ASSAY
A NEWSLETTER ABOUT ACID SULFATE SOILS

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International Conference – abstract deadline extended

The 6th International Acid Sulfate Soil Conference will be held in China from 16-20 September. The conference, which will be run in conjunction with the Acid Rock Drainage Symposium, provides researchers and industry with an opportunity to highlight new developments and identify directions for future research on acid sulfate soil related issues.

The deadline for abstracts for either oral or poster presentations has been extended until June 30, 2008. However, only full paper manuscripts received by May 16, 2008 will be included in the conference proceedings.

Papers concerning the characteristics, processes, distribution, classification and management/remediation of sulfidic soils in coastal, mining and mined, and other inland environments are welcomed. Papers also dealing with biogeochemical processes, eco-toxicological assessment and remediation of acid drainage from coastal and mine site acid sulfate soils are requested.

For further information visit www.6assard.org

In this edition:

Update on National Standards for analysis of acid sulfate soils

Glenn Barry, Angus McElnea & Col Ahern

Standards Australia was infiltrated by approximately 70 soil experts from all over Eastern and Western Europe, Scandinavia, United Kingdom, Japan, Korea, Kenya and Australia during November. No, they weren't spying on the operations of Standards Australia, but were delegates attending the annual meeting of International Standards Organisation / Technical Committee 190 – Soil Quality which was hosted by Standard Australia's Committee EV-009, Analysis of Soil and Biota. This was the second time such a meeting was held in Australia and only the third time hosted outside Europe since its inception 22 years ago.

The Standards Australia Committee EV-009 has produced many Australian Standards, either fully or partially, based on ISO Standards. However, at this recent ISO meeting steps were taken to see a number of Australian Standards developed by working group EV-009-02-01 – Analysis of Acid Sulfate Soil, be adopted as ISO Standards. A meeting of international experts on acid sulfate soils will be convened to develop a proposal to have a working group established within TC 190. This working group will look at the Australian Standards on acid sulfate soils as the basis for developing ISO Standards in the near future.

For further information contact Patricia Carreto, Projects Manager for Standards Australia at patricia.carreto@standards.org.au

Monitoring the health of acid sulfate soils

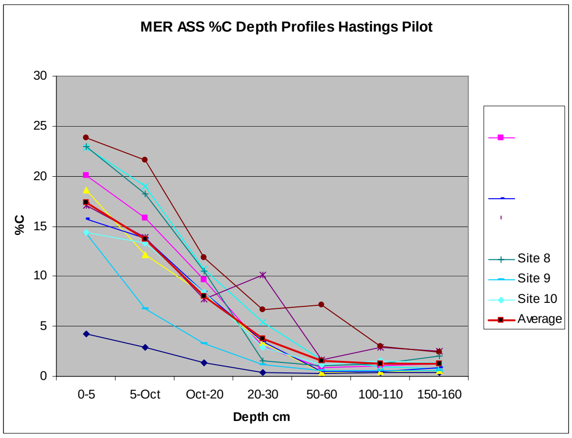
The NSW Department of Environment and Climate Change will be undertaking a project in the first half of 2008 to establish baseline data to monitor the health of acid sulfate soils on the NSW coast. This is part of a larger project monitoring soil health across the state in order to monitor a Natural Resource Commission target of *"By 2015 there is an improvement in soil condition"*.

The broader soil condition monitoring program will provide information suited to both state wide and Catchment Management Authority surveillance monitoring and data generated will also roll-up to satisfy national soil monitoring requirements. The monitoring program will provide data relating to baseline and trend in soil condition as well as prediction of change using land use and land management practice surrogates.

Dr Richard Bush (SCU) completing a soil description at Partridge Creek, a reference site in the new monitoring program.

Because the acid sulfate soil problem is greatest at lower elevations, the monitoring of change of acid sulfate soil health will be confined to areas that are mapped as high risk acid sulfate soil land of elevation < 2 m AHD. This represents a total area of 153,000 ha on the NSW coastal floodplains of which 30,000 ha (20%) is in the highest risk < 1 m elevation class.

The project will select 60 sites for detailed soil description and sampling. Four samples from each site will be sent to Southern Cross University laboratory for acid sulfate soil analysis and 40 samples will go to a Department of Environment and Climate Change laboratory for organic carbon analysis. The carbon data will help measure carbon sequestration rates on coastal floodplains. A pilot study of 10 sites on the Hastings floodplain showed high carbon contents in acid sulfate soil with values dropping from 14-24% in the topsoils to 2-5% at 50 cm.



Ten sites have been sampled from across the Hastings floodplain. In all samples carbon levels reduced with depth from ground surface.

It is planned to revisit and resample these sites on a five yearly rotation. It is also hoped to establish six acid sulfate soil reference sites in NSW that are intensively sampled and documented. The first of these was established at Partridge Creek on the Hastings Floodplain during the pilot study. It is hoped with additional funding the reference site network can be expanded.

For further information contact Glenn Atkinson, Senior Environmental Scientist, Department of Environment and Climate Change Kempsey on (02) 6561 4969 or Glenn.Atkinson@dnr.nsw.gov.au

New project investigates macropores

A NSW Department of Primary Industries (NSW DPI) project investigating the behaviour of groundwater in north coast acid sulfate soils is providing valuable information for the management of these soils.

"Networks of small tunnels created by old roots, have been found to play a significant role in the export of acid from these soils," said Dr Peter Slavich, soils research leader with NSW DPI. "NSW DPI scientists observed that groundwater escapes into the drainage system up to 1000 times faster when these tunnels, called macropores, are present".

The new project, which is supported and funded by a consortium of local councils, involves a rapid field test for soil porosity (or hydraulic conductivity) at a range of locations up and down the north coast. Tests will be carried out at six high-risk backswamps in each of the Tweed, Richmond, Clarence, Hastings, Macleay and Manning catchments.

Dr Slavich said the site specific information from the project will help to minimise acid export to river systems and maximise environmental and agricultural outcomes. Training will also be provided to local government staff to enable further assessments to be made at key local sites.

"To reduce the impacts of acid sulfate soils, we need to slow the export of groundwater from the soils into the drains because the bulk of acidity entering the drainage system is directly from groundwater," said Dr Slavich. "Unfortunately dense networks of these macropores can speed up the groundwater flow dramatically."

While 'plugging' up the pores is not a viable option, reducing the gradient that drives the groundwater through the pores is more achievable with low cost in-drain water retention structures. "These can be designed to keep the water in the drains at a similar level to the groundwater and reduce the gradient that moves groundwater sideways into the drains," he said.

Clarence Floodplain Project a finalist for major award

Clarence Valley Council joined elite company as a finalist in a major nation-wide environmental award last year. The Clarence Floodplain Project was one of five finalists in the local government category of the prestigious Banksia Environmental Awards, which recognise outstanding environmental achievements by businesses and individuals across the nation.

Project manager, Peter Wilson, said it was a remarkable achievement to reach the final. "When you consider that Westpac, BHP Billiton, Telstra and Rio Tinto are Banksia Award finalists in other categories, you get an idea of how prestigious they are," he said.

The Clarence Floodplain Project started in 1997 when a group of community, industry and government stakeholders formed a partnership to tackle environmental issues on the Clarence River floodplain and estuary.

"It's all about better managing floodplain watercourses and wetlands," Mr Wilson said. "Benefits to the environment have been spectacular and include better water quality, improved aquatic habitat, reduced acid discharges from acid sulfate soils and restoration of wetlands.

"Over the past decade more than 60 floodplain watercourses and wetlands have been restored with assistance from floodplain landowners and other stakeholders. About 250 Clarence landowner volunteers have now signed management plans and actively manage the watercourses adjoining their properties."

Mayor Ian Tiley said the Clarence Floodplain Project was regarded as an Australian leader in floodplain management. "It's encouraging to be nationally recognised for the significant environmental outcomes it has achieved as well as the community partnerships that have been developed," the mayor said.

Scientists and teachers adding excitement to chemistry

Scientists from the Queensland Government showcased practical ways to help the environment when they met science teachers in Brisbane during November.
A group of 18 secondary school teachers from 14 schools took part in a special chemistry workshop at Cavendish Road State High School in Holland Park.

The workshop was part of an innovative Queensland approach to demonstrate in the high school syllabus how chemistry is used in real-world environmental situations.

Minister for Natural Resources and Water Craig Wallace said the scientists had teamed up with the Department of Education, Training and the Arts, the Science Teachers' Association of Queensland and the Queensland branch of the Australian Society of Soil Science. The team is developing packages for schools that teach scientific principles with real life examples.

"Chemistry and science can be exciting," Mr Wallace said. "Today's students are tomorrow's scientists – we need to show them how they can transform the science they are learning at school into a rewarding career option that will benefit the whole community."

As part of the workshop, scientists from Department of Natural Resources and Water presented a case study from the East Trinity acid sulfate remediation project, a site adjacent to Cairns Harbour.

Prior to treatment, the East Trinity site released sulfuric acid and heavy metals into the ocean, killing marine life and damaging the local environment. The researchers showed how to use chemistry to treat acid sulfate soils through studying their chemical properties, sampling the soils and measuring acidity in the field.

Laboratory staff from the Department of Natural Resources and Water's chemistry centre demonstrated the basic principles of titration and how this is applied to the analysis of acid sulfate soils.

Mr Wallace said Department of Natural Resources and Water scientists also participated in similar workshops with teachers in Brisbane and Cairns during October and would continue to seek opportunities to support science education in Queensland schools.

Brisbane State High School science operations officer Frances Smith (left), Department of Natural Resources and Water technical officer Niki Finch (centre) and science operations officer Dorothy McCullough from Corinda State High School take part in the recent chemistry workshop at Cavendish Road State High School, Brisbane.

Updating coastal acid sulfate soil information in Victoria

Victoria is currently developing a state strategy for coastal acid sulfate soils. With the assistance of Natural Heritage Trust funding from the federal, state and regional level, development of the strategy will include:

- further site investigations to increase the accuracy and quality of existing coastal acid sulfate soil mapping,
- development of a strategic policy and planning framework, which clarifies roles and responsibilities and establishes a risk management process, and
- raising awareness and building capacity, so that decision makers have the confidence to consider coastal acid sulfate soils during the planning process.

Work to improve the accuracy and quality of existing acid sulfate soil mapping is currently underway. This new investigation will build upon a pilot study that occurred in 2003, which determined an indicative distribution of coastal acid sulfate soils across Victoria. The results of this investigation can be viewed at www.dpi.vic.gov.au under Victorian resources on line. The pilot study utilised existing data such as:

- digital elevation models, derived in part from 10m contours from 1:25,000 topography maps,
- 1:250,000 geology maps, and
- 44 field investigation sites.

Bass Landing showing estimated distribution of acid sulfate soils from the 2003 pilot study.

The new investigation will utilise an understanding of coastal geomorphology to identify acid sulfate soils not previously identified in the 2003 pilot study. A geomorphic approach will determine mid Holocene high tide level in river channels and shorelines (dune ridges). These old shore lines will give an indication of the areas ideal for coastal acid sulfate soils formation. Soil sampling will occur within the areas defined by this geomorphic approach.

Bass Landing showing estimated distribution of acid sulfate soils using geomorphology.

Current geomorphology mapping www.dpi.vic.gov.au/vro estimates that there is 280,000 ha of coastal land in Victoria, of which the pilot study estimated that there are only 55,000 ha of coastal acid sulfate soils. Investigators suspect that the area of acid sulfate soils may be significantly under-estimated in the 2003 pilot study.

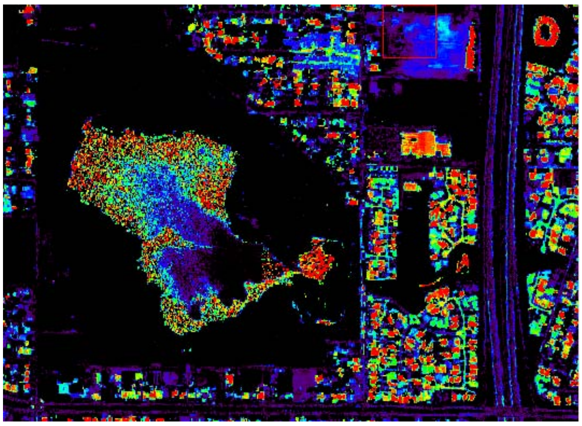
The current site investigations will focus on priority areas determined by pressure for land-use development and where acid sulfate soil issues are occurring.

Bass Landing has been identified as a priority area. The 2003 pilot study estimated approximately 380 ha of potential acid sulfate soils in the area, where as using the geomorphic approach this has been refined to an estimate of 510 ha. This has been further verified by soil sampling done in the area.

The final products of the current investigation will be maps showing where acid sulfate soils are likely to be found, where they are not likely to be found and areas that have not yet been sampled. All data will be compatible with ASRIS and the national database of acid sulfate soils

Hyperspectral imaging on Swan Coastal Plain

The Australian Government's Natural Heritage Trust is funding cutting edge technology, more commonly used by the mining industry to find ore bodies, to help pinpoint high risk acid sulfate soil areas in Western Australia. The Department of Environment and Conservation has contracted CSIRO to use hyperspectral remote sensing to locate acid sulfate soil 'hotspots' in a project which aims to validate current acid sulfate soil risk maps of the Swan Coastal Plain.



An iron abundance image --this hyperspectral data indicates iron oxides (red) in the creek water discharging into Lake Gwelup in Stirling

Hyperspectral imaging combines spectroscopy and imaging technologies. Special cameras mounted on an aeroplane gather data about the spectra of light reflected from the land below. CSIRO's hyperspectral environmental geoscientist Ian Lau said hyperspectral remote sensing was a valuable tool that allowed scientists to determine a material's chemical composition. "It measures how materials at the Earth's surface interact with light, including visible and infra-red," said Dr Lau. "This technology allows us to remotely collect information on materials on the ground and to differentiate between them."

A spectrum is gathered for each pixel in an image so information can be obtained about how the mineral content varies in different parts of the landscape. It is proposed that airborne hyperspectral imaging be used within the Perth metropolitan and Peel regions to measure the levels of acid sulfate soil oxidation products (secondary iron and aluminium sulfate minerals) and chemical indicators (aluminium compounds, iron compounds, arsenic compounds) present on soil surfaces.

"By evaluating the hyperspectral data we can locate the surface presence of minerals, identify those minerals and quantify the different minerals," said Dr Lau. "We can also describe what conditions are like on the ground, indicate high pH areas and determine the locations of potential acid sulfate soil hotspots."

Dr Lau's ground truthing work is currently focussed on the Peel region where the airborne data has already been flown. The work will continue throughout the summer months when the ground is dry and the minerals are precipitating on the surface.

"Our preliminary studies have found target sites which we will now visit to take further spectral measurements using a portable spectrometer", he said. "We will also collect soil samples to bring back for laboratory testing."

Once verified, the hyperspectral imaging maps generated by the project will be integrated into Department of Environment and Conservation's GIS framework to support the acid sulfate soil hazard maps. The aim is to provide additional layers of information such as soil profile descriptions and soil chemistry data to reveal the actual and potential acid sulfate soil layers and images of disturbed sites.

Dr Lau said hyperspectral technology would play an increasing role in an environmental capacity, providing reliable, high quality data. "I would like to see the uptake of hyperspectral remote sensing by industry in Australia and around the world as a best practice technique for routine environmental monitoring," said Dr Lau.

Understanding the adoption of conservation practices by rural landowners

Pannell, D.J. Marshall, G.R. Barr, N. Curtis, A. Vanclay, F. and Wilkinson, R. (2006) Understanding and promoting adoption of conservation practices by rural landowners. Australian Journal of Experimental Agriculture, 46:1407-1424.

Environmental programs such as the National Landcare Program, the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality encourage landowners to adopt a range of conservation practices to address land and water degradation. Some of these conservation practices have been readily adopted while others are not. This has been an on-going source of frustration for many involved with natural resource management.

This paper reviews a large body of literature about the adoption process. The results and implications are relevant and interesting reading for all involved in natural resource management.

The adoption process, or why a landowner decides to change their practices, is a dynamic process that involves many different factors. These factors will be individual to each landowner in question. The process can include personal, social, cultural and economic factors as well as factors about the innovation itself.

Generally adoption will occur when the landowner perceives that the change or innovation will achieve one or more of their personal goals. Goals vary widely between individual landowners depending on their circumstances and personal preferences, but many include economic, social and environmental outcomes.

The adoption process has two distinct phases:

- the collection, integration and evaluation of information about the innovation, and
- trialling the innovation.

Trialling the innovation involves the skill of applying the innovation to their own situation. Factors which determine whether this is possible include the complexity of the innovation, its ability to be partially trialled, the risk involved, its compatibility with existing farm practices, the cost involved and how observable the benefits or results are.

One typical sequence of the adoption process is: awareness of the problem, non-trial evaluation, trial evaluation, adoption, review and modification, or non-adoption.

What does this understanding mean for those involved in natural resource management?

Possible implications for research are:

- the need for innovations that meet a number of goals (economic, social and environmental) and can be easily trialled, and
- adopt a participatory approach with landowners when researching and developing conservation practices.

Possible implications for extension are:

- understand that extension is more than just a communication exercise,
- use multiple methods of delivery to assist landowners adopt the innovation, and
- recognise the complex web of adoption and how important it is to understand the farming system in question.

Possible implications for policy and funding bodies are:

- understand that non-adoption is not necessarily from insufficient communication or education,
- facilitate the development of innovations that are not only good for the environment but also economically superior to current practices,
- where innovations are not attractive, financial incentives can be offered, but be realistic about the level of payment required to the level of outcomes achieved, and
- in some cases, research and policy may need to address the task of living with the problem.

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

Arsenic eating super-bug to help remediate soil and water

Australian scientists have discovered an arsenic-eating super-bug that can help clean up the landscape. The super-bug was identified after screening thousands of samples of microbes from soils heavily contaminated with poisonous arsenic which was once used to control parasites on sheep and cattle.

"It was a case of serendipity," says Professor Megh Mallavarapu of the CRC for Contamination Assessment and Remediation of the Environment and the University of South Australia. "We'd been looking for over a year at microbes that tolerate arsenic and DDT – and this one popped up. It takes in the highly toxic arsenite, and oxidises it to the much less dangerous arsenate form, which can easily be immobilised by other methods.

"There are so many microbes in the soil we might easily have missed it – but luckily we didn't." The bug holds hope of developing an efficient biological method for cleaning up the hundreds of thousands of arsenic stock dip sites in Australia, New Zealand, Argentina and other countries, places where arsenic-treated timber posts have been made or used, sites of old railway lines, as well as old gold-mining regions where arsenic flushes out of tailings dumps into surface and groundwater, posing a risk to those who drink it.

The microbe could also be used to cleanse household drinking water in Bangladesh, India, China and South East Asia where an estimated 100 million people face daily poisoning from arsenic in their well water, Professor Mallavarapu says.

Besides being known to cause cancer of the skin, lung, bladder, kidney, liver and uterus, arsenic is also linked to several skin diseases, nerve disorders, diabetes, lung disease, heart disease, suspected birth defects, liver and blood disorders, says CRC CARE Managing Director Professor Ravi Naidu.

"This is a truly momentous discovery by Professor Mallavarapu and his team, as it addresses one of the most intractable contamination problems facing almost all societies," he says. "They are to be congratulated on this important advance for Australian remediation science."

Further information is available at www.crccare.com

Arsenic can be mobilised through the oxidisation of acid sulfate soils. A new super-bug has been identified that can remediate soil and water contaminated with arsenic.

Understanding acid discharge

Green, R. Macdonald, B.C.T. Melville, M.D. and Waite, T.D. (2006) Hydrochemistry of episodic drainage waters discharged from an acid sulfate soil affected catchment. Journal of Hydrology, 325:356-375.

How acid leaves an acid sulfate soil affected catchment is influenced by a number of different factors. Understanding the processes which lead to acid outflow or discharge is important in developing appropriate strategies to treat waters leaving these areas.

This paper discusses the influences on acid discharge at McLeods Creek, a right-bank tributary of the Tweed River, in northern NSW. The study site is used to grow sugar cane, and has a series of drains that feed into McLeods Creek and then into the Tweed River.

The majority of land has been laser levelled, allowing surface water to flow directly from the land into main drains. The study site has minimal topographic relief (0.3-0.8m above sea level) and an electric pump is used to discharge all water from the sub-catchment downstream into the Tweed River. The pump is automatically triggered by a depth sensor that records every 15 minutes.

The area has a sulfuric horizon of pH <4, which is around 70cm thick and contains no pyrite. These soils overlay several meters (more than 8) of a sulfidic clay gel of pH ~7, with a pyrite content of between 1 and 4%. Average hydraulic conductivity of the upper horizons is in the order of 0.7m a day.

Four rainfall events were monitored during the course of the study, and identified that acid discharge is very variable and can be influenced by:

- the magnitude of rainfall events,
- the preceding conditions, and
- the particular phase of discharge.

The initial increase in acidity and dissolved metals concentrations after rainfall can be attributed mainly to ‘first flush’ effects. During extended periods of dry weather or low rainfall, salts can evapo-concentrate in the upper soil layers. As the water table lowers, further evaporation occurs leaving high concentrations of salts in the upper soil horizons. Rainfall can then flush these salts and metals into nearby waterways.

During the middle of large rainfall events, acid and dissolved metal concentrations may become diluted. During the study the lowest acidity was found at the peak of inundation when large volumes of water dilute dissolved metals and the acidity. When dilute runoff water mixes with rainwater and alters the pH, precipitation of iron and aluminium oxyhydroxides can occur.

Increases in acidity and dissolved metals (particularly aluminium) concentrations in the later phase of the rainfall event often occurs as small field drains discharge into main channels. This can be attributed to groundwater discharging when there is little downstream buffering capacity downstream.

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

Are oysters a 'canary in the coal mine' for acid sulfate soils?

Dove, M.C. and Sammut, J. (2007) Histological and feeding response of Sydney Rock Oysters, *Saccostrea glomerata*, to acid sulfate soil outflows. Journal of Shellfish Research, 26:509-518.

The state of New South Wales is the largest producer of Sydney rock oysters *Saccostrea glomerata* with an industry worth approximately US$26 million annually. However, since the mid 1970's diseases, competition from other species and declining water quality has halved production.

Acid sulfate soil runoff can rapidly affect downstream oysters.

Sydney rock oysters are primarily grown in estuaries and their tidal tributaries, many of which are impacted by acid sulfate soils. Runoff from disturbed acid sulfate soils is not only acidic but also contains elevated concentrations of metals, principally iron and aluminium.

Estuaries which are regularly impacted by acid sulfate soils have higher levels of oyster mortality and reduced oyster growth when compared to areas that are not acidified. This paper discusses the results from two laboratory experiments conducted to investigate reasons for poor oyster production at sites exposed to acid sulfate soil-affected waters. The effects of acid sulfate soil runoff on oyster feeding and whether exposure to acidified water caused damage to the soft tissues of oysters, were examined.

When oysters were placed in acidified water, pH 5.5, the oysters had unusual shell movements and could not feed at the same rate as oysters in water pH 8. When placed in acidic water containing aluminium (7.64 mg L–1) or acid sulfate soil by-products, changes to the oysters soft tissues quickly occurred.

Iron contained in the acid sulfate soil affected water, caused degenerative effects. Iron precipitates accumulated on the gills and mantle of the oyster and were observed in the stomach, intestine, digestive tubules and rectum.

Results from this study highlight the rapid, damaging, effects of acidified water as well as the problems caused by high levels of iron and aluminium to oysters.

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

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information and awareness