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final report

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Sources and Delivery of Suspended Sediment and Phosphorus to Australian Rivers

Project number: ANU9

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National Eutrophication Management Program (NEMP)

Sources and Delivery of Suspended Sediment and Phosphorus to Australian Rivers:

PART A - Radionuclides and Geomorphology, CWA21
PART B - Nd and Sr Isotopes and Trace Elements, ANU9

FINAL REPORT

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This final report encompasses the outcomes of two NEMP projects, ANU9 (Martin) and CWA21 (Wallbrink and Wilson). The final reporting is undertaken jointly as the projects were conceived and executed within a common experimental design, given as Figure 3.1 in the accompanying Final Technical Report.

The two projects had a series of joint objectives for which the achievement criteria and the results from them are given below.

Achievement criteria:

A: Provide a summary of the relative contributions of topsoil and subsoil, as well as natural, anthropogenic and dissolved sources of P for generic landform/use catchment types.

In order to achieve this we concentrated our research efforts on two different study locations, a) Bundella Creek, within the Namoi NEMP focus in NSW and b) Berner Creek, within the North Johnstone catchment in QLD. Both of these catchments had the same landuses within them, i.e. native forest, cultivation and pastoral activities. However it was assumed that due to the large differences in climate, land management, fertiliser applications, and landform that the style of sediment and P delivery would be very different between them. This was largely found to be the case. It should also be noted that the data for Bundella Creek is restricted to fine grained material of <10 μm in diameter. This is the predominant grain size fraction transported within the Namoi River basin (Caitcheon ed., unpub. CSIRO report, 2000). The data for Berner Creek is measured on bulk soil, as material in this region is generally eroded and transported as soil aggregates. The methodology involved combining a suite of tracer approaches which allowed us to determine the relative contributions of surface and subsurface erosion from each landuse and to quantify the P content associated with each eroded proportion and the fractional fertiliser P contribution to the total P pool. The full methodology is described in detail in the accompanying technical report.

Results and interpretation– Bundella Creek: Table 1 below describes the different relative proportions of topsoil, subsoil and amounts of phosphorus associated with sediments from the different landuses at Bundella Creek.

Table 1: Different relative proportions of topsoil and subsoil and calculated amounts of P from them for sediments from different landuses and locations in Bundella Creek, NSW.

Land use	**source**	**Sed. amount (%)**	**P amount (%)**	**error**
Forests + channels	surface	43	62	6
	subsoil	57	38	
Pastureland + small gully	surface	41	52	7
	subsoil	59	48	
Cultivated + subsoil from graded banks	surface	44	57	14
	subsoil	56	43	
Sheet erosion from cultivated + big gully	surface	27	27	4
	subsoil	63	63	
Homestead	surface	33	42	20
	subsoil	67	58	
Catchment outlet	surface	32	41	19
	subsoil	68	59	

The majority of P in sediments draining the forest and pastureland regions is derived from surface soils, which have high P concentrations compared to the subsoil components (defined as > 30 cm depth). The overall flux of sediment and P at the catchment scale however is very much dominated by subsoil erosion from channels and gullies within the catchment.

The different proportions of P derived from anthropogenic and native sources in these landuses are summarised in Table 2 below.

Table 2: Final proportions of P from fertiliser, native surface, and native subsoil sources to fine-grained sediments in Bundella Creek.

land form	fertiliser surface (%)	native surface (%)	native subsoil (%)	error (%)
Forests + channels	0	62	38	6
Pastureland + small gully	19	42	40	7
sheet erosion cultivated	3	61	36	12
sheet erosion cultivated + big gully				
Main channel at Homestead	13	33	54	20
Main channel at Outlet	9	36	55	19

As fertilisers are applied to the soil surface, it was assumed for this analysis that the fertiliser component is associated with surface eroded P. The data show that at the landuse scale fertiliser P can make a significant contribution to offsite P fluxes, up to 19 ± 7% from pastureland areas. Some of this fertiliser can be observed on sediments at the catchment scale in Bundella Creek, although there is considerable variability between events.

The contribution of fertiliser P to dissolved P (SRP) from the same landuses was also calculated in Bundella Creek. The results of this analysis are given in Table 3 below.

Table 3: Fertiliser P contributions to SRP in runoff from different landuses in Bundella Ck.

location		fert p	native P	
	(n)	(%)	(%)	error
forest	2	0	100	-
pasture	6	17	83	4
cultivated	6	69	31	7
homestead	4	8	92	8
Catchment outlet	2	10	90	-

The data show a significant contribution of fertiliser P to runoff from pastureland areas and a very high contribution from cultivated regions, although this latter result is for surface runoff alone and does not include the influence from the large gully system. Nonetheless, at the landuse scale the contribution to soluble P from fertilizers can be very significant. The effect of this appears to be partially propagated downstream with some 7% of SRP in waters at the catchment scale being derived from fertiliser.

Results and interpretation– Berner Creek: The different contributions of sediment and P from different landuses in Berner Creek is given in Table 4 below.

Table 4: Different relative proportions of topsoil and subsoil and calculated amounts of P from them for sediments from different landuses and locations in Berner Creek, QLD.

catchment	landuse	erosion	contribution		P205		P	
location		process	amount	se	(wt%)	se	amount	error
			(%)				(%)	
IL95017	**uncultivated**	**surface**	1.0	3.0	0.434	0.036	1	3
	cultivated	**surface**	68.8	14.0	0.759	0.051	84	14
	channels/gullies	**subsurface**	30.2	11.0	0.306	0.061	15	11
IL95029	**uncultivated**	**surface**	8.0	5.0	0.434	0.036	7	5
	cultivated	**surface**	32.0	14.0	0.759	0.051	53	14
	channels/gullies	**subsurface**	60.0	12.0	0.306	0.061	40	12

Overall it is clear that the delivery of sediment in this tropical system is heavily influenced by surface erosion processes, especially at the local hillslope scale where cultivated lands feed directly onto river drainage lines. The data also suggest that the high sediment yields from the cultivated lands have a large influence on the local delivery of P to waterways, which at the scale of ~280 ha can account for 85% of the total P flux. This outcome is in contrast to that observed in the Bundella Creek system where the bulk of the P was associated with subsoil erosion from channels and gullies. In both catchments however, the yield of surface derived material from cultivated lands was greater than that from surface erosion of pastureland or forested areas.

The different proportions of P derived from anthropogenic and native sources in these landuses are summarised in Table 5 below. Soils from pasture lands in general have low proportions of fertilizer P. The results for the sediments from channels draining the pasture lands show more evidence of fertilizer, which may be due to the transport of fine particles off the landscape or the direct application of fertilizer to drainage lines themselves. The soils on cultivated lands almost all show evidence of their history of heavy fertilizer usage, with up to 98% of the P in the samples being of fertilizer derivation. There is also evidence that fertiliser P from the cultivated lands is being transported into the channels.

Table 5: Final proportions of P from fertiliser, native surface, and native subsoil sources to sediments in Berner Creek.

Land form	Fertiliser surface	native surface	subsurface
	(%)	(%)	(%)
Forests + pasture + channels	11	12	77
Cultivated + channels	50	39	11
IL95017, IL99004	30	46	24
IL95029 (middle)	16	30	54
IL99035 (catchment outlet)	42	28	30

There is a fertiliser contribution to sediments transported from pastoral and rainforest regions. As the rainforest regions are not fertilized a possible explanation is that there has been direct application of fertilisers to channels in pastureland areas. In the cultivated parts of the catchment, 89% of the P is surface derived, with 50% coming from fertiliser P. As discussed above, this is probably due to the very high fertiliser application rates in cultivated areas.

The high rate of delivery of sediment and P from cultivated areas is propagated downstream. At location IL95017/IL99004 the contribution of surface eroded sediment bound P is 76%, and some 30% of the total is derived from fertilisers. Downstream, at location IL95029, the contribution of surface derived P has decreased, due to substantial additions of subsoil from channels and drainage lines in the uncultivated regions. At the catchment outlet (location IL99035), however, the total proportion of P from surface has increased back up to 70%. Of this the largest single source is fertiliser P, reflecting an increase in the proportion of catchment under cultivation.

In summary, the processes of sediment and P delivery in temperate and tropical catchments with a basaltic substrate have important similarities and differences. The most important difference is that subsoil dominates sediment and P delivery in the temperate catchment whereas surface soil dominates in the tropics. For both settings, the relative yields of sediment and P from the cultivated areas was many times higher than in uncultivated areas. The overall sediment and P flux from forested areas was greater in the temperate case. Fertiliser P contributes a substantial amount to the total P flux in the tropical catchment, and was less important but highly variable in the temperate catchment.

b) Description of the developed landscape analysis technique and set of rules governing the behaviour and efficiency of sediment and P delivery to streams.

The GIS-based geomorphic model was developed to provide a simple predictive tool to assess the relative contributions of sediment and P from different sources in any landscape. It can also be used to predict sediment loads, but must be calibrated with annual or event yield data (from plots, sediment budgets or monitoring data) for this purpose. The model is designed to use accessible soil, landuse and topographic data available from the NSW Land Information Centre, and other State land and water resource agencies, within an ARC INFO framework.

The geomorphic tool was applied and tested in both the Berner and Bundella Creek catchments with good agreement with geochemical analyses performed in those catchments. The technique requires estimations of production rate parameters for sediment and phosphorus, K and P respectively, that are linked to landuse and soil type. It also requires a function that represents the extent and form of the channel network. The technique can be applied to digital elevation data supplied on any grid size, as long as the data is clean enough to perform standard ARC INFO flow direction and flow accumulation commands.

The equations describing the geomorphic analysis are as follow:

Surface P Load, Native = Pn * K * CA * S (1)

Surface P Load, Fertiliser = Pf * K * CA * S (2)

Subsurface P Load, Native = Ps * K * CA * S * R (3)

Erodible channel surface area, R (m2) = x CA^m (4)

ARC INFO grids are produced for each of the above equations using grid multiplication. Here K is a coefficient that defines the intensity of sediment or phosphorus production for a given land use or soil type. The product of upslope catchment area, CA, and slope, S, is proportional to the stream power available to drive erosion and transport within each grid cell. Pn, Pf and Ps are the proportions of soil mass that are comprised of phosphorus from unfertilised surface soil, fertilised surface soil and subsoil, respectively. These values are derived from XRF analyses performed on a small number of cores and surface samples taken from source soils in the catchments. The proportion of P in the soil as given by Pn, Pf and Ps vary as a function of soil type and fertiliser use.

The parameters x and m used to calculate R, the erodible channel surface area, are empirical coefficients derived from the manner in which the width and depth of the channel changes with drainage area (Dunne and Leopold, 1978). Digital blue lines can be used to describe the extent of the channel network within the GIS, otherwise the channel can be defined by ARC INFO using field data on the drainage area required to support a channel.

Sediment and phosphorus loads are calculated by summing the production values in each upslope cell along flowpaths using the ARC INFO flow accumulation command with the weighting grids produced by equations (1), (2) and (3) above. The summed values are used to calculate the proportions of sediment and phosphorus derived from different processes (channel erosion and surface erosion) and upstream landuse at any selected site within the catchment and stream network.

c) Results of investigation of whether the isotopic composition of algae can be used to monitor the source of bioavailable P.

Methodology: The use of Sr isotopes as tracers in biological systems is not common but nevertheless an established technique (e.g. Graustein, 1990). Trace element enrichments in biota have been established in a number of studies (e.g. Mann and Fyfe, 1985), but none have been reported for Australia or related directly to sourcing the P involved in the production of algal blooms. This work was undertaken to follow up on initial results on an algal bloom in the Fitzroy river done in collaboration with Phillip Ford and Myriam Bormans at CSIRO Land and Water Canberra (CEM7), which were described in ANU9 Milestone report #3.

This work was undertaken in two parts. (1) *Anabena* was cultured specifically to measure their trace element concentrations by the addition of known amounts of selected trace elements to the culturing media. (2) A field-based study in the Shepparton area involved measurement of trace element and isotopic ratios in biota, waters filtered to different levels, and associated suspended and bed sediments. This work was done in collaboration with Dr Rod Oliver of the Murray Darling Freshwater Research Centre in Albury (MDR17).

Culturing of *Anabaena* took place at MDFRC between December 1999 and February 2000. The standard culturing media used was modified by the addition of a "spike" mixture of trace elements in solution that had been prepared at the RSES. After culturing, the *Anabaena* was freeze dried and sent to RSES for analysis, along with splits of the media before and after the culturing. Natural samples were collected from Lake Kialla, a small urban lake just outside of Shepparton, in August 1999. A species of *Anabaena* was blooming at this location and the prevailing wind blew the surface bloom into a dense slick against one edge of the lake. *Anabaena* samples were obtained by 'skimming' the surface using a 30 µm sieve. Leaves and roots of a reed (*Cyprus sp*?) were collected for comparison of with the bloom biota. Water and bottom sediment samples were also taken. Water was sequentially filtered to <0.45 µm, <0.2 µm and 0.03 µm to obtain suspended sediment and "dissolved" fractions. Cultured and natural samples were prepared for analysis by ICP-MS at RSES using similar methods to those described in Martin and McCulloch (1999), with modifications for biota decomposition. In addition, some leaches of the bed sediments were performed, using methods similar to those commonly used to access the bioavailable P in sediments.

Results of culturing experiments: The results are shown in Figure 1, where selected elements are plotted relative to their concentration in the culturing media. For elements with widely ranging geochemical behaviour, including alkaline earths, rare earths, and potentially toxic metals, the *Anabaena* concentrated the element by between two and four orders of magnitude relative to the culturing media solution.

These results are significant because the enrichment of natural algae samples in elements such as Ti and the rare-earth elements is confirmed. For the natural samples from the Fitzroy previously analysed, there was doubt that these elements were actually in the algae because of the possible incorporation of sediment. Since these cultures took place with no sediment present, the enrichment factors are real. Furthermore, this uptake means that it should be possible to use the direct analysis of biota as a monitor of water conditions during the time of algal blooms or in long-lived biota as a monitor of non-bloom, more typical water conditions.

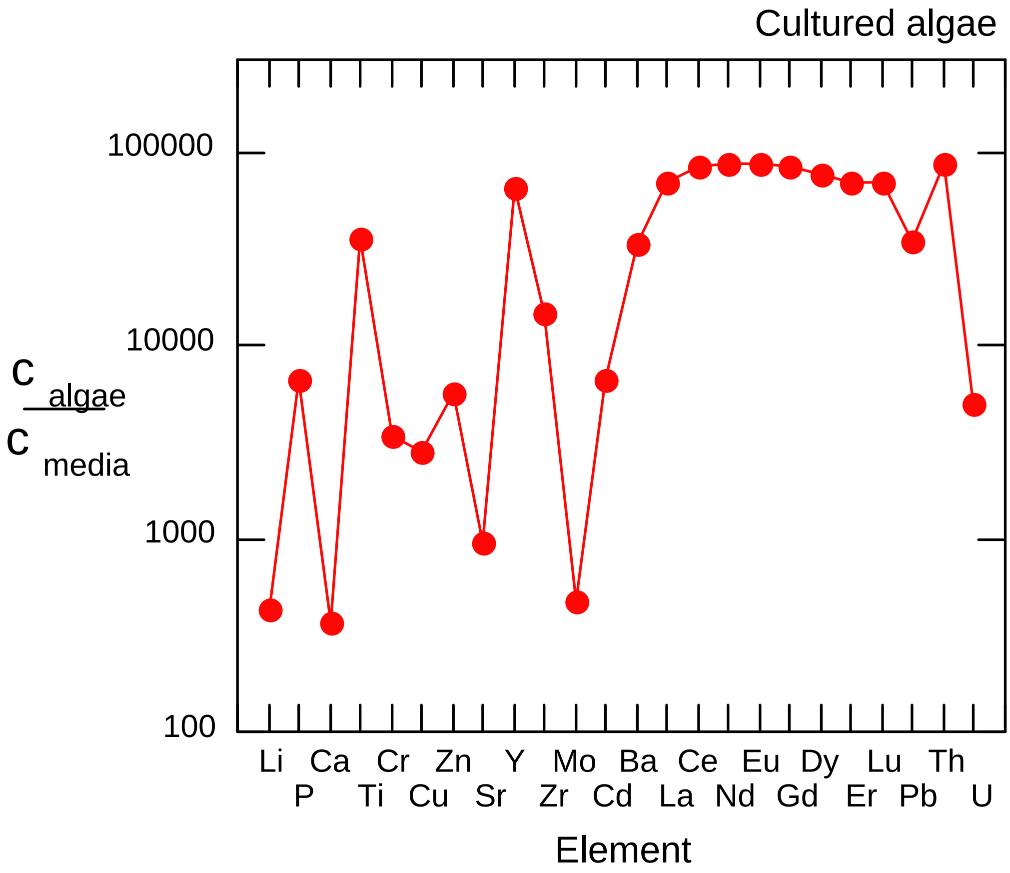

Figure 1. Plot of concentration of selected elements in *Anabena* relative to the media in which they were cultured.

Results of Lake Kialla biota study: The concentration ratios for the different biota and the more ultra-filtered waters relative to the 0.45 µm filtered water are shown in Figure 2 below. All the elements analysed are concentrated by between 2 and 5 orders of magnitude in the biota relative to the water. Interestingly, the elements Mo and Cd have much higher enrichment levels than were measured in the culturing experiment. This would be consistent with an extreme degree of depletion of these elements in the relatively static waters around the algae. On the other hand, the enrichments observed for the REEs are about two orders of magnitude less than what we obtained in the lab experiments. The reason for this is a combination of a relatively low concentration of REEs in the algae (e.g. Nd is about 0.9 ppm compared to 7 ppm in the experiment) and relatively high concentration of REEs in the water (2.5 ppb natural vs. 0.08 ppb experimental). This may be due to the pH of the waters in the natural conditions being lower than in the cultures, which stabilises REEs in solution. Note too that the biota patterns are more similar to the 0.45 and 0.2 µm filtered waters and the leachate of a sediment than they are to the 0.03 µm filtered water. This suggests that the patterns in the biota arise from interactions the entire pool in the <0.45 µm fraction.

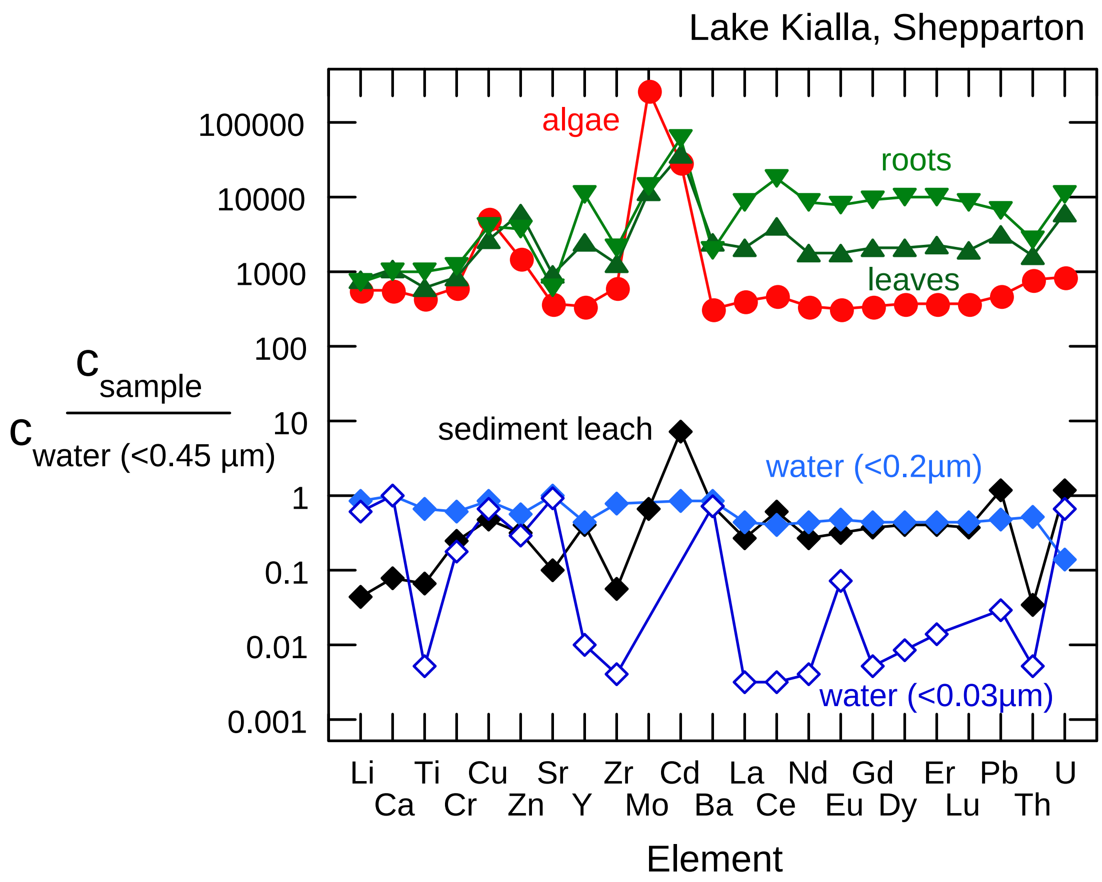

Figure 2. Plot of concentration of selected elements in biota, ultra-filtered waters and a sediment from Lake Shepparton sampled during an *Anabena* bloom that took place in August 1999, relative to the concentrations measured in water filtered to <0.45 µm.

The Sr and Nd isotopic compositions of the biota, sediment and water samples vary substantially (Figure 3). The leaves, roots and 0.45 and 0.2 µm filtered water have identical Nd isotopic compositions. The strong leach of the bottom sediment, with the lowest Nd and highest Sr isotopic compositions, is unlike any of the other materials analyzed. This is to be expected, because the sediment contains old minerals that are not very soluble and would therefore be unavailable to the biota. The mild leach of the bed sediment has a Sr isotopic composition that is nearly identical to the 0.03 µm filtered water and to the biota. The suspended sediment is not isotopically the same as the bed sediment, having a higher Sr isotopic composition. The waters filtered to <0.45 µm and <0.2 µm have nearly identical isotopic compositions that are also nearly identical to the roots and leaves of the reed. The algae sample has a somewhat lower Nd isotopic composition than the other biota, however its Sr isotopic composition is nearly identical to the 0.45 µm filtered water. This is not due to the incorporation of suspended sediment, because the Nd isotopic composition of the suspended sediment is higher than that of the algae. The difference in Nd isotopic composition between the algae and the reed therefore suggests that there was a somewhat different bioavailable source (fertiliser?) that resulted in the formation of the algal bloom.

Most importantly, the similarity in the isotopic composition of the biota to the filtered waters and the sediment leaches support the suggestion that these isotopic tracers do monitor the source of the bioavailable fraction in the lake. Therefore this pilot project is considered to be a success.

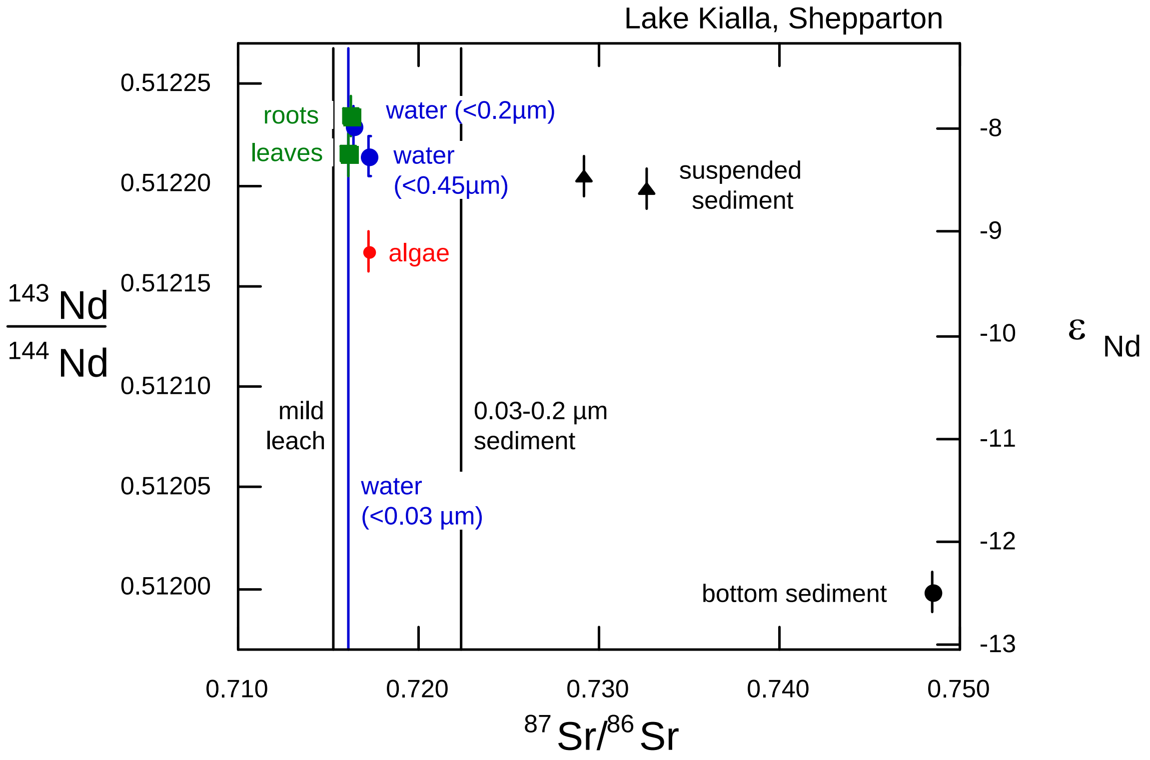

Figure 3. Plot of Nd versus Sr isotopic compositions of biota, sediment and waters from Lake Kialla, Shepparton, sampled during an *Anabena* ("algae") bloom in August 1999. The vertical lines indicate the Sr isotopic compositions of fractions for which Nd data were not obtained.

d) Evaluation of the potential to develop a technology transfer package for adapting the techniques and/or outcomes for easy use by resource agencies and community groups.

The geomorphic analysis is comprised of a simple set of ARC INFO commands applied to a digital topographic data for a catchment. The method is amenable to development of documentation and an automated package that runs within the ARC INFO framework. A workshop could be developed to train agency personal in its application to catchments of interest. The package could be developed to explore "what if" scenarios involving changes in fertiliser management or landuse in catchments, and its impact on adsorbed P delivery to streams.

e) Outcomes of communications and technology transfer activities.

One of the major outcomes of the project has been the transferal of project expertise into a set of rules of thumb for the Liverpool Plains Land Management Committee (LPLMC). This was undertaken in the form of an expert panel comprising project scientists (Wallbrink, Wilson, Martin) in addition to other researchers. The full list of panel members is given in the Technical report. The NEMP CWA21 and ANU9 projects formed the technical basis for this panel.

The panel met for two days in May 2000 under the auspices of Di Bentley from the LPLMC committee and various DLWC delegates. The first day was spent in a reconnaissance of the Liverpool plains, speaking with landholders, catchment managers and soil and water conservation practitioners, examining first hand some of the issues related to sediment and nutrient delivery in the plains. On the second day the panel reconvened, and formally outlined the issues affecting the delivery of sediment and nutrients to waterways within the

Namoi. Through a discussion process, the panel then derived a comprehensive set of required technical actions (RTA's) for each of these issues. Specifically, each RTA was a guideline, recommendation or action for landholders to undertake in a physical or practical way, in order to directly reduce, or assist in, reducing the flow of sediments and nutrients from their holdings.

A measure of the veracity of each RTA was also established by defining whether they were directly supported by research , ie. a scientific study in which the results were presented in the scientific literature, or whether they simply represented best practice common sense, or the collective will of the panel. The overall recommendations from the panel were then presented to a community workshop on nutrient and sediment delivery on the Liverpool plains in Tamworth on 25th May 2000. The LPLMC is now in the process of assessing and combining these recommendations with those from other expert committees on streamside vegetation, groundwater and salinity control.

The outcomes from this project have also been presented at various international meetings and workshops as well as divisional seminars, which are listed below.

International presentations:

- How catchment runoff gets to streams: The role of small alluvial fans in valleys. N F Herron and **C.J. Wilson**. *American Geophysical Union Meeting*, December 1997.
- Geomorphic Controls on the Hydraulic Properties of Soils in a Confined Stream Valley, R. Butterworth, **C.J. Wilson**, and N.F. Herron. *American Geophysical Union Meeting*, December 1997.
- How surface runoff gets to streams. **C. Wilson**. Invited talks presented at both: Univ. of Toronto, Dept. of Geography and USGS Menlo Park, CA., December 1997.
- Geochemistry of riverine particulate and dissolved loads, Darling River Basin, Australia. **C.E. Martin**. *Ninth International Conference on Water-Rock Interaction*, March 1998.
- Estimating Sediment and Nutrient Sources from Terrain Data, Airborne Laser Altimetry, Radionuclides & Nd, Sr Isotopes Using a GIS Framework. H22C-14. *December 1999, AGU Meeting:* **Wilson, C.W.**, Crowell, K., **Martin, C.E. and Wallbrink, P.J**. Also presented at Los Alamos National Laboratory, April, 2000.
- Using tracers and landscape modelling to predict sources of sediments and phosphorus to waterways in Bundella Ck. NSW Australia. **P.J. Wallbrink, C.J. Wilson and C. Martin**, *SPERA, workshop*, New Caledonia, June 19-23, 2000.

National presentations:

- A river runs through it (sometimes): Geochemical tracers of sediment in the Darling River Basin, NSW. C.E. Martin, Research School of Earth Sciences Seminar, 21 May 1998.
- Combining tracers and landscape modelling to predict sediment and phosphorus from different landuses and erosion processes. P.J. Wallbrink, C.J. Wilson and C. Martin, *CSIRO Land & Water* divisional seminar, August 2, 2000.
- NEMP Annual Workshops held in Rockhampton (1997), Denmark (1998), and Tamworth, (1999).

g) List of publications in preparation or published.

Gell, P.A. **Wallbrink, P.J.** Tassicker, G. and Illman, M. Secrets in the Sediments: a history of sediment and pollution loads in the Torrens River, South Australia, *Proceedings of 2nd national Conference on Stream Management*, Adelaide 8-11 February, 287-293, 1999.

Herron, N.F and **Wilson, C.J.**. The role of small alluvial fans on near-stream hydrologic buffering. *Proceedings of 2nd national Conference on Stream Management*, Adelaide 8-11 February, 319-324, 1999.

Herron, N. and **Wilson, C. J**. The influence of small alluvial fans on runoff delivery from tributary catchments to trunk streams, in prep.

Martin, C.E. and McCulloch, M.T. Geochemistry of riverine particulate and dissolved loads, Darling River Basin, Australia. *Proceedings of the 9th International Symposium on Water-Rock Interaction* (eds. Arehart, G.B. and Hulston, J.R.), 59-62, 1998.

Martin, C.E. and McCulloch, M.T. Nd-Sr isotopic and trace element geochemistry of river sediments and soils in a fertilized catchment, New South Wales, Australia. *Geochimica et Cosmochimica Acta* 63, 285-303, 1999.

McCulloch, M.T., Pailles, C., Moody, P., and **Martin, C.**, 2000, Tracing the source of sediments and nutrients (P) into the Great Barrier Reef Lagoon. Submitted, *Nature*.

Wallbrink, P.J., Olley, J.M., Murray, A.S. and Olive, L.J., Determining sediment sources and transit times of suspended sediment in the Murrumbidgee River, NSW, Australia using fallout ^{137}Cs and ^{210}Pb, *Wat. Res. Res*., 34:4, 879-887, 1998.

Wallbrink, P.J. Wilson, C.J., Olley, J.M and Beavis, S. Management implications of channel incision in the Liverpool plains, NSW, Australia, *Proceedings of 2nd national Conference on Stream Management*, Adelaide 8-11 February, 667-673, 1999.

Martin, C.E., **Wallbrink, P.J.**, and **Wilson, C.J.** Sources of particulate and dissolved phosphorus to streams: influence of geology, climate and land use, in prep.

Sinclair D., **Martin C.E.**, and Oliver, R. Using trace elements and isotopes to trace the source of bioavailable P in water bodies, in prep.

Wilson, C.J., Crowell, K., **Martin, C.E.,** and **Wallbrink, P.J.** Estimating sediment and nutrient sources and delivery in a large catchment from terrain data, airborne laser altimetry, radionuclides, and geochemistry in a GIS framework, in prep.

Wallbrink, P.J., **Martin, C.E.**, and **Wilson, C.J.** Combining tracers and landscape analysis to predict sources of sediment and P, in prep.

Project Reviews:

A reference panel of senior academics and agency personnel was selected and gathered on October 9th in Canberra to review and co-ordinate the overall aims/objectives, experimental plans and outcomes of our research projects to this point. Because of their close scientific linking this panel sat jointly for projects CWA21 and ANU9. Members of the panel were Dr David Heggie (AGSO), Professor Bob Wasson (ANU), and Dr Bob Crouch (DLWC), Dr

John Olley (CSIRO) also attended.

Workshops:

1) A workshop to communicate the importance and relevance of the CWA21 findings to landowners, DLWC, LPLMC (Liverpool Plains Land Management Committee), and NEMP management committee members, planned for Milestone 4, was undertaken on November 15 in the Namoi catchment at Tamworth. Attendees included:

Anna Porter, Neil Forster, Col Rosewell:	DLWC
Klaus Koop, Richard Davis:	NEMP
Jim McDonald, Sheila Donaldson:	LPLMC
Neil Davison	Landowner
Cathy Wilson, Peter Wallbrink	CWA21
Candace Martin	ANU9

2) NEMP Namoi Workshop, October 14-15, 1997: Peter Wallbrink "Sources and delivery of suspended sediment and phosphorus to Australian Rivers"
3) NEMP Annual Workshop, November 10-12, 1997: Cathy Wilson and Candace Martin "Presentation of project status"
4) NEMP Annual Workshop, November 15-17, 1999: Wallbrink, Wilson and Martin "Presentation of project status"

5) Peter Wallbrink and Cathy Wilson conduct field day with landholders in Bundella Creek, Neal and Cam Davidson, December 23, 1997.

Abstract:

"Combining tracers and landscape modelling to predict sediment and phosphorus from different landuses and erosion processes"

Sedimentation in streams and rivers draining agricultural land has resulted in severe environmental degradation. Eutrophication is a major associated issue, and the persistent occurrence of algal blooms has been linked with excess available P. The total amount of P in these systems has been shown to be dominated by the sediment bound load derived from erosion of diffuse sources, although fertiliser P has also been implicated. The major diffuse sources of sediment include surface erosion from cultivated, pasture and steep forested land as well as subsoil erosion from the significant number of channels and gullies present within these systems. In this NEMP sponsored project we determine the relative contributions of both sediment and sediment bound P from these different landuses and erosion sources in two contrasting catchments. The Bundella Ck catchment (8,700 ha) is in the Liverpool plains NSW, Berner Creek catchment (1069 ha) is in tropical QLD. Overall we found important similarities and differences in the delivery of sediment and P from the temperate and tropical systems. The most important difference is that subsoil dominates sediment and P delivery (~60%) in the temperate catchment whereas surface soil dominates P in the tropics (~70%). For both settings, the relative yields of sediment and P from the cultivated areas was many times higher than in uncultivated areas. The overall sediment and P flux from forested areas was greater in the temperate case. Fertiliser P contributes a substantial amount (~40%) to the total P flux in the tropical catchment, and was less important but highly variable in the temperate catchment (~10%). The contribution of fertiliser P to soluble reactive P was considerable (~70%) in runoff from cultivated lands in the temperate region, and slightly less important from pastural areas (~19%). This is important at the land use scale. We also created a topographic model to independently predict the contributions of sediment and P from these different sources. The strength of the model was its ability to characterize not only fluxes of material from surface erosion, but also that from subsoil channel and gully erosion processes. We found that the model predictions of fluxes of sediment and P from both these systems were consistent with those from the tracers within uncertainties.