ASSAY

A NEWSLETTER ABOUT ACID SULFATE SOILS

No. 45 April 2008

Welcome to edition 45

There is certainly no shortage of topics to highlight in this edition.
In NSW, with the return of wetter conditions we've had a major fish kill in the Richmond River and outbreaks of red-spot up and down the coast. Queensland continues to map and assess acid sulfate soils along the critical Great Barrier Reef coast. Western Australia starts a new project investigating the degree of acidification of one of Perth's most important groundwater supplies. Tasmania is coming to grips with the extent of acid sulfate soils in their state, and we learn more about the formation and distribution of acid sulfate soils throughout the lower Murray River.
Acid sulfate soils are a complex issue, presenting itself differently across the country. It has the potential to impact upon nearly every sector of the community, and requires partnerships between stakeholders if we are to manage and address these impacts.
However, never before has there been as much interest and awareness of acid sulfate soils as there is now and that is thanks to your efforts and involvement in identifying, understanding, managing and remediating acid sulfate soils.
I'll be on maternity leave until later this year and will leave you in the capable hands of Harry Rose. Till then keep up the great work in addressing one of the most important natural resource issues facing the country.
Chrisy

New webpage on acid sulfate soils

CSIRO Land and Water have developed a new webpage on acid sulfate soils. The webpage contains information on the national acid sulfate soil atlas and the formation and distribution of inland acid sulfate soils.

Visit the new webpage at
www.clw.csiro.au/acidsulfatesoils/murray.html

ASSAY continues until June 2009

Thanks to funding from the Australian Government, ASSAY will continue to be published until June 2009.

ASSAY started as a simple one page newsletter in 1993. Originally produced for the north coast of NSW and south-east Queensland, ASSAY has grown to be a nationally recognised publication. With the current extension, ASSAY is one of the longest running, continually produced natural resource newsletters in the country.

In this edition:

Acid sulfate soils mapped as the Lower Murray dries out

Fitzpatrick, R. Marvanek, S. Shand, P. Merry, R. Thomas, M. and Raven, M. (2008)
Acid Sulfate Soil Maps of the River Murray below Blanchetown (Lock 1) and Lakes Alexandrina and Albert when water levels were at pre- drought and current drought conditions. CSIRO Land and Water Science Report 12/08. CSIRO, Adelaide, 17 pp

Acid sulfate soils are soils that either contain sulfuric acid, or have the potential to form sulfuric acid when exposed to air. As water levels in the lower Murray River system below Blanchetown (Lock 1) to Lakes Alexandrina and Albert drop during the current, unprecedented drought, the sulfidic materials in the subaqueous soils that were once covered by water are now exposed to air. Once exposed the sulfidic material in these anaerobic soils oxidise and transform to sulfuric material (pH range <4), with implications for on- and off-site water supply, biodiversity and public health.

The report listed above provides a conceptual model to explain four sequential phases that occur as the subaqueous soils are exposed to air. By applying this model and integrating detailed field survey work, laboratory data and the Australian Soil Classification Scheme, fourteen subtypes of acid sulfate soils have been identified.

Bathymetry, soil and vegetation GIS mapping data have been combined to predict the distribution of these fourteen subtypes of acid sulfate soils according to two water-level scenarios:

(i) pre-drought water level, i.e. plus 0.5 m Australian Height Datum (AHD); and
(ii) current (February 2008) drought level, i.e. minus 0.5 AHD.

The authors note that field observations suggest that the GIS data used to under-pin the map predictions to be too coarse to 'capture' the true spatial variability of acid sulfate soils encountered. However, where possible, map units have been verified through field investigations, and the predictive mapping modified manually to reflect the actual subtype of acid sulfate soils present.

Work will continue to verify and refine map boundaries on a case-by-case basis, or until new GIS data at scales consistent with the true spatial variability of acid sulfate soil subtypes, becomes available. New water-level scenario predictions for the River sections (Lock 1 to Wellington) will be performed once new bathymetry data is supplied in March 2008.

As such, the mapping will continue to be refined as: (i) more detailed models are developed based on new field and laboratory investigations, (ii) more suitable GIS data becomes available, and; (iii) there is increased demand for new predictions as water levels drop further.

The report also presents best management principles and a summary of management options for the various main subtypes of acid sulfate soils encountered in this region. The report can be downloaded with or without the maps from
http://www.clw.csiro.au/publications/science/2008/sr12-08_withmaps.pdf or
http://www.clw.csiro.au/publications/science/2008/sr12-08_nomaps.pdf

New information sheet on acid sulfate soils in the lower Murray available

An information sheet describing the formation and occurrence of acid sulfate soils throughout the lower Murray River is available on line.

To download a copy visit
http://www.dwlbc.sa.gov.au/assets/files/RM_acid_sulfate_dec07.pdf

'Blackwater' event in Richmond River

Major flooding in the Richmond River during January has resulted in a massive fish kill. The fish kill occurred after dissolved oxygen levels crashed in the estuary to less than 1mg/L for around a week.

The levels of dissolved oxygen dropped when floodwaters, which had inundated the floodplain for for nearly a week, discharged into the estuary. Rotting floodplain vegetation and mono-sulfidic black ooze are thought to have generated the large volume of deoxygenated water, which killed thousands of fish and prawns.

As a result the Department of Primary Industries closed the Richmond River to all forms of fishing for one month, while the river recovered. This is the second major fish kill associated with summer floods in the Richmond River, with the first occurring in 2001 leading to the river being closed for six months.

The geomorphic features of the Richmond catchment make it particularly vulnerable to de-oxygenation or 'blackwater' events. It has the largest coastal floodplain in NSW, and in terms of catchment to floodplain ratio, the Richmond has a very large and mature floodplain for the size of its catchment. This is a direct result of the high rainfall the catchment receives: an average of 1,650mm per year and a 6,864km^2 catchment. By contrast the Clarence, a well known catchment to the south, receives an average of 1,072mm per year and has a 19,800km^2 catchment. The run off from such a large floodplain, particularly following summer flooding, into a relatively small receiving water can deoxygenate extensive stretches of the estuary for prolonged periods of time. In comparison the Clarence is the reverse, an extensive catchment and a large river, but with a less mature and small floodplain.

Red spot outbreaks after rain

The return to wetter conditions on the north coast of NSW during January and February has resulted in a number of outbreaks of red spot. Previous outbreaks of red spot disease or epizootic ulcerative syndrome in NSW have been associated with acid water run-off, particularly after heavy rain following a prolonged dry spell.

The skill and gills of fish are damaged by waters acidified by acid sulfate soils, which increases the susceptibility of fish to fungal infection and in turn leads to diseases such as red spot. To date outbreaks have been recorded in the Richmond, Clarence, Manning and Hawkesbury estuaries.

Regional forum held in Grafton

Acid sulfate soils experts and scientists from around Australia met in Grafton as part of a forum organised by NSW Department of Primary Industries. The forum entitled 'sharing our experiences' highlighted the latest developments in acid sulfate soils. Speakers included nationally and internationally recognised acid sulfate soils scientists in addition to well known local and regional experts. The presentations covered a diverse range of subjects on the identification, regulation, management and remediation of acid sulfate soils.

More than 120 people attended the forum representing a wide range of groups, including landowners, fishermen and oyster growers, scientists and government managers. The forum coincided with the National Committee for Coastal Acid Sulfate Soil's bi-annual meeting held at Yamba.

Drilling Gnangara to determine extent of acidification

The Department of Environment and Conservation (DEC) has begun drilling on the Gnangara Mound as part of a study to determine the extent of soil and groundwater acidity within Perth's largest water source.

The Gnangara Mound groundwater system provides 60 per cent of Perth's scheme water but is under threat from declining rainfall and the increased demands of a growing population. In addition, naturally occurring acid sulfate soils in the wetlands and peaty soils of the Gnangara area, are vulnerable to disturbance through increased groundwater pumping, drainage and excavation. Excessive fertiliser use and tree and crop harvests in areas with light sandy soils can also lead to increased soil acidity.

Drilling at Gnangara Mound

DEC Contaminated Sites Branch manager Kerry Laszig said the drilling work was the first stage of a project to better understand the chemical processes of the Gnangara water supply. The focus of the DEC study is primarily in the areas of cleared and uncleared pine plantations on the mound, banksia woodlands and areas being used for agriculture and market gardens.

"The first phase of the investigation involved drilling and installing 10 monitoring wells on the Gnangara Mound from three to five metres below the water table," Ms Laszig said. The wells are locatedbetween the wetlands in the west and the dunes in the east and will be used to detect the current groundwater quality including assessing the extent and severity of the acidity footprint in the shallow groundwater system.

"These wells are designed specifically to look at the acidity of the water table and will be supplemented by intensive soil sampling at 13 different sites and the installation of 10 additional groundwater monitoring wells," Ms Laszig said.

She said the soil and groundwater sampling was part of a cross government initiative designed to ensure a sustainable water supply for drinking and commercial use and to protect the environment. Previous monitoring has shown that the amount of groundwater pumped for water supply, irrigation and industrial use had trebled over the past 30 years.

Ms Laszig said, as a result, the water table had dropped significantly in some areas and there was evidence of acidification of the soil and groundwater. "The data collected in this study will help determine the mechanisms that are affecting groundwater quality," she said.

The information gained will be used to predict the consequences of different land uses, optimise management of these activities and better define future land use options for the area.

Wetland soils on Tasmania's east coast

Broad scale mapping of Tasmania suggests that 328,000 ha of land is potentially underlain with acid sulfate soils with an additional 186,000 ha of tidal and subtidal areas identified. Management of this acid potential is challenging due to land managers low level of awareness about these soils, their distribution and potential impacts.

As a result, raising the awareness about acid sulfate soils was high on the agenda at the recent statewide Wetlands Forum, an initiative of the Australian Government NRM Facilitators based in Tasmania. The forum included multiple stops around the spectacular Moulting Lagoon Ramsar site on Tasmania's east coast. Over 50 participants listened to expert speakers on a range of topics including: climate change, the role of local government, preparing ecological character descriptions for Ramsar sites and acid sulfate soils.

Moulting Lagoon Ramsar Wetland

Rob Moreton from the Department of Primary Industries and Water, and the Tasmanian representative on the National Committee for Acid Sulfate Soils provided an overview of acid sulfate soils in Tasmania and conducted a simple field test for the forum participants with impressive results (pictured). This demonstration identified potential acid soils within a soil profile from a tidal area of Moulting Lagoon Wetland and simulated the oxidation process that could occur if these soils were disturbed.

Tasmania has nine Ramsar listed sites along with numerous other important coastal wetlands. With increasing development pressure and use of coastal resources the risks of disturbing acid sulfate soils increases and the need for greater understanding and guidance becomes more critical.

For more information contact Rob Moreton from Department of Primary Industries and Water on (03) 6336 5441 or rob.moreton@dpiw.tas.gov.au

Rob Moreton (left) undertaking field test of acid sulfate soils at the Tasmanian Wetlands Forum, Moulting Lagoon Ramsar site, Tasmania.

School science teachers learn about acid sulfate soils

On the 5th of March 2008, Carl Cross, Lauren O'Brien and Ashneel Sharma from the Department of Natural Resources and Water (NRW) conducted a half day acid sulfate soils workshop for a group of 15 secondary school teachers from seven schools in the Brisbane area.

The workshop, coordinated by Sue Monteath from Education Queensland, provided a hands-on opportunity for senior science school teachers to see acid sulfate soils at Nudgee Beach on the shores of Moreton Bay.

NRW provided sampling tools and field equipment for the school teachers to practice sampling of acid sulfate soils. Acid sulfate soils provide teachers with a real life, practical demonstration of acid-base and redox chemistry in the natural environment. The investigation and field testing of acid sulfate soils by students promises to be an interesting addition to the senior science curriculum.

This project is a joint initiative of NRW, Education Qld, Science Teachers Association and the Qld Branch of the Australian Soil Science Society to encourage students to take an active interest in science.

Lauren O'Brien demonstrates acid sulfate soil sampling using a gauge auger, while Carl Cross (extreme left), provides commentary to the science teachers.

Awareness of acid sulfate soils in central Queensland

In 2004 an awareness survey of acid sulfate soils was undertaken in central Queensland. At the request of the Department of Natural Resources and Water (NRW), a set of questions were included in a larger social survey undertaken by the Centre for Social Science Research at Central Queensland University.

In 2007 these questions were repeated to identify any changes in opinions and awareness. This was of particular interest to NRW who conducted an acid sulfate soils mapping project in central Queensland during that period.

The survey targeted a cross-section of randomly selected people from central Queensland, who may be considered representative of the region, however as with most research caution should be taken when drawing conclusions from the data.

Summary of findings

- The general awareness of acid sulfate soils reported by respondents in 2004 and 2007 appears quite similar, with 33% and 37% of respondents reporting in 2004 and 2007 respectively that they had heard of acid sulfate soils. However, this is a statistically significant increase in the proportion of respondents who reported an awareness of acid sulfate soils in this time interval.

- A lower proportion of Rockhampton residents report awareness of acid sulfate soils compared to residents of other central Queensland locations sampled in both 2004 and 2007. There were no significant changes across time in either area.

- A greater proportion of respondents residing in rural areas report awareness of acid sulfate soils compared with those residing in cities or towns. Significantly more city residents reported awareness of acid sulfate soils in 2007.

- In 2007 a significantly lower proportion of respondents who have resided in their current community for five years or less reported awareness of acid sulfate soils compared with those residing in their community for longer than five years.

- A slightly lower proportion of respondents residing in non coastal areas report awareness of acid sulfate soils compared with those residing in coastal areas.

- Awareness of acid sulfate soils was significantly higher for those respondents employed in primary industry and lowest amongst those employed in tertiary industry in both 2004 and 2007.

- A significantly higher proportion of respondents who have undertaken technical or tertiary studies report awareness of acid sulfate soils compared with those who have completed secondary schooling or below in both 2004 and 2007.

- The most common sources of information about acid sulfate soils were print media, television and word of mouth. Work, school/university and associations with farming were also mentioned as sources of information.

- In both 2004 and 2007 there was strong support for providing public funds to map and monitor acid sulfate soils and avoid their disturbance. There were no significant changes over time.

Detailed mapping of acid sulfate soils needed to protect reef

Over the past 150 years, mangrove and saltmarsh habitats in some areas of north Queensland have been reclaimed for urban and industrial development, port expansion, salt farms, mining, aquaculture, and agriculture. Such coastal development has a high risk of disturbing acid sulfate soils and places pressure on the Great Barrier Reef coast. Detailed mapping of acid sulfate soils is urgently required in the region.

Carl Cross notes down GPS coordinates next to the Geoprobe coring machine, for a site at near Cairns North Qld.

Initial investigations of the distribution of acid sulfate soils have started in the Cairns region. Field sampling is currently being conducted by Department of Natural Resources and Water (NRW) staff from the Brisbane (QASSIT) and Mareeba Offices and staff based at the East Trinity remediation project.

Existing local government acid sulfate soil maps are indicative only; they are based upon geomorphology, vegetation, soil types, climate and elevation. These indicative maps can be fairly useful to identify the potential distribution of acid sulfate soils however they are likely to overestimate in some areas and underestimate in other areas.

The field sampling and laboratory analysis currently being undertaken is vitally important to determine the exact distribution of acid sulfate soil. However sampling has to occur at a sufficient intensity to map the depth of the acid sulfate soil layer below the surface, which is critical information for good management decisions. Most landholders will be currently unaware that they have acid sulfate soils on their properties and at what depth these soils occur.

Jeremy Manders working with the Geoprobe coring machine, for a site at Cairns.

Other information gathered from the field sampling will include the identification of any actual acid sulfate soil areas, and if the soil contains any neutralising capacity. NRW staff are currently waiting for the wet season to finish before recommencing sampling. Field sampling in the Cairns Region should be finished by late June 2008.

The benefit of opening floodgates

Johnston, S.G. Slavich, P.G. and Hirst, P. (2005) The impact of controlled tidal exchange on drainage water quality in acid sulfate soil backswamps. Agricultural Water Management 73:87-111

Extensive networks of drains and modified watercourses exist on the coastal floodplains of northern NSW. These drainage systems were historically designed to rapidly remove flood water and prevent tidal inundation, allowing agriculture to expand in coastal areas. Floodplain drainage systems regularly contain poor water quality, particularly during and after wet periods. Opening floodgates to allow controlled tidal exchange has become a popular way of improving water quality in drainage systems.

This paper describes the changes in water quality, particularly acid and dissolved oxygen levels, which occurred during controlled floodgate openings. Both drains studied are located in high risk acid sulfate soils and water quality is frequently acidic and low in dissolved oxygen.

The results of this study show that opening floodgates can improve water quality. Acidity was reduced, dissolved oxygen levels increased and the daily fluctuation of dissolved oxygen was moderated.

The extent of the improvement in water quality was found to be largely dependent on the frequency, magnitude and duration of opening. The volume and quality of the water exchanged also influenced the level of improvement achieved.

The study notes that there are significant limitations and complexities involved with opening floodgates to improve water quality. Any improvements in water quality may often be followed by rapid reversion to pre-opening conditions when the floodgates are closed again. If the drain was acidic before the floodgates were opened, a sharp improvement in pH can occur quickly, closely mirroring the tidal influence. This reduction in acidity can be a result of dilution, neutralisation by the acid buffering agents contained in tidal water, displacement of drain water by tidal water or a combination of the three. However a reoccurring feature was the rapid reversion to acidic conditions once the floodgates were closed again.

Although tidal water can reduce acidity, the concentration of buffering agents is strongly related to the salinity in the estuary which is highly variable. The study noted that the acid in drainage water often overwhelms the buffering capacity of estuarine tidal water.

The study also demonstrated the potential for increased acid discharge after floodgate openings. During the study, opening the floodgates on one drainage system recharged adjacent groundwater levels and when the gates were closed again acid export was enhanced. The drainage system was located in highly permeable soils and when the gates were opened a gradient running from the drain to the groundwater was created. Tidal water moved into the surrounding groundwater system, with the ingress recorded 300m away from the drainage channel. When the floodgates were shut again, the gradient changed direction and acidic groundwater discharged into the drainage system.

Dissolved oxygen levels in drainage systems fluctuate daily due to photosynthesis and respiration cycles. When the floodgates were opened dissolved oxygen levels improved, closely mirroring the tidal influence. Again, once when the floodgates were shut levels rapidly declined.

The study noted there are practical constraints which limit the impact of opening floodgates in improving water quality, particularly in the lowest lying areas of the floodplain. In these areas, the risk of saline overtopping into agricultural land or freshwater natural ecosystems is high. Also during wet periods when acid discharge is greatest, the buffering capacity of estuarine water is at its lowest. In terms of minimising acid discharge from drainage systems, further modifications to the drainage system are needed to address the source of acid discharge within each system.

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

Fish observed avoiding acid in fluviarium trials

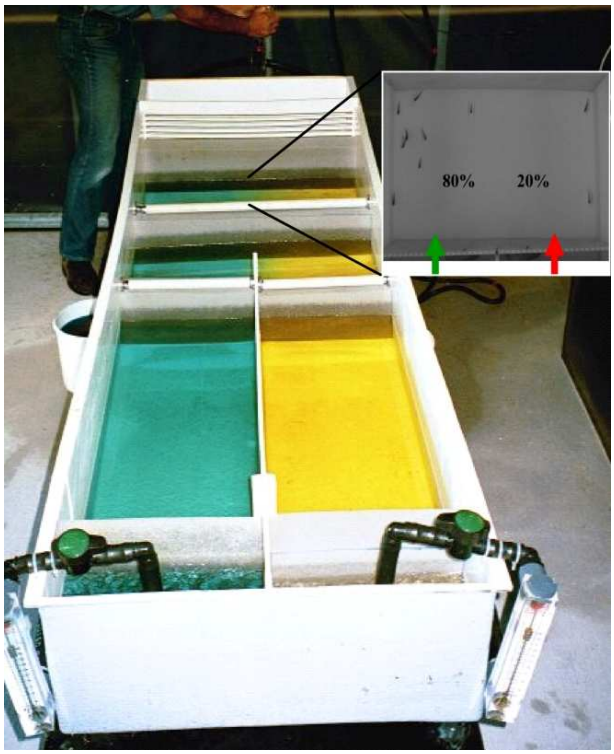
Kroon, F.J. and Housefield, G.P. (2003) A fluviarium with controlled water quality preference-avoidance experiments with fish and invertebrates. Limnology and Oceanography: Methods, 1:39-44.

Fluviariums are large aquarium-like structures used to investigate the 'preference-avoidance' behaviour of fish to water quality. Flowing water moves through the fluviarium, maintained by gravity. The sharp gradient provides fish with a choice of usually two water qualities, sharply demarcated at a relatively narrow boundary zone. This paper provides a detailed description of a fluviarium recently constructed to study acid avoidance behaviour in juvenile fish and prawns.

Maintaining water quality is an important aspect of sustainable aquatic ecosystem management. Poor water quality, such as that due to disturbed acid sulfate soils, may affect where and when fish and prawns move throughout an estuary. Acid discharge may create invisible barriers to movement, potentially affecting fish and prawn migration and access to nursery habitats.

The fluviarium used in this experiment uses hydrodynamic design to control water quality, while still being affordable. Controlling water quality is an important aspect in providing consistent experimental conditions. Another important feature of the design used is that fish are continuously exposed to both water qualities without getting trapped in either of the two channels.

In this experiment sulfuric acid was added to the water to regulate levels of acidity. Behavioural observations were made using continuous video footage and the number of fish in each half of the test area observed and recorded.



The fluviarium which exposed juvenile fish or prawns to two separate streams of water in one open area (see inset).

For a copy of the above paper contact the Information Officer on (02) 6626 1355 or christina.clay@dpi.nsw.gov.au For further information visit http://www.dpi.nsw.gov.au/agriculture/resources/soils/ass/posters/acid-avoidance

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ASSAY is a free newsletter funded by the Australian Government.

Australian Government
Department of the Environment, Water, Heritage and the Arts

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information and awareness