

ASSAY

A NEWSLETTER ABOUT ACID SULFATE SOILS

Issue # 56

June 2011

A warm winter welcome

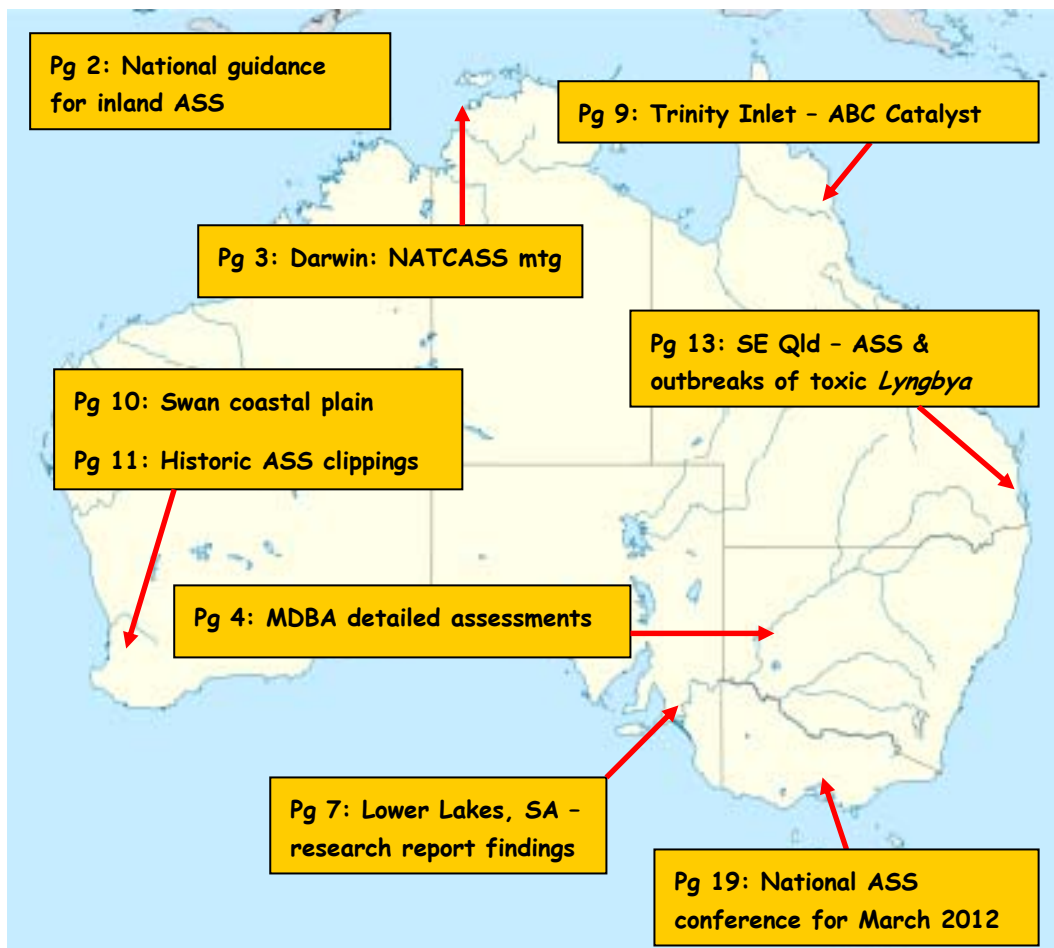
This bumper 56th issue of ASSAY contains an intriguing mixture of stories, research findings and images covering the range of acid sulfate soil issues and management techniques found around Australia.

Inside you'll find information on the publication of national guidelines for the management of inland acid sulfate soils (which until relatively recently were thought by many to be a relatively minor issue!); a report on the NATCASS committee's visit to Darwin; a wrap-up of a program that assessed over 200 wetlands in the Murray-Darling Basin; plus an exploration of the links between acid sulfate soils and outbreaks of toxic marine cyanobacteria *Lyngbya* in south-east Queensland.

There are also links to footage of the Trinity Inlet story that recently featured on Catalyst – ABC TV's flagship science show. Finally, research highlights from extensive monitoring programs in both West and South Australia round out this quarter's issue.

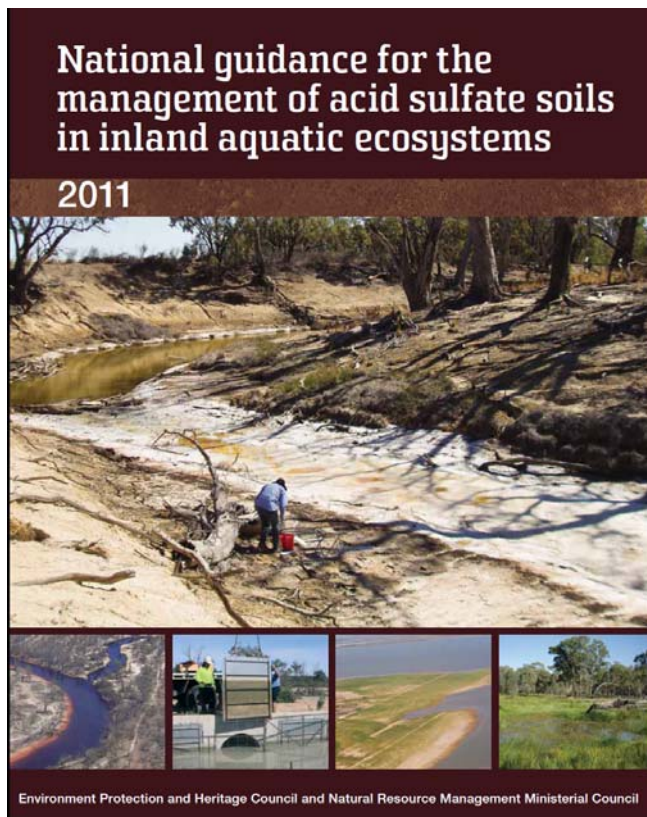
Happy reading...Simon

Stories and places in this issue.....



New document launched – *National guidance for the management of acid sulfate soils in inland aquatic ecosystems*

Emma Warren, Department of Sustainability, Environment, Water, Population and Communities



Acid sulfate soils in inland aquatic ecosystems are an emerging issue of national importance. Australian, state and territory governments are working together to address acid sulfate soil issues and this collaboration has resulted in the *National guidance for the management of acid sulfate soils in inland aquatic ecosystems*.

The document provides an authoritative reference on the best practice management of inland acid sulfate soils to reduce or prevent the risks they pose to the Australian environment, economy and society.

Acid sulfate soils may produce acid, cause metal release and the loss of dissolved oxygen in the water column if disturbed or exposed. This can lead to risks in water and soil quality, aquatic ecosystems, human health, primary industries and the built environment.

The formation, accumulation and exposure of acid sulfate soils in inland aquatic ecosystems

is increasingly likely with changes to land uses, hydrological regimes and the demand for water, with drought and climate change intensifying matters. Despite higher water availability from recent rainfall, this problem has not gone away.

Australian, state and territory government ministers and agencies responsible for water quality and natural resource management issues have recognised the potential harmful effects of inland acid sulfate soils and the lack of management guidance nationally.

To address this situation, the Environment Protection and Heritage Council and the Natural Resource Management Standing Committee endorsed the development of this resource. This document is designed to help natural resource managers, planners, policy makers and other practitioners best assess and manage acid sulfate soils in inland aquatic ecosystems and communicate the issues.

Download the guidelines from:

<http://www.environment.gov.au/water/publications/quality/guidance-for-management-of-acid-sulfate-soils.html>

If you would like further information on this document or would like to provide feedback, please e-mail Water.Quality@environment.gov.au and include “acid sulfate soils” in the subject line.

Bernie Powell, NatCASS Chair

NatCASS has the responsibility of facilitating implementation of the *National Strategy for the Management of Coastal Acid Sulfate Soils*. It also applies these same principles to the inland ASS environment. Its membership comprises representatives of the relevant Australian, state and territory government agencies, CSIRO, tertiary institutions and affected industries. NatCASS is chaired by Bernie Powell, the Queensland representative.

Field trip

NatCASS met in Darwin on 4 - 5 May 2011. A highlight of the meeting was a field trip visiting sites around Darwin. Darwin Harbour is ringed by over 100,000 ha of mangroves and mudflats containing ASS and under development pressure.

However Jason Hill and his team at the Department of Natural Resources, Environment, the Arts and Sport are making significant progress in having ASS assessment and management considered in the land development process.

Jason also commented that the recent ASS training course led by Southern Cross University (and facilitated through the NatCASS network) had helped raise awareness and the standard of ASS management.

Sites visited were the widening of Tiger Brennan Drive (the main arterial route into Darwin), the East Arm Industrial Estate (the site of extensive past ASS disturbance) and the Weddell Land Capability Study.



Tiger Brennan Drive being widened over disturbed areas of acid sulfate soils

(Photo - Rob Fitzpatrick)

New member

At the meeting NatCASS welcomed new member David Sim, representing the Urban Development Institute of Australia (UDIA). David hails from Perth and works with consultants RPS. He has worked on ASS management with a number of large developments in WA and has provided input into ASS training and policy making.

Govdex website

A new development for NatCASS was the establishment of a Govdex website accessible to all members of NatCASS. Govdex allows members to upload agenda items, meeting minutes and reports and will be a repository for all NatCASS documents.

MDBA risk assessment project

As well as receiving jurisdiction reports on progress, Rob Kingham also reported on the Murray-Darling Basin Authority ASS Risk Assessment Project that is about to conclude after 3 years. This has produced a substantial amount of new data on inland ASS ranging from a desktop assessment of 19,000 wetlands to 100 wetlands selected for detailed risk assessment. The project also allowed for new methods of assessment to be developed and refined.

ASSAY funding

NatCASS government jurisdictions also agreed to continue funding ASSAY for 2010-11 under a proportional funding arrangement, with the option of 6 monthly instalments, pending the opportunity for external funding.

ASS news

Items of interest raised by jurisdictions include the fish kills in the Anglesea River, Victoria that appear to have an ASS link; the significant community involvement in monitoring and remediating ASS in the Lower Murray Lakes; the announcement of a National ASS Conference in Victoria on the 6 - 7 March 2012 and the ongoing demand for ASS training courses, even though Caring for our Country funding concludes in June 2011.

ASS Centre proposal

A proposal and business plan has been approved by CSIRO and University of Adelaide for Professor Rob Fitzpatrick (Director) and Dr Paul Shand (Deputy Director) to establish and lead the Acid Sulfate Soils Centre (ASSC), which will bring together scientists in the University of Adelaide (mostly in the School of Earth and Environmental Sciences and Environment Institute) and CSIRO (CSIRO Land and Water) to address applied and basic research and its development in the fields of environmental science, soil technology and mineral exploration.

ASS Atlas

ASS National Atlas upgrades and Australian Soil Classification revisions are being progressed by a NatCASS subcommittee that met the day before the NatCASS meeting. Progress is reported at each NatCASS meeting.

The next meeting of NatCASS will be held at Newcastle on 9 - 10 November 2011.

Murray-Darling Basin acid sulfate soils risk assessment project wraps up

Rob Kingham, MDBA

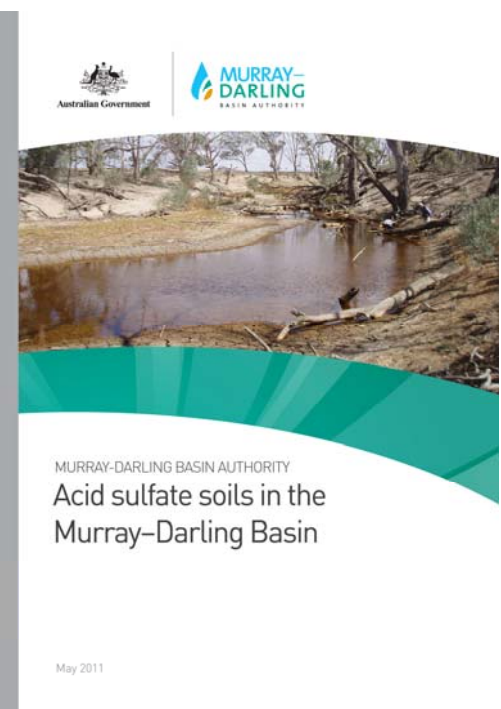
The first Basin-wide assessment of acid sulfate soils is wrapping up, with the completion of the Murray-Darling Basin Acid Sulfate Soils Risk Assessment project.

The summary report *Acid Sulfate Soils in the Murray-Darling Basin* is available on the Murray-Darling Basin Authority website at: <http://www.mdba.gov.au/programs/acid-sulfate-soils-risk-assessment>

Individual reports that provide the detail of the project will also be made available as they are completed.

Since the last project update (ASSAY #51 - March 2010), detailed assessments to determine acid sulfate soil hazards have been completed at almost 200 wetlands throughout the Basin, including selected channels in the Edward-Wakool River system.

Where the detailed assessment found acid sulfate soils to be a priority concern, selected samples underwent further investigations to determine the nature, severity and the



specific risks associated with the acid sulfate soil materials.

As a result, 54 sites were identified as requiring further detailed assessment, including:

- 36 wetlands along the lower Murray River in South Australia;
- 11 wetlands and channels in the Edward-Wakool River system in NSW;
- 2 wetlands along the Murray River near Mildura; and
- 5 wetlands and channels in the Loddon River and Goulburn River catchments in Victoria.

This three-year project has led to major advances in knowledge and understanding of acid sulfate soils in inland aquatic ecosystems.

Project collaborators have been at the forefront of research into this subject and in developing opportunities

for further research; as a result, this new knowledge is being employed in the assessment of acid sulfate soil occurrence - and the associated hazards and risks - in the priority wetlands of the Murray-Darling Basin.

Background

The record low inflows and river levels of recent years led to the drying of many permanent wetlands in the Murray-Darling Basin, resulting in the exposure of acid sulfate soils. The impacts of these soils had previously been an issue only at localised sites, but it became clear that acid sulfate soils may present a significantly larger scale issue in some parts of the Basin.

In March 2008, the Murray-Darling Basin Ministerial Council agreed to support an assessment of the spatial occurrence of, and risk posed by, acid sulfate soils at priority wetlands in the Murray River system, wetlands listed under the Ramsar Convention on Wetlands of International Importance and other key environmental sites in the Murray-Darling Basin.

A tiered assessment program was utilised, whereby priority wetlands were screened through a desktop assessment stage, followed by a rapid on-ground appraisal, and then detailed on-ground assessment if results of previous stages indicated an increased likelihood of occurrence of acid sulfate soils.



A thick salt crust overlies acid sulfate soils in a wetland of the Little Toolunka Flat complex of the lower Murray River, South Australia

Gerard Grealish / © CSIRO Land and Water

Major findings

The Murray-Darling Basin Acid Sulfate Soils Risk Assessment project substantially increased knowledge of the occurrence of acid sulfate soils throughout the Basin, and the hazards and risks associated with these materials.

In all, over 19,000 wetlands received desktop assessment; 1,385 wetlands received rapid on-ground assessment, and nearly 200 wetlands and river reaches received detailed assessment, including 14 of the 16 Ramsar-listed wetlands in the Murray-Darling Basin.

The summary project report, *Acid Sulfate Soils in the Murray-Darling Basin*, was released by the Murray-Darling Basin Ministerial Council in May 2011. This report is supported by more than 50 reports produced throughout the project that document the following outcomes:

- Waterways found to contain acid sulfate soils at levels of concern were located in the southern part of the Murray-Darling Basin. Acid sulfate soils were extensive throughout many wetlands along the lower River Murray in South Australia and in the western part of the Edward-Wakool River system in New South Wales. In Victoria, the affected sites appear localised around Mildura and in some areas impacted by dryland salinity.
- Of the Ramsar-listed wetlands, acid sulfate soils were found at levels that present a medium-to-high acidification, deoxygenation and/or metal release hazard at Banrock Station wetland complex, Riverland, some lakes in the Kerang Wetlands and (in a separate study) the Lower Lakes.
- While acid sulfate soils in the other Ramsar wetlands were at elevations that do not currently pose a substantial hazard, it is noted that many had significant concentrations of sulfate, indicating the potential for acid sulfate soils to form in the future if water levels in these wetlands are kept high for unnaturally long periods. This is an important input into the future management of these ecologically significant sites.



Many of the affected wetlands were re-flooded during the extensive floods of 2010-11. The impacts on water quality through re-flooding of acid sulfate soils were diluted by the size of the flood. However, despite the floods, acid sulfate soil material is still likely to be present in many of the wetlands previously affected.

Furthermore, the underlying conditions, which caused the formation of acid sulfate soils in the first place, have not changed. Therefore, the ongoing risk posed by acid sulfate soils is unlikely to have been mitigated and hence will need to be managed.

Project outputs were key components in the development of the *National guidance for the management of acid sulfate soils in inland aquatic ecosystems* produced by the Environment Protection and Heritage Council and the Natural Resources Management Ministerial Council, which includes broad principles for the management and mitigation of acid sulfate soils in inland waterways.

The Murray-Darling Basin Acid Sulfate Soils Risk Assessment project has been a success because of contributions made by many dedicated professional people. The project manager would like to thank and acknowledge the contribution of current and former project staff, and current and former members of both the Acid Sulfate Soils Risk Assessment Advisory Panel and the Scientific Reference Panel, whose efforts played a vital role in establishing, supporting and completing this large project.

South Australian Lower Lakes acid sulfate soils research reports released

Ann-Marie Jolley & Ceridwen Synnot, DENR

The South Australian Department of Environment and Natural Resources (DENR) has released the findings of its extensive Acid Sulfate Soils Research Program in the Lower Lakes of the River Murray.

The research program was initiated in 2009 to fill critical knowledge gaps and better inform decisions on how to manage the risks posed by extensive areas of exposed acid sulfate soils in the Lower Lakes.

The soils had been exposed as a result of unprecedented low water levels (below sea level to -1 m AHD) between 2008 and 2010. As a consequence, soil and water body acidification occurred over large areas, placing the environment and the communities of the Lower Lakes and surrounding Coorong and Murray Mouth areas at great risk.

Lead by Dr Luke Mosley from the EPA and Dr Liz Barnett from DENR, experts from the CSIRO, Southern Cross University, Earth Systems Consulting and the University of Western Australia have contributed to this high quality body of knowledge.



Exposed sulfuric soils in Boggie Lake on the northern edge of Lake Alexandrina, March 2010

DENR, 2010

Five research areas were examined:

- acid sulfate soil spatial heterogeneity/mapping survey
- measurement of acid generation rates
- assessment of the *in-situ* contaminant generation, transport and neutralisation processes
- laboratory and field studies of the potential for mobilisation of contaminants following inundation with seawater compared to river water
- geochemical modelling of lake water quality to analyse the

acidification risk at a range of water levels, and following inundation with seawater and freshwater.

Air quality monitoring was also undertaken to assess possible community health impacts from exposed acid sulfate soils. This report will be available shortly.

Research highlights

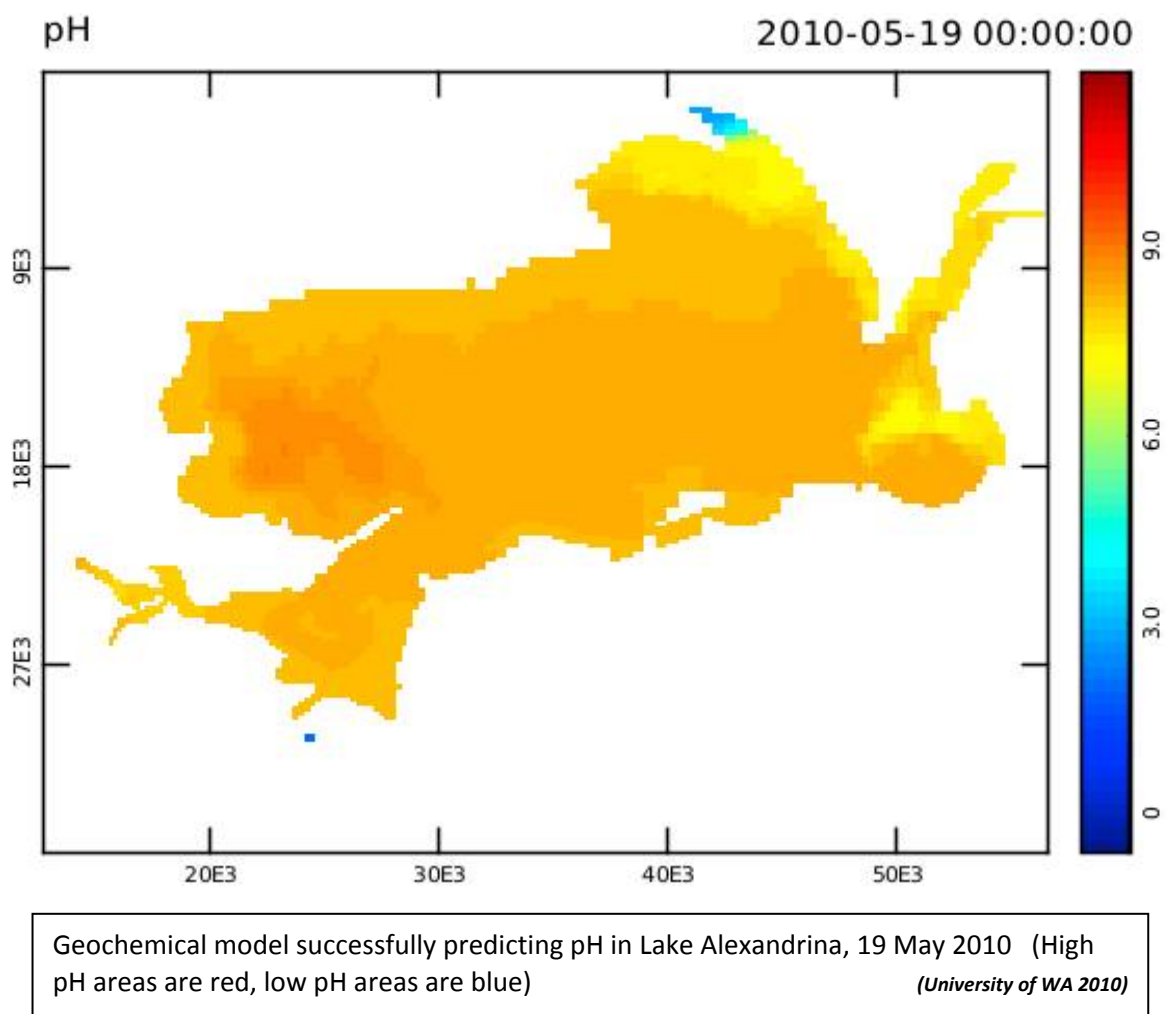
Highlights from the research program so far are:

- there is an extensive and considerable long-term acid sulfate soil hazard in the Lower Lakes
- acidity was generated rapidly in drying sandy and clayey lake margins, which increased the risk of waterbody acidification when rewetting occurred
- the exposure of clay-rich sediments in the deeper parts of the lakes must be avoided due to large amounts of acid sulfate soils with a high potential to cause acidification
- the use of fresh water to keep sediments submerged is a lower risk to the environment than using

Managing acid sulfate soils in the region

The main management implications highlighted by the research program to date are:

- some exposed sulfuric materials in acid sulfate soil hotspots can be managed or treated locally
- the risk of broad-scale lake acidification is reduced if minimum water levels are stabilised above 1.5 metres below sea level in Lake Alexandrina and 0.5 metres below sea level in Lake Albert. The risk substantially increases below these water levels and/or with prolonged time near these levels
- while adding seawater is a valid option to prevent drying out and acidification of submerged sediments, it is a higher risk option compared to using freshwater, as more acidity and metals will be mobilised from previously exposed soils
- following lake acidification, water quality could take months to years to recover. Recovery from soil acidification will take much longer and achieving previous conditions may not be possible.



The program has been a proven success by directly underpinning key management actions conducted in the Lower Lakes. Further research is underway and is focusing on recovery from acidification and the potential for associated hazards to emerge now that water levels have risen.

The research program is part of the South Australian Government's Murray Futures program funded by the Australian Government's Water for the Future initiative, and also received funding from the Murray-Darling Basin Authority.

The reports can be found at:

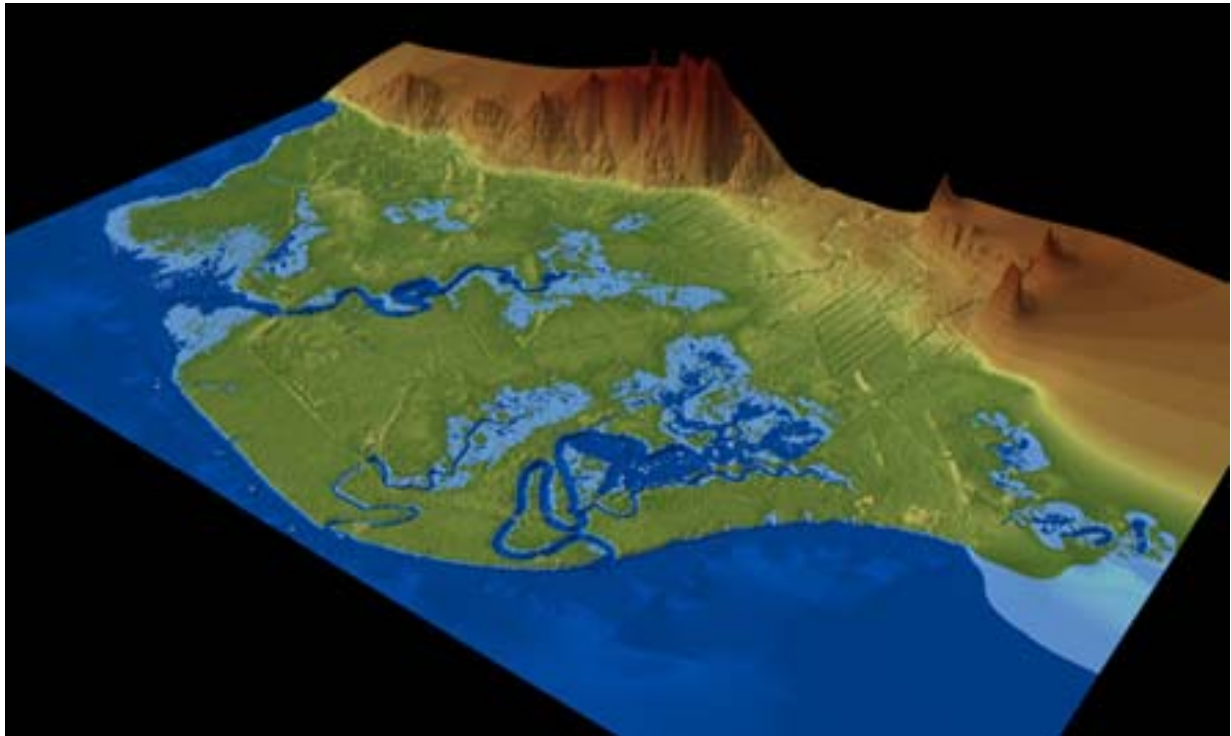
http://www.environment.sa.gov.au/Conservation/Rivers_Wetlands/Coorong_Lower_Lakes_Murray_Mouth/The_environment/Acid_sulfate_soils/Acid_Sulfate_Soils_Research_Program_reports

For further information contact Dr Liz Barnett liz.barnett@sa.gov.au or visit: www.environment.sa.gov.au/clmm

ABC's Catalyst story on Trinity Inlet research, Cairns, Queensland

<http://www.abc.net.au/catalyst/stories/3221659.htm>

All images: DERM



Trinity Inlet digital elevation model

The above link connects to a story that originally aired on the ABC's Catalyst show on 19 May 2011.

This ten-minute snippet provides a very clear overview of the Trinity Inlet site, from the initial drainage works and construction of the bund wall, detailing the subsequent impacts of oxidised acid sulfate soils, through to the success of on-going remediation strategies that focus on controlled tidal flushing.

The second link provides further background into the site and the actual making of the Catalyst story.

<http://therocknews.com.au/2011/05/19/east-trinity-the-acid-test/>



Acidification in the sandy aquifer of the Swan Coastal Plain

Clare Nixon, DEC

Some dampland areas in WA's Bassendean Dune system may need to be reclassified as high to moderate risk following a recent research project in Perth.

Soils containing ASS materials occur widely across the Perth metropolitan area, most commonly in sumplands near lakes, wetlands and along the Swan and Canning river systems. They are also found in damplands and in higher topographic landscapes.

The joint Department of Environment and Conservation and University of Western Australia study found that the topographic lows of the Bassendean Dune System host humus podzol with strongly



Tractor-mounted sonic drill rig used for extracting soil cores

cemented dark brown and organic B horizon (coffee rock). In the topographic mid slopes and crests, iron-humus podozol and iron podozol, respectively, occurs.

DEC soil scientist Balbir Singh said all these soils were sandy, highly leached and consequently provided little or negligible acid buffering capacity.

"The depth and intensity of this coffee rock material varies with groundwater table depth," he said.

Areas outside WA's estuarine environment are dominated by Bassendean Sands - white, grey, brown or coffee rock sand that covers much of the Swan Coastal Plain within the Perth metropolitan area.

Areas with coffee rock materials also contained amorphous aluminosilicate as cementing materials and were usually found at or near watertable in the seasonal wetlands. The highest sulfur content found in these Bassendean materials was 0.5% S. The median S_{Cr} content was 0.02% S while median pH_{FOX} was 2.0.

The chromium reducible sulfur (S_{Cr}) content of the majority of sand dominated sites in the Bassendean formation was lower than the ASS action trigger at 0.03% S.

"Investigation found that these areas exhibited very low pH_{FOX} values," said Balbir.

"This suggests these soils have the potential to become very acidic when exposed to air.

"The low pH_{FOX} values are of concern as these sand dominated sites represent a significant geographical area within the Perth metropolitan area."

Balbir said very low pH_{FOX} values shown in Bassendean sands (S_{Cr} value <0.02%) could be attributed to their poor acid buffering capacity.

"Mineralogical analysis of the materials has shown that quartz sand is the dominant mineral, while acid buffering materials such as clays or carbonates occur in negligible amounts," he said.

"In the absence of these, small amounts of sulfides are able to produce very low pH_{FOX} values."

“It’s unclear if these sandy soils will oxidise naturally to a very low pH when exposed to air so this investigation includes a laboratory-based incubation experiment using soils in chip trays that have undergone natural oxidation at room temperature,” said Balbir.

Natural oxidation at room temperature of Bassendean Sands with a sulfur content below the action criteria led to extreme acidification with soil pH as low as 2.5. The soil pH after natural oxidation was consistently higher than the pH_{FOX} value by about 1 unit.

“The latter may be used as a reliable predictor of potential acidity in the field,” said Balbir.

In some near surface horizons, however, the pH_F and pH_{FOX} were not significantly different, probably due to presence of certain organic species in the soil that provided some buffering.

“Clearly, low pH_{FOX} in near surface horizons may sometimes result in false positives.”

The DEC and UWA technical reports will be publicly available once the technical review has been completed.

For more information, please contact clare.nixon@dec.wa.gov.au



A 6m soil core extracted from a site using sonic drilling.

Early reports of acid sulfate soil from Western Australia

Simon Walsh

Continuing the series of articles that highlight historic reports of acid sulfate soils, are these examples from Western Australian newspapers...

Western Mail - 8 April 1911

Re: Osborne Park, Njookenbooroo

“For months the residents of Osborne Park, especially in the Njookenbooroo district, have been attempting to cultivate portions of the swamp areas but their efforts have failed, owing to what was surmised to be a kind of poison in the ground. The question was discussed at the meetings of the local Agricultural Society, and it was decided to send samples of the soil to the Agricultural Department...”

...The water itself does not disclose anything of a marked nature, but the soils are decidedly of an undesirable character. They all contain considerable amount of salt - from 0.429 per cent to 0.972 per cent sodium chloride - while nos. 2 and 3 in particular show the presence of a considerable quantity of sulfide of iron, and also the presence of salts of alum”.



Njookenbooroo drain, WA, 1903

Source: City of Stirling libraries

The West Australian - 27 August 1931

Re: Herdsman Lake, Perth

"...on the foreshore crops were growing normally, but when it was attempted to crop the swamp lands of the lake it was found that the crops either grew abnormally, or failed to reach maturity if they did not die right off. The settlers believed this was due to some injurious substance in the swamp soils rendering them unsuitable for cultivation.

The West Australian - 3rd July 1939

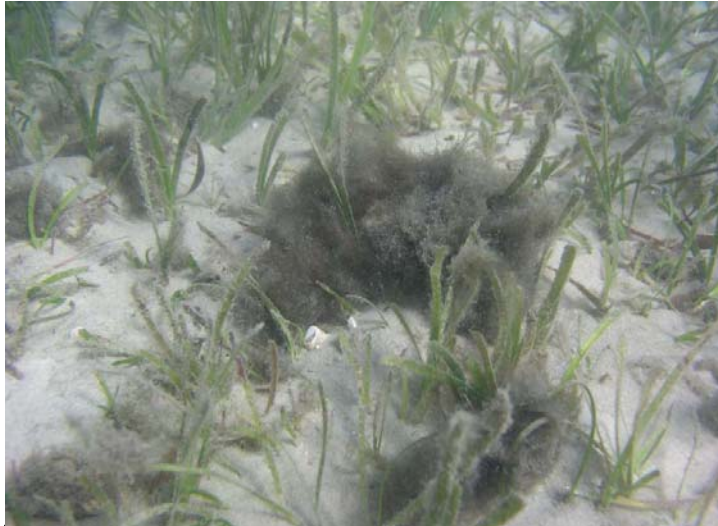
Re: Oyster Harbour, Albany, WA

"A special problem of great scientific interest, is the development of excessive acidity following drainage in certain cases. As a result of the oxidation, following drainage, of certain minerals in the soil known as sulphides, sulphuric acid is produced which renders the land sterile when sufficiently concentrated. Areas damaged by sulphuric acid have been observed near Grasmere, on the Robinson estate and near Oyster Harbour. It is expected that chemical treatment, as well as improved drainage to remove the acid waters, will be needed to counteract this trouble which is affecting areas of otherwise very fertile soil".

Workshop on Lyngbya bloom hazard, Bribie Island

Shane Pointon, DERM

A joint workshop involving staff from the Department of Environment and Resource Management (DERM) and the Queensland University of Technology (QUT) was held on Bribie Island on Wednesday 4 May. The two main topics discussed were coastal algal bloom hazard mapping for southern Bribie Is (Shane Pointon - DERM) and a groundwater visualisation model for Bribie Island (Dr Malcolm Cox - QUT).



Lyngbya can smother sea grass communities

DERM

The coastal algal bloom of concern is *Lyngbya majuscula*, a species of cyanobacteria.

Toxins present in Lyngbya can cause irritation upon contact with the skin. The inhalation of dried Lyngbya can also exacerbate respiratory problems such as asthma. It can form dense blooms capable of smothering sensitive seagrass beds.

Acid sulfate soils are linked to Lyngbya outbreaks through the potential to supply soluble / bioavailable iron to initiate and / or support Lyngbya blooms. Numerous bioassay trials, both *in-vitro* and *in-situ* have shown that the

addition of bioavailable iron to the organism results in an increase in growth (Ahern *et al.* (2007) *Harmful Algae* 6(1): 134-151).

<http://www.sciencedirect.com/science/article/pii/S1568988306001016>

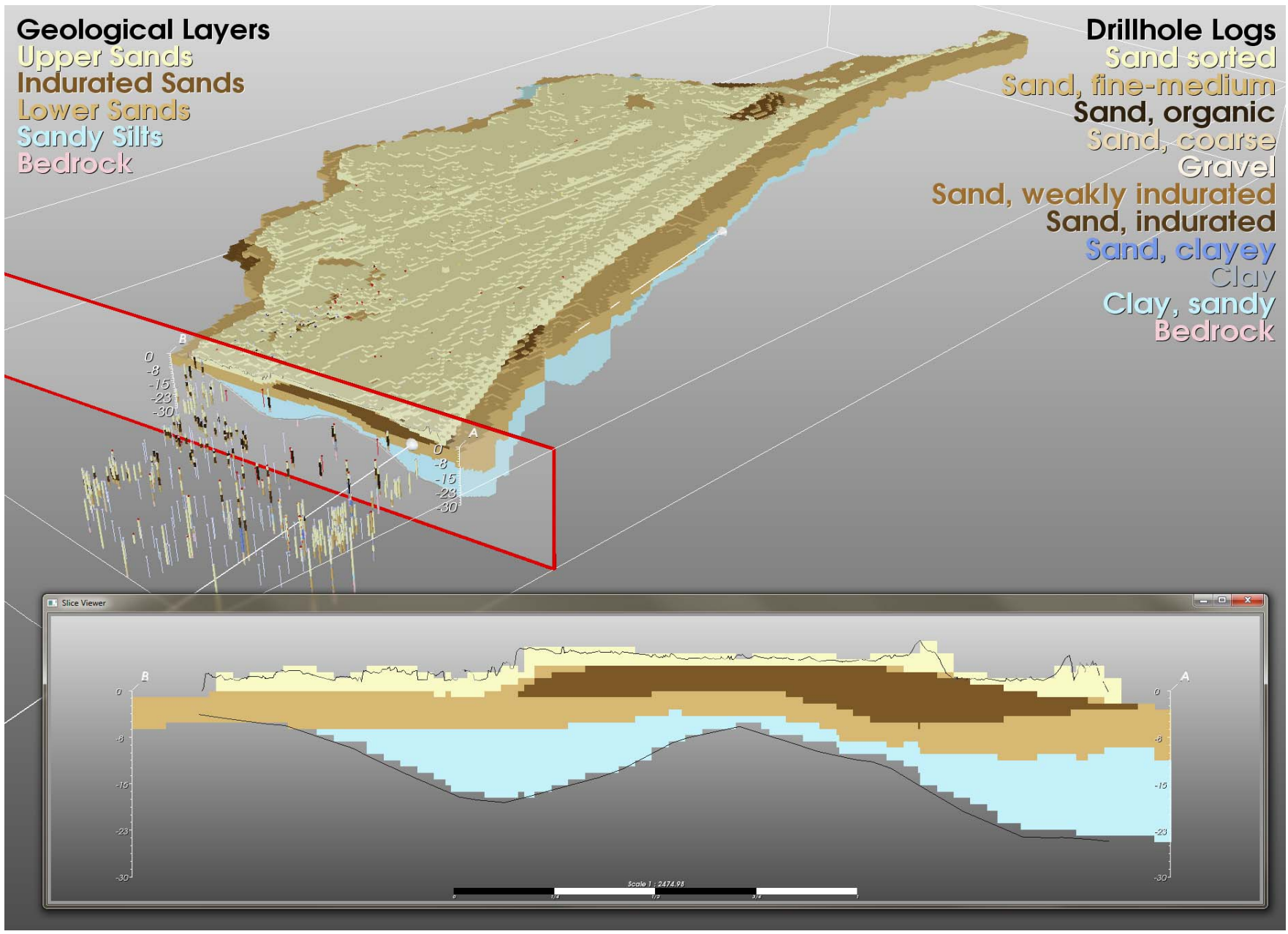
The methodology for the hazard model includes the use of soil and acid sulfate soils (ASS) GIS layers for the determination of nutrient hazard of particular areas. At the time of project initiation, the Bribie Is study area did not have an appropriately scaled soil map (1:50,000 or better) or an ASS map that covered the entire study area.

As part of the hazard mapping project, 1:50 000 scale maps of both soils and ASS have been completed for the Bribie Is study area. Results show that potential ASS (PASS) underlies the majority of the study area with shallower depths to PASS observed on the western side of the island.

The Bribie Island Groundwater Visualisation Model (GVM) was compiled for SEQwater to support the sustainable management of Bribie Island groundwater systems. The GVM used key locations, topographic surfaces, bore data, soil profile descriptions, bedrock surface, and surface geology to produce a visualised time series of water levels of upper and lower aquifers given different rainfall and water extraction rates.

For more information contact Shane.Pointon@derm.qld.gov.au or go to the DERM website for some more general details on Lyngbya:

http://www.derm.qld.gov.au/environmental_management/coast_and_oceans/marine_habitats/lyngbya_updates/commonly_asked_questions.html



Extract from the Bribie Island Groundwater Visualisation Model (GVM)

Malcolm Cox, QUT

Latest publications

de Weys J., Santos I.R., Eyre B.D. (2011) Linking groundwater discharge to severe estuarine acidification during a flood in a modified wetland. *Environmental Science & Technology* 45(8):3310-3316.

Periodic acidification of waterways adjacent to coastal acid sulfate soils (CASS) is a significant land and water management issue in the subtropics.

In this study, we use 5-months of continuous radon (^{222}Rn , a natural groundwater tracer) observations to link estuarine acidification to groundwater discharge in an Australian CASS catchment (Tuckean Swamp). The radon time series began in the dry season, when radon activities were low (2-3 dpm L^{-1}), and the pH of surface water was 6.4.

We captured a major rain event (213 mm on 2 March 2010) that flooded the catchment. An immediate drop in pH during the flood may be attributed to surface water interactions with soil products. During the post-flood stage, increased radon activities (up to 19.3 dpm L^{-1}) and floodplain groundwater discharge rates (up to 2.01 $\text{m}^3 \text{s}^{-1}$, equivalent to 19% of total runoff) coincided with low pH (3.77). Another spike in radon activities (13.2 dpm L^{-1}) coincided with the lowest recorded surface water pH (3.62) after 72 mm of rain between 17 and 20 April 2010.

About 80% of catchment acid exports occurred when the estuary was dominated by groundwater discharging from highly permeable CASS during the flood recession.

Glover F., Whitworth K.L., Kappen P., Baldwin D.S., Rees G.N., Webb J.A., Silvester E. (2011) Acidification and Buffering Mechanisms in Acid Sulfate Soil Wetlands of the Murray-Darling Basin, Australia. *Environmental Science & Technology*. 45(7):2591-2597.

The acid generation mechanisms and neutralizing capacities of sulfidic sediments from two inland wetlands have been studied in order to understand the response of these types of systems to drying events.

The two systems show vastly different responses to oxidation, with one (Bottle Bend (BB) lagoon) having virtually no acid neutralizing capacity (ANC) and the other (Psyche Bend (PB) lagoon) an ANC that is an order of magnitude greater than the acid generation potential. While BB strongly acidifies during oxidation the free acid generation is less than that expected from the measured proton production and consumption processes, with additional proton consumption attributed to the formation of an acid-anion (chloride) Fe^{III} (oxyhydr)oxide product, similar to akaganeite ($\text{Fe}(\text{OH})_{2.7}\text{Cl}_{0.3}$).

While such products can partially attenuate the acidification of these systems, resilience to acidification is primarily imparted by sediment ANC.

Macdonald B.C.T., Denmead O.T., White I., Byrant G. (2011) Gaseous Nitrogen Losses from Coastal Acid Sulfate Soils: A Short-Term Study. *Pedosphere*. 21(2):197-206.

NO_x and N_2O emissions from coastal acid sulfate soils (CASS) cultivated for sugarcane production were investigated on the coastal lowlands of northern New South Wales, Australia.

Two series of short-term measurements were made using chambers and micrometeorological techniques. Series 1 occurred during the wet season, the water-filled pore space (WFPS) was between 60%-80% and the site flooded during the measurements. Measurements were made directly after the harvest of soybean crop, which fixed an estimated 100 kg N ha^{-1} , and the emission amounted to 3.2 $\text{kg NO}_x\text{-N ha}^{-1}$ (12 d) and 1.8 $\text{kg N}_2\text{O-N ha}^{-1}$ (5 d). Series 2 was made towards the end of the dry season

when the WFPS was less than 60%. In Series 2, after an application of 50 kg N ha⁻¹, emissions were markedly less, amounting to 0.9 kg N ha⁻¹ over 10 d.

During both series when the soil was moist, emissions of NO_x were larger than those of N₂O. The emission of NO_x appeared to be haphazard, with little time dependence, but there was a clear diurnal cycle for N₂O, emphasising the need for continuous measurement procedures for both gases.

These results suggest that agricultural production on CASS could be important sources of greenhouse gases and nitrogen practices will need to be optimised to reduce the offsite effects of atmospheric warming, acidification or nitrification. Many questions still remain unanswered such as the emissions during the soybean bean filling stage and crop residue decomposition, the longer-term losses following the fertiliser application and emissions from CASS under different land uses.

Johnston S.G., Keene A.F., Burton E.D., Bush R.T., Sullivan L.A. (2011) Iron and Arsenic Cycling in Intertidal Surface Sediments during Wetland Remediation. *Environmental Science & Technology*. 45(6):2179-2185.

The accumulation and behavior of arsenic at the redox interface of Fe-rich sediments is strongly influenced by Fe(III) precipitate mineralogy, As speciation, and pH. In this study, we examined the behavior of Fe and As during aeration of natural groundwater from the intertidal fringe of a wetland being remediated by tidal inundation.

The groundwater was initially rich in Fe²⁺ (32 mmol L⁻¹) and As (1.81 μmol L⁻¹) with a circum-neutral pH (6.05). We explore changes in the solid/solution partitioning, speciation and mineralogy of Fe and As during long-term continuous groundwater aeration using a combination of chemical extractions, SEM, XRD, and synchrotron XAS.

Initial rapid Fe²⁺ oxidation led to the formation of As(III)-bearing ferrihydrite and sorption of > 95% of the As (aq) within the first 4 h of aeration. Ferrihydrite transformed to schwertmannite within 23 days, though sorbed/coprecipitated As (III) remained unoxidized during this period. Schwertmannite subsequently transformed to jarosite at low pH (2-3), accompanied by oxidation of remaining Fe²⁺. This coincided with a repartitioning of some sorbed As back into the aqueous phase as well as oxidation of sorbed/coprecipitated As(III) to As (V). Fe(III) precipitates formed via groundwater aeration were highly prone to reductive dissolution, thereby posing a high risk of mobilizing sorbed/coprecipitated As during any future upward migration of redox boundaries.

Longer-term investigations are warranted to examine the potential pathways and magnitude of arsenic mobilization into surface waters in tidally reflooded wetlands.

Kingsford R.T., Walker K.F., Lester R.E., Young W.J., Fairweather P.G., Sammut J., Geddes M.C. (2011) A Ramsar wetland in crisis - the Coorong, Lower Lakes and Murray Mouth, Australia. *Marine & Freshwater Research*. 62(3):255-265.

The state of global freshwater ecosystems is increasingly parlous with water resource development degrading high-conservation wetlands. Rehabilitation is challenging because necessary increases in environmental flows have concomitant social impacts, complicated because many rivers flow between jurisdictions or countries. Australia's Murray-Darling Basin is a large river basin with such problems encapsulated in the crisis of its Ramsar-listed terminal wetland, the Coorong, Lower Lakes and Murray Mouth.

Prolonged drought and upstream diversion of water dropped water levels in the Lakes below sea level (2009-2010), exposing hazardous acid sulfate soils. Salinities increased dramatically (e. g. South Lagoon of Coorong >200 g L⁻¹, cf. modelled natural 80 g L⁻¹), reducing populations of waterbirds, fish, macroinvertebrates and littoral plants. Calcareous masses of estuarine tubeworms (*Ficopomatus enigmaticus*) killed freshwater turtles (Chelidae) and other fauna.

Management primarily focussed on treating symptoms (e. g. acidification), rather than reduced flows, at considerable expense (>AU\$2 billion). We modelled a scenario that increased annual flows during low-flow periods from current levels up to one-third of what the natural flow would have been, potentially delivering substantial environmental benefits and avoiding future crises. Realisation of this outcome depends on increasing environmental flows and implementing sophisticated river management during dry periods, both highly contentious options.

Hong Y.S., Kinney K.A., Reible D.D. (2011) Acid volatile sulfides oxidation and metals (Mn, Zn) release upon sediment resuspension: laboratory experiment and model development. *Environmental Toxicology & Chemistry*. 30(3):564-575.

Sediment from the Anacostia River (Washington, DC, USA) was suspended in aerobic artificial river water for 14 d to investigate the dynamics of dissolved metals release and related parameters including pH, acid volatile sulfides (AVS), and dissolved/solid phase Fe^{2+} .

To better understand and predict the underlying processes, a mathematical model is developed considering oxidation of reduced species, dissolution of minerals, pH changes, and pH-dependent metals' sorption to sediment. Oxidation rate constants of elemental sulfur and zinc sulfide, and a dissolution rate constant of carbonate minerals, were adjusted to fit observations. The proposed model and parameters were then applied, without further calibration, to literature-reported experimental observations of resuspension in an acid sulfate soil collected in a coastal flood plain.

The model provided a good description of the dynamics of AVS, Fe^{2+} , $\text{S}^0_{(s)}$, pH, dissolved carbonates concentrations, and the release of $\text{Ca}_{(aq)}$, $\text{Mg}_{(aq)}$, and $\text{Zn}_{(aq)}$ in both sediments. Accurate predictions of $\text{Mn}_{(aq)}$ release required adjustment of sorption partitioning coefficient, presumably due to the presence of Mn scavenging by phases not accounted for in the model. The oxidation of AVS (and the resulting release of sulfide-bound metals) was consistent with a two-step process, a relatively rapid AVS oxidation to elemental sulfur ($\text{S}^0_{(s)}$) and a slow oxidation of $\text{S}^0_{(s)}$ to $\text{SO}_4^{2-}_{(aq)}$, with an associated decrease in pH from neutral to acidic conditions.

This acidification was the dominant factor for the release of metals into the aqueous phase.

Kilminster K., Cartwright I. (2011) A sulfur-stable-isotope-based screening tool for assessing impact of acid sulfate soils on waterways. *Marine & Freshwater Research*. 62(2):152-161.

Early warning indicators for waterways affected by acid sulfate soils (ASS) are valuable tools for water management organisations. Oxidised ASS may discharge high concentrations of metals, acid and sulfur to surrounding water. The origin of sulfate may be determined by $\delta^{34}\text{S}$ values.

$\delta^{34}\text{S}$ values of dissolved sulfate in ~ 300 samples of fresh, brackish and estuarine surface water from south-west Western Australia ranged from -6.6 to 31.4 ‰ (Cañon Diablo Troilite). An indicator was developed based on $[\text{SO}_4^{2-}]$, $[\text{Cl}^-]$ and $\delta^{34}\text{S}$ that categorised samples into groups with similar isotopic influences (iso-groups). Signals of disturbed ASS were identified in ~ 4.5% of sites.

Multivariate statistical analysis showed that water quality had deteriorated at ASS-influenced sites. Although highly variable, average aluminium concentrations were higher (up to 0.12 mg L^{-1} , compared with $<0.05 \text{ mg L}^{-1}$ elsewhere) in samples that are influenced by ASS disturbance. The categorisation of samples into iso-groups provides a simple tool to prioritise sites for further investigation.

This study shows that $\delta^{34}\text{S}$ values provide an early warning indicator for water affected by disturbed ASS, particularly in localities where rainfall is marine dominated with a similar $\delta^{34}\text{S}$ to seawater.

Kang D.J., Seo Y.J., Ujiie K., Vijarnsorn P., Ishii R. (2011) Agronomic and Tolerant Performance of Acid Soil-Tolerant Wild Soybean (*Glycine soja* Sieb. and Zucc.) in Acid

Sulfate Soil of Thailand *Plant Production Science*. 14(2):156-163.

We screened acid soil-tolerant wild soybean (*Glycine soja* Sieb. and Zucc.) accessions and evaluated their agronomic and tolerant performance under acid sulfate soil (ASS) conditions.

Only three accessions, J-13, J-19 and J-55, among 381 *G. soja* accessions obtained from *G. soja* Germplasm Collection of Japan, were identified as having strong tolerance by the acid soil toxicity score (ATS) at soil pH 3.3. These three tolerant *G. soja* accessions showed significantly lower aluminum (Al), iron (Fe) and manganese (Mn) contents in the above ground part than the intolerant ones in 0.25 lime requirement (LR) conditions (pH 3.8).

Above ground dry matter weights (DW) and seed yields of three tolerant *G. soja* accessions, except seed yield of a tolerant accession J-55, were also significantly higher than intolerant ones under the 0.25 LR condition. This clearly indicates that lower contents of toxic mineral in the ASS-tolerant *G. soja* led to higher macro-nutrient uptake, DW, and seed yields.

We conclude that the three tolerant *G. soja* accessions identified in the present study possess high levels of tolerance to the soil acidity and Al-excess soil conditions, and could be valuable genetic resources for soybean improvement programs.

Whitworth K.L., Baldwin D.S. (2011) Reduced sulfur accumulation in salinised sediments. *Environmental Chemistry*. 8(2):198-206.

The accumulation of reduced sulfur species in the sediments of salinised inland waterways poses a serious environmental risk to many historically freshwater environments. Here the effects of salinity (and associated sulfate concentration), organic carbon load and temperature on reduced sulfur accumulation and speciation in closed microcosms containing sediments from a wetland that had not previously been salinised are examined.

At conductivities of up to 10 000 $\mu\text{S cm}^{-1}$, extant sediment carbon was sufficient to allow reduction of the entire sulfate load. Sulfate reduction was carbon limited at higher salinities. The rate of sulfate reduction approximately tripled with an increase in temperature from 20 to 30° C.

Speciation studies showed that elemental sulfur and an unidentified sulfur species - probably reduced organic sulfur - were the dominant reduced sulfur species present during the early stages of sulfate reduction. By the end of the incubation period (226 days), reactive forms of S (elemental sulfur and acid-volatile sulfide) dominated.

In the low conductivity treatments (0 and 1000 μS^{-1}) reduced sulfur was approximately equally distributed between the two forms; acid volatile sulfide comprised ~75% of the reduced sulfur at higher salinities. Formation of less reactive di-sulfide minerals was inconsequential over the timescale of this experiment.

Technical Note - Sulfate-resisting concrete

The following hyperlink connects to a Technical Note that discusses the mechanisms of external sulfate attack on concrete.

<http://www.concrete.net.au/publications/pdf/TN68Sulfate.pdf>

Current Australian specifications for sulfate-resisting concrete are reviewed within the document.

Anyone considering designing or constructing concrete infrastructure in areas associated with acid sulfate soil issues will find this publication useful.



Southern Cross GeoScience is proud to announce that the 3rd National Acid Sulfate Soil Conference will be held in Melbourne, Victoria during March 2012.

The aim of the conference is to facilitate information exchange between all stakeholders involved with managing ASS. The conference will be multi-disciplinary in nature and looks set to attract delegates from a wide range of stakeholder groups including: federal, state and local government, researchers, consultants, developers, contractors, representatives from the construction industry, regional NRM boards and other non-government organisations.

The conference program will include a number of themes such as:

- understanding the nature of ASS, their impacts and distribution
- policy, regulation and education
- laboratory analysis and assessment techniques
- managing disturbance during development and mitigating the impacts
- understanding inland ASS
- broad acre remediation of ASS disturbance in wetlands and agricultural landscapes.

A call for papers that address the above themes will be announced shortly.

For further information on the conference, please visit www.scu.edu.au/nationalassconference

Caring for our Country funding ends for acid sulfate soil short course program.

Chrisy Clay, SCU

The last acid sulfate soil short course, to be held under the Caring for our Country program, will be run this month on the Gold Coast. Interest in the course, which will be held on 29 – 30 June, has been extremely high and is a good example of the response the program has generated nationally. The course has been so well received, that although Caring for our Country funding has come to an end, Southern Cross GeoScience will continue to offer short courses nationally.

The course, which covers how to manage acid sulfate soils during development, has been specifically developed for consultants, engineers, contractors, environmental officers and town planners. Developed in conjunction with the relevant regulatory authorities in each jurisdiction, the course is state-specific and adapted to suit the legislative framework and unique acid sulfate soil characteristics of each state or territory

Caring for our Country, through their 2008 Community CoastCare Program, has assisted with the

delivery of 11 courses, reaching 325 participants across the country over the past two years.

The course has been run at least once in every state and territory, with repeat courses held in Western Australia, Queensland and New South Wales due to demand. The response to the short course program, has far exceeded expectations and has uncovered a significant knowledge gap in many professionals operating in the field.

Since the early 1990s planning controls, policies and guidelines have been progressively introduced across the country, to ensure the disturbance of acid sulfate soils is properly managed. However, to date, there has been little or no professional training on how to manage the issue during development and many stakeholders are unsure of current best management practices.

Organisers have found that even experienced practitioners, who have been working in the field for some years, have improved their knowledge, skills and confidence by attending the course. In particular participants are interested in further information on the analysis of acid sulfate soils and how to interpret laboratory results. This, as well as, conducting a desktop and preliminary assessment, identifying suitable management options and writing a management plan are all covered during the course.



Participants of the recent Adelaide short course listen to presenter Dr Rob Fitzpatrick in the field at Gillman

Demand for the course has steadily built during the Caring for our Country project, to the point where wait lists now exist for most locations. To meet the increasing demand and interest in the course, Southern Cross GeoScience will continue the run short course program. Courses will now be run on demand, and people wanting to attend future courses are encouraged to register their interest with organiser Chrisy Clay on chrisy.clay@scu.edu.au

Future courses for 2011 have been confirmed for Victoria and Western Australia. For further information on Southern Cross GeoScience's short course program visit: www.scu.edu.au/geoscience

Acid sulfate soils workshop in the Fredericksburg, Virginia area, Nov. 3-4 2011, and article about a new soil horizon subscript (*se*) for sulfides in soil materials.

Pedologue Editor - Del Fanning. DelvinDel@aol.com

A new (Winter-Spring 2011) issue of Pedologue, the MAPSS (Mid-Atlantic Association of Professional Soil Scientists) Newsletter has been posted on the MAPSS web site, <http://sawgal.umd.edu/MAPSS/Pedologue/PEDOLOGUEWinterSpring11.pdf>.

This issue announces an acid sulfate soils workshop to be run by MAPSS and VAPSS (Virginia Association of Professional Soil Scientists) with the University of Maryland and Virginia Tech on 3-4 November 2011 in the Fredericksburg, Virginia area - where there are many problems from the exposure of geologic *sulfidic materials* by deep land disturbance, e.g. in the construction of the Stafford County, VA regional airport as shown on the World Congress of Soil Science in 2006, and from highway constructions and in housing developments.

The first day, Thursday, 3 Nov. will be inside at the hotel/motel, where the event will be headquartered (final arrangements are still being completed), where principles/problems of acid sulfate soils will be explained by Del Fanning and Martin Rabenhorst of the University of Maryland and W. Lee Daniels and Zenah Orndorff of Virginia Tech and others.

The second day will be a field trip to examine situations where there have been major problems, such as at the Airport and housing developments (e.g. at the Carriage Hills development as described in the Summer 09 Pedologue issue

http://www.sawgal.umd.edu/mapss/Pedologue/PEDOLOGUE_2009Summer.pdf

There will probably also be a stop to view cliff faces along the tidal Potomac River to show the boundary between the oxidized zone and the un-oxidized zone of the soil-geologic column. Those who are interested may contact me at my e-mail address given above.

The new Pedologue issue also has an article that critiques a new soil horizon subscript, *se*, (ftp://ftp-fc.sc.egov.usda.gov/NSSC/Soil_Survey_Manual/proposed/Suffix%20symbol%20for%20presence%20of%20sulfides.pdf) to indicate the presence of sulfides in soil materials that has been adopted for use in soil descriptions in soil survey programs. In the article it is suggested that an additional subscript or way of designating soils materials that contain monosulfides, such as what in Australia are referred to as monosulfidic black oozes or MBOs.

ASSAY contact details

Previous issues of ASSAY are available from:

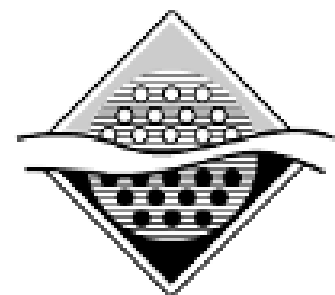
<http://www.dpi.nsw.gov.au/aboutus/resources/periodicals/newsletters/assay/>

ASSAY is a free, quarterly newsletter about acid sulfate soils around Australia, and is available to all people interested in this issue.

It is produced by NSW Department of Primary Industries with funding assistance from the Federal, State and Territory governments.

To subscribe, email the editor, Simon Walsh with "Subscribe ASSAY" in the subject line:

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