 2, where about 75% of the banks are of this type.

Measurement of the erosion throughout each of the zones in the middle Gordon river is often discussed relative to turbine operation level. When all three turbines are operational discharge will be greater and is indicated by a higher plimsoll line on the river banks than under two turbine operation. The fluctuation of the river due to power station operation can be anything from 2-4 metres, however this needs to be placed in context with natural floods entering tributaries that can discharge far larger volumes of water into the catchment.

Methodology and Results for 2006-2007 - Erosion Pins

An erosion pin essentially sets a benchmark. It is usually a long metal stake, hammered into the ground until it is stable. The initial measure from ground level to head of pin is taken as the benchmark.

- Pins were installed in the Gordon River in sets of 3 to 5 in a line perpendicular to the flow of the river.
- Repeated measuring of the length of pin exposed above the surface of the bank allows the quantification of net erosion or deposition at a site over time.

<u>1-2 Turbine Level</u> - There was little change to the erosion or deposition recorded by pins in the 1-2 turbine level, but due to less erosion being recorded by the pins, net erosion rates decreased over the monitoring year in this turbine level. The decrease in net erosion rates is the largest recorded for this turbine level since monitoring was initiated.

<u>2-3 Turbine Level</u> - There was an increase in erosion and small decrease in deposition over the monitoring year relative to previous results. Although there was a decrease in the ratio of pins showing erosion to deposition, net erosion rates remained consistent with previous trends. This is surprising as there was no 3-turbine power station operation during the March 2006 – October 2007 monitoring period, indicating that releases from the power station were not responsible for the direct erosion of this turbine level. The continued erosion of the banks at this level is likely attributable to the impact of natural inflows from the tributaries on the banks, bank collapse due to under-cutting of the lower bank, and erosion of the exposed denuded banks by rainfall. Tributary inflows would have the greatest impact downstream of the Denison River in zones 4 and 5 where inflows constitute a substantial proportion of total flow, especially during the winter months.

Conclusions
The first year of post-Basslink monitoring has coincided with power station operations which differed from the pre-Basslink operating regime, and did not contain several of the flow elements

predicted to occur under Basslink. This was due to extended maintenance at the power station limiting discharge to two turbines for much of the monitoring year combined with an extended drought and a very high flow event in May 2007.

- Net erosion rates are within pre-Basslink baseline range for zones 1-4. Scour erosion in response to sustained 2-turbine flows is suggested as the predominant erosion process during the monitoring year.

- The rate of deposition in zone 5 has slowed and is outside of the baseline range – may be in response to reduced upstream erosion and sediment supply.

- A number of events deemed to present high seepage erosion risk were identified, with most associated rapidly decreasing flows associated with power station shutdown. Despite this, seepage erosion was not considered to be a major contributor to erosion rates for the year.

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