



ASSAY

A NEWSLETTER ABOUT ACID SULFATE SOILS

No. 49 July 2009

Welcome to edition 49

There is certainly no denying that acid sulfate soil is now a national issue. This edition contains further information on inland acid sulfate soils and the difficult situation facing people in the Murray Lower Lakes. Lime is currently being flown and trucked into the area in a bid to neutralise the acid being generated as water levels drop. Work also continues in Western Australia, where a recently completed mapping project confirms that acid sulfate soils are widespread throughout Perth. While along Victoria's Gippsland Coast, acid sulfate soils could threaten a number of Ramsar wetlands. While such great progress is being made in the identification and management of acid sulfate soils across the country, the future for ASSAY is uncertain. This will be the last edition under current funding arrangements, with attempts to obtain further funding under the 09/10 Caring for our Country program unsuccessful. Thanks for all of your contributions, which has made ASSAY the great newsletter it is. Till next time, Chrisy

Lime flown and trucked in to save Lower Lakes

June 16, 2009
Stock Journal - Fairfax Digital

A new trial to add limestone to the drying lakebeds at Currency Creek using aircraft will be undertaken this week. The aerial trial is part of the South Australian State Government's emergency response to manage acid sulfate soils in the region.

SA Department for Environment and Heritage's Russell Seaman said the trial would involve two low-flying aircraft dispersing about 360 tonnes of ultra-fine grained limestone directly onto the lower and upper reaches of Currency Creek.

"At present, the water quality in most of Currency Creek is declining rapidly, so without this urgent response, there is a significant risk that the water in this area will turn highly acidic," he said. "The planes will be flying low, about 20 to 50 metres above the ground, and mainly along the middle of the water bodies to reduce any dust dispersal. The limestone dosing will not be directly over the land and should not adversely impact the vegetation in the area."

"Landholders are advised to provide alternate water supplies for stock and to restrict livestock access to the water as a precaution. The government will closely monitor the situation, and water quality monitoring will take place before, during and after the aerial limestone works."

"The Currency Creek, Finniss River and Goolwa Channel region is one part of the Lower Lakes most at risk of acidification because it is shallow and has large areas of exposed soils." The use of limestone is aimed at raising water pH to levels where natural bioremediation will occur, neutralising soils and removing acid from the water.

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"The initial limestone trials that involved placing mounds of limestone across the lakebeds have proven successful to neutralise small amounts of acid that were mobilised in parts of the Finnis River, but are too slow to deal with the scale of the problem we are now facing in Currency Creek," Mr Seaman said.

The trials are being undertaken in partnership with Rural Solutions SA. The State Government is working with local communities, scientists, technical experts and engineers to address immediate drought response issues and also develop long-term sustainable solutions. The trial is part of planning for a worst-case scenario – that the drought continues and acidification at the Lower Lakes worsens.

Department for Environment and Heritage is currently developing a long-term plan for the region. The long-term plan is due for completion in October 2009, after which a funding bid to implement the plan will be submitted to the Federal Government.

Acid sulfate soil information kits distributed

As part of the Acid Sulfate Soil Knowledge Project funded by the Australian Government, a kit of acid sulfate soil information has been compiled for distribution nationally. The kit contains publications which have been produced to raise awareness of the problem and provide guidance on the management of acid sulfate soils.

To date 1,000 information kits have been distributed across the country to stakeholders such as regional natural resource management organisations, local government and industry.

A limited number of kits are still available for organisations and individuals, please contact the Information Officer on (02) 6626 1355 or christina.clay@dpi.nsw.gov.au if wish to obtain a copy.

Uncertain future for ASSAY

ASSAY, the national newsletter on acid sulfate soils, is again facing an uncertain future, with this the last edition under current funding arrangements.

Thought to be one of Australia's longest running natural resource management newsletters, ASSAY was first produced in March 1993. From that time it has grown from a simple A4 back and front update for the north coast of NSW to a comprehensive national newsletter.

Although the future is unknown, ASSAY has a history of surviving uncertainty. Many changes have occurred in natural resource management since the early 1990's and through it all ASSAY has continued to exist. ASSAY has survived department amalgamations, Natural Heritage Trust phase one and two and the transition to regional delivery, no small feat for a newsletter entirely reliant on external funding.

For the past 12 months ASSAY has been directly funded by the Australian Government, through the Coastal Catchments Initiative. An application made to continue the newsletter under the new federal funding program, Caring for our Country, was unfortunately unsuccessful, leaving the newsletter with no funds to continue.

Now going into its sixteenth year of production, ASSAY has been the country's primary source of information on acid sulfate soils and a valuable resource for those working in the field.

Acidic water could be the final straw

Verity Edwards and Pia Akerman
May 18, 2009
The Australian

First it was salt, now it is acid preventing farmers at Currency Creek and along the Finniss River from using Murray River water.

While it may have been a blessing at the time, heavy rains last month have mobilised acid in exposed soil beds in sections of South Australia's Lower Lakes, sparking warnings to keep livestock away from the two tributaries and fears the flowing water could have an impact on the health of local landowners.

For dairy farmer Don Galpin, the increased acidification could not have come at a worse time. Mr Galpin, who runs his family's 100-year-old farm on the banks of Currency Creek, has spent the past three years battling drought, falling milk prices, a doubling of feed costs and being forced to buy water to ensure it is of a high enough quality to run his business.

"It certainly is (a nail in the coffin)," Mr Galpin told The Australian. "It's a negative as far as the area is concerned. It's the last thing we need." The 64-year-old, his wife, Sue, and sons Jarrad and Andrew have battled tough conditions for three years. They considered selling, but are "hanging in there".

There is little water left to pump from the river. When the pipes are not running dry, the water is too acidic. The farmer has spent more than \$6,000 buying water this year. "If we hadn't been able to buy water from the Myponga Reservoir, we would have had to close down," Mr Galpin said. "That's more or less saved us at a price."

Health SA has advised that the acidic water could irritate the eyes, and has warned people to avoid contact with the tributaries. Landholders have been asked to keep stock away from the water and to provide alternate supplies.

Modelling last year predicted Finniss River and Currency Creek would acidify once water levels dropped to 0.75m below sea level. River Murray Minister Karlene Maywald said last week water levels in the Goolwa Channel were well below that point and the tributaries had disconnected, allowing acidic material to build up.

More than 300 tonnes of fine limestone have already been placed in Currency Creek, and 80 tonnes in the Finniss River to neutralise the acid. It is hoped temporary barriers across the Goolwa Channel from Clayton to Hindmarsh Island, and across the mouths of the Finniss River and Currency Creek, will prevent further acidification.

The barriers have been approved by federal Environment Minister Peter Garrett to prevent a "bad environmental outcome" and to manage "acidification impacts".

The Ngarrindjeri Native Title Committee is opposed to any temporary or permanent barriers across any section of the Murray or Lower Lakes. "We do not want them because it's going to have a huge impact on our country, on our culture and connecting to our stories," chairman Matt Rigney told The Australian.

"We do understand the importance of water for Adelaide and the major country towns, but we've been caught in a situation where we're damned if we do, damned if we don't."

Priority acid sulfate soil investigations along the Gippsland coast

Priority investigations for acid sulfate soils along the Gippsland coast were carried out in 2007-08 as a component of the Australian Government funded Gippsland Coastal Catchment Initiative. The investigations were completed by Mr Doug Crawford of Department of Primary Industries Victoria, and Mr Neville Rosengren of Latrobe University.

The investigations centred along the Gippsland coast (from Waratah Bay to Lake Tyers) with a particular focus on two Ramsar wetlands: the Gippsland Lakes and Corner Inlet.

Around 170,000 ha was investigated for coastal acid sulfate soils, with soil sampling conducted at 65 sites. The investigations confirmed that approximately 130,000 ha of that land has the potential to contain coastal acid sulfate soils.

The risks from these soils were ranked against environmental values identified by the West Gippsland and East Gippsland Catchment Management Authorities' River Health Strategies and Water Quality Action Plan. Following are the key findings from that exercise:

- For the Gippsland Lakes Ramsar site; Lake Wellington, and the lower reaches of the La Trobe, Mitchell and Tambo Rivers, have a combination of high environmental value and high risk for potential acid discharge if acid sulfate soils were disturbed. The risk posed has already been realised to some extent as actual acid sulfate soils were detected at Lake Wellington and along the lower reach of the La Trobe River.
- The lower reaches of the Nicholson River; although not ranked as 'high coastal value', contains large areas of potential coastal acid sulfate soils, most of which is privately owned. This investigation has since confirmed the presence of coastal acid sulfate soils. The disturbance of coastal acid sulfate soils along this river could lead to acidic leachates entering the nearby river and estuary system.
- For the Corner Inlet Ramsar site; and neighbouring high coastal value areas (Waratah Bay and Shallow Inlet, the lower reach and estuary of the Franklin River and the Agnes River), disturbance of coastal acid sulfate soils has the potential to generate acidic leachates from the coastal plains, flood plains and swamps, and from the lower reaches of the Tarra, Jack and Agnes Rivers.

The investigation identified a range of activities and related changes to the landscape along the Gippsland coast that place coastal values (in particular the Ramsar wetland sites) at risk from acid discharge events.

1. The un-natural hydrology of the Gippsland Lakes. (Gippsland Lakes Ramsar site)
2. Artificial drainage networks. (Gippsland Lakes and Corner Inlet Ramsar sites)
3. Infrastructure which has in the past, been designed and constructed without consideration of coastal acid sulfate soils, e.g. urban services, septic tanks, old gas pipelines. (Gippsland Lakes and Corner Inlet Ramsar sites)
4. Erosion of natural levees and beach ridges. (Gippsland Lakes and Corner Inlet Ramsar sites)
5. Destruction of peat. (Gippsland Lakes and Corner Inlet Ramsar sites).

For further information contact Rebecca Price of the Department of Sustainability and Environment on (03) 9637 8551 or Rebecca.Price@dse.vic.gov.au

Learning more about monosulfidic black ooze in WA

The environmental impacts of monosulfidic black ooze (MBO) will be the subject of a significant study in the Peel region of Western Australia. This project will be lead by Professors Richard Bush and Leigh Sullivan and Dr Ed Burton at Southern Cross GeoScience at Southern Cross University. Department of Environment and Conservation's acid sulfate soils section manager Stephen Wong said the project had attracted funding through the Australian Research Council's Linkage Grant program which aimed to encourage partnerships between government, industry and universities.

He said the high level research project would be jointly funded by two local councils – the Shire of Murray and the City of Mandurah – and three State government departments – Water, Planning and Infrastructure and Environment and Conservation. “The project will run over three years and the money contributed will pay for the services of two research associates and one PhD student and cover costs for field sampling and analysis,” Stephen said.

He said the problems of sulfidic-rich ooze accumulation in eutrophic estuaries had only recently been recognised as an ongoing environmental risk in estuaries and canals that require periodical dredging. “Research has demonstrated that mobilisation of monosulfidic black ooze is linked to severe water quality impacts,” said Stephen. “The accumulation of monosulfidic black ooze is a recognised environmental impact of eutrophication and algal bloom cycles. However, to date there have been no detailed studies in WA to understand how these materials form and accumulate.”

He said this basic understanding was required to inform management at all levels from on-ground dredging and maintenance through to strategic policy. “This project will address a major knowledge gap by developing a clear understanding of monosulfidic-rich ooze formation in estuaries,” said Stephen. The study will be conducted in the mid reaches of the Peel Inlet.

“This project will make use of the impressive amount of relevant data that has already been published about this site,” said Stephen. “The mid reaches of the Peel Inlet in the Yunderup/Murray Waters area is known to experience the prolific accumulation of monosulfidic black ooze and has a long history of dredging to maintain boat passage through the canals.”

For further information contact Stephen Wong from the Department of Environment and Conservation on (08) 6364 7089 or stephen.wong@dec.wa.gov.au

A new indicator for aquatic impacts of disturbed acid sulfate soil.

Disturbance of acid sulfate soils has well-described effects on aquatic ecosystems, however in Western Australia these effects are considerably less obvious than in eastern Australian locations.

Although there are large areas of potential acid sulfate soils, widely spread along the coastal plain of south-west Western Australia, there are very few locations where actual acidity has been found using the normal indicators. This is despite many locations where oxidised acid sulfate soils could have a potential impact upon the aquatic environment.

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The Department of Water has been trialling sulfur isotopic abundance as a tracer of acid sulfate soil influence. Extra sulfur in waterways (other than from seawater) may come from oxidation of pyrite, but may also come from fertiliser and/or greywater. Sulfur occurs naturally in four stable isotope forms, of which ^{32}S and ^{34}S are most abundant (95% and 4.2% respectively). Differences in the abundance of these two isotopes from different sources (i.e. pyrite, seawater, greywater or fertiliser) can be exploited to provide a signal of acidic drainage in water.

The dissolved sulfate in approximately 300 water samples collected from waterways throughout the south-west corner of Western Australia was analysed for $\delta^{34}\text{S}$ (indicates relative abundances of ^{32}S and ^{34}S) using isotopic ratio mass spectrometry. Based on this signal, approximately 5% of sites sampled were identified as receiving acidic drainage. Only a few of these sites had low pH, significantly high total

acidity, or elevated metal concentrations (i.e. typical indicators of acid sulfate soil influence on waterways). However, elevated aluminium and iron were found in fish sampled within the Peel Harvey Estuary at sites where acidic drainage was identified by using $\delta^{34}\text{S}$ as the indicator. Another 15% of sites might also be influenced by acid sulfate soil, however the $\delta^{34}\text{S}$ showed mixed sulfur influences for these sites. These results suggest that disturbance of acid sulfate soil is having a chronic rather than acute effect on water resources in Western Australia. Although the technique may need some refinement to better differentiate between potential sulfur sources, the use of $\delta^{34}\text{S}$ as an indicator of acidification due to acid sulfate soil shows promise.

For further information please contact Dr Kiernyn Kilminster on (08) 6364 7839 or kiernyn.kilminster@water.wa.gov.au



Collecting water samples from waterways throughout the south-west corner of Western Australia.



Elevated aluminium and iron were found in fish sampled from the Peel Harvey Estuary.

Drilling program confirms acid sulfate soils widespread throughout Perth

A rigorous 12-month drilling and mapping project (previously reported in edition 45) has confirmed that potential acid sulfate soils are widespread in the Perth metropolitan area. With the intensive ground truthing program now drawing to a close, the Department of Environment and Conservation (DEC), has drilled and sampled 185 sites from Gnangara in the north to Baldivis in the south.

DEC's acid sulfate soils section manager Stephen Wong said the information gained from the project highlighted the extent of sulfide bearing soils found within the Perth metropolitan area. "With increased urban development spreading across many areas of the Swan Coastal Plain, it is important that we understand the delicate balance between excessive soil and groundwater disturbance in areas underlain by framboids and single crystal pyrite."



185 sites were drilled and sampled during the investigation.

In addition, DEC has commissioned University of Western Australia to study the mineralogical processes controlling landscape acidity and heavy metal mobilisation on the Swan Coastal Plain. "This investigation is vital to better understand the geochemical changes in acid sulfate soil landscapes due to declining annual rainfall, changes in land use and increased groundwater abstraction," Mr Wong said. "All these impacts have resulted in widespread disturbance of iron sulfides."

The mapping program, made possible by Commonwealth and State funding, has collected hundreds of core samples from across Perth's suburbs. The drill sites within the mapped area were selected where the groundwater table is closest to the ground surface. "Low lying swampy areas around lakes and wetlands, suburban parks and reserves were preferred sites because the depth to the water table is not too far," Dr Singh said. "Usually these areas are quite accessible."

Dr Singh said the study proved that potential acid sulfate soils were widespread across the Perth metropolitan area. "They are certainly not limited to currently known hotspots such as those in the City of Stirling," he said.

"Broad scale maps will show the presence or absence of acid sulfate soils but more detailed mapping will show acidity hotspots and the depth to and concentration of actual and/or potential acid sulfate soil layers containing pyrite," Mr Wong said.

"This information is necessary to address the issue of avoidance and/or appropriate management for any development activities that could potentially disturb acid sulfate soil," Mr Wong said.

New guidelines released

Western Australia's new acid sulfate soil guidelines have been released for public comment. The Department of Environment and Conservation's Contaminated Sites Branch has published the draft guidelines – "Treatment and management of soils and water in acid sulfate soil landscapes".

Acid sulfate soil section manager Stephen Wong said the guideline document provided thorough and comprehensive direction for land developers, consultants and regulatory authorities. "These guidelines have been much anticipated and we expect it to be welcomed by our stakeholders as it consolidates management of soils and water into one document," he said.

"In addition, the guidelines address the additional sources of acidity that are contributing to the acidification of groundwater in poorly-buffered sandy aquifers on the Swan Coastal Plain." Although not confined to the coastal regions of Western Australia, acid sulfate soils cover much of the Swan Coastal Plain. The 'National Atlas for Acid Sulfate Soils' has identified 27,500km² of coastal and estuarine acid sulfate soils in Western Australia.

"Understanding the distribution of acid sulfate soil materials and other potential sources of environmental acidity is a prerequisite for managing disturbance of these soils to prevent environmental problems," said Mr Wong. "This is a document based on more than five years of practical experience in dealing with acidity issues in WA urban landscapes."

The guidelines can be downloaded from DEC's website at <http://www.dec.wa.gov.au/management-and-protection/acid-sulfate-soils/guidelines.html>

Research update

What controls aluminium activity in tropical acid sulfate soils?

Hicks, W.S. Bowman, G.M. Fitzpatrick, R.W. (2009) Effect of season and landscape position on the aluminium geochemistry of tropical acid sulfate soil leachate. *Australian Journal of Soil Research* 47:137-153

Aluminium is one of the metals mobilised during the oxidisation of acid sulfate soils. It is very harmful to the surrounding environment, particularly downstream aquatic environments and has been associated with a range of negative impacts on fish.

In order to minimise the impacts of aluminium, it is important to understand how aluminium behaves and what controls its mobilisation. This paper discusses a range of different theories, including van Breeman's 1973 model.

The paper examines data gathered from East Trinity, a tropical estuarine wetland in North Queensland and examines the complex biogeochemical cycles of aluminium, iron and sulfate.

Samples of surface water, groundwater and water discharging from the site were collected and analysed. The paper develops a model to explain the variation in aluminium concentrations in these waters and their relationship to environmental variables.

For a copy of the above paper contact the Information Officer on (02) 6626 1355 or christina.clay@dpi.nsw.gov.au

Acidified groundwater bores a potential health hazard in WA

Hinwood, A. Horwitz, P. and Rogan, R. (2008) Human exposure to metals in groundwater affected by acid sulfate soil disturbance. *Arch Environ Contam Toxicol* 55:538-545

A recent investigation has suggested that domestic groundwater bores located in coastal areas of Western Australia may be a potential health hazard. Concerns were raised after high concentrations of metals were recorded in residential groundwater bores. The heavy metals have been linked to the oxidisation of acid sulfate soils in the local area.

The disturbance and oxidisation of acid sulfate soils not only increases acidity, but also mobilises high concentrations of metals in groundwater or connected surface water. If this contaminated water is then used for activities such as growing produce, there is a significant risk that humans may become exposed to these metals and may experience a range of associated health effects.

A previous study (highlighted in edition 40) of 67 households in Stirling, a suburb of Perth, confirmed the presence of elevated metal concentrations in residential groundwater bores. Very high concentrations of aluminium and arsenic were recorded, as well as elevated concentrations of lead and cadmium.

This new study undertakes a preliminary investigation of human exposure to metals, recruiting 27 residents from Stirling, of which 21 residents used a groundwater bore to irrigate home grown produce, and 6 residents did not. Participants completed a questionnaire and provided a sample of urine, toenails, hair, and bore water for testing.

Results indicate that people using bore water with high levels of aluminium, cadmium and lead, had higher hair metal concentrations than people who didn't use bore water. This suggests that bore water users might be exposed to metals and further investigation is warranted, even though the concentrations recorded in this study were low.

Whilst many areas on the Swan Coastal Plain are impacted by acid sulfate soils, the scale of human exposure to subsequent contaminated groundwater is not known. However, two preliminary investigations now indicate that activities such as growing home grown produce may provide a route for exposure. This combined with recent reports of even higher concentrations of metals being recorded in groundwater in acid sulfate soil affected areas, heightens health concerns.

The study indicates that contaminated bore water is increasing in urbanised areas of Western Australia and recommends that its impact on the population is assessed to determine the relationship between environmental exposure, consumption of home-grown produce, and potential health effects.

For a copy of the above paper contact the Information Officer on (02) 6626 1355 or christina.clay@dpi.nsw.gov.au

Tidal inundation of acid sulfate soils at East Trinity – iron is king

Ongoing research by Southern Cross GeoScience and Qld Department of Natural Resources and Water is demonstrating the vitally important role iron (Fe) has in controlling the long term outcomes of lime-assisted, tidal exchange used to remediate East Trinity.

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Everyone who works with acid sulfate soils appreciates that Fe(III) minerals are a distinctive feature of these soils. What is less well known is what happens to this iron when the soils are subject to tidal inundation. At East Trinity, tidal inundation is causing dissolution of Fe(III) minerals, including jarosite, which had accumulated during previously drained and oxidised conditions. This dissolution generates very high concentrations of Fe²⁺ in the groundwater. This Fe²⁺ is highly mobile and tidal fluctuation of groundwater levels encourages the redistribution of this iron within the landscape. As a result there is enhanced accumulation of reactive Fe(III) minerals near the soil surface (up to ~40%).

All this extra iron near the surface is influencing the kinds of sulfide minerals that are reforming. Whilst pyrite is certainly being reformed and consuming acidity in the process, the high concentrations of Fe(III) near the soil surface favour the formation of more reactive mono-sulfides and elemental sulfur. If tidal inundation ceased, these reactive sulfides could oxidise relatively quickly. Therefore, once tidal inundation begins it is important that it continues, otherwise the benefits of remediation could be rapidly reversed.

A recent paper

Johnston, S. G. Keene, A.F. Bush, R.T. Burton, E.D. Sullivan, L. A. Smith, D. McElnea, A.E. Martens, M.A. Wilbraham, S. (2009) Contemporary pedogenesis of severely degraded tropical acid sulfate soils after introduction of regular tidal inundation. *Geoderma* 149:335-346

.....documenting some of these and other findings is available from the Information Officer on (02) 6626 1355 or christina.clay@dpi.nsw.gov.au

Research at the site is ongoing and for further information contact project leader Prof. Richard Bush at richard.bush@scu.edu.au



Very high concentrations of reactive Fe(III) minerals staining the inter-tidal zone surface at East Trinity.

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