ASSAY
A NEWSLETTER ABOUT ACID SULFATE SOILS

No. 42 June 2007

Working together in Tassie to inform and engage

Across Australia there have been partnerships formed and projects developed to manage acid sulfate soils, but the majority of these have been on the mainland. In Tasmania the understanding and strategies for dealing with acid sulfate soils are really just beginning.

Earlier this year, a number of acid sulfate soil forums were run in northern Tasmania to inform stakeholders about the issue and the potential impacts it can have on the environment, infrastructure and industry. The forums provided examples of how other states have dealt with acid sulfate soils including presentations on policy, research and remediation.

A core team organised and ran the forums including Chrisy Clay (National ASS Information Officer), Rob Moreton (Tas DPIW Land Resource Assessment Officer), Jenni Rigby (Local Government NRM Facilitator) and Nicole Middleton (Australian Government Coastal NRM Facilitator).

Rob Fitzpatrick (CSIRO) and Bernie Powell (Qld DNRW) presented at the forums, providing updates on the national Acid Sulfate Soil Atlas and the Queensland's state strategy and management guidelines.

The feedback received from forum participants was positive with most going away with a greater understanding of the potential for impacts within Tasmania. Highlighted was the need for further investigations to identify priority areas around Tasmania's coastline.

These workshops also demonstrated how working together and using the networks across the country enabled a large task to be undertaken and furthered the awareness of acid sulfate soils in Tasmania.

Workshop participants at Burnie.

Rob Fitzpatrick presenting at Launceston.

For further information contact
Nicole Middleton on (03) 6233 3849
nicole.middleton@nht.tas.gov.au or
Rob Moreton on (03) 6336 5441 or
rob.moreton@dpiw.tas.gov.au

During a recent holiday to Scandinavia, Port Macquarie-Hastings Council's Natural Resources Officer, Thor Aaso, visited the Skjern River wetlands in western Denmark, where he found some remarkable similarities to Australian acid sulfate soil experiences.

In order to increase agricultural production in the 1960's the Danish Government embarked on a series of flood mitigation works on the Skjern River. Works included the construction of 80km of artificial drainage, installation of groundwater pumping stations and straightening the Skjern River.
Over 4,000ha of wetlands were converted into arable cropping land. However within 19 years of being drained, environmental impacts were beginning to take hold:

Acidic drain in Denmark.

- large tracts of peatland had sunk by one metre
- the salmon stocks in Skjern River were depleted due to acidic groundwater and agricultural runoff, and
- agricultural land became marginal.

The receiving waters being the Ringkøbing Fjord became increasingly degraded by the acidic groundwater and agricultural runoff from the Skjern River. The Skjern River discharged over 2,400 tonnes of iron floc per annum prior to being remediated.

Skjern River wetlands.

Since 1987 the Danish Government began investigating how the Skjern River wetlands could be remediated. By 1999 works were underway which involved in-filling drainage lines and reforming the natural course of the Skjern River.
Half of the previously drained land (2,200ha) has now been remediated back to a complex of wetlands, shallow lakes, and wet pastures. Discharge of acidic groundwater and agricultural runoff has been reduced and the wetlands are now a habitat for a range of migratory birds and aquatic life and is listed as a RAMSAR wetland.
The Skjern River wetlands now supports a range of activities including wetland habitat, wet pasture grazing, reed cutting, recreation and tourism and bird watching.
The project has cost the Danish Government $283 million, equivalent to $65 million AUD of which $23 million was spent in land acquisitions. Ironically the initial drainage works have been estimated at $53 million.

For further information visit
http://www.skovognatur.dk/Lokalt/Jyllandsyd/Oxboel/Skjern_Enge/Skjern+River+Wetlands.htm
http://www.dmu.dk/Udgivelser/Faglige+rapporter/Nr.+500-549/Abstracts/FR531_uk.htm

National atlas team collects information on Tasmanian acid sulfate soils

NatCASS members from Adelaide and Brisbane travelled to Launceston Tasmania prior to their meeting in Hobart during February to ground-truth and test the new mapping available for acid sulfate soils.

The group consisted of Bernie Powell, Rob Fitzpatrick, Paul Shand, Chrisy Clay and Rob Moreton, together with additional CSIRO staff specialising in Geographic Information Systems and Mineralogy - Steve Marvanek and Mark Raven.

Guided by Rob Moreton, Land Resource Assessment Officer for Tasmania's Department of Primary Industries and Water, the team visited a number of sites within the Tamar Estuary in the north, the north eastern coastal lagoons, and localities within the north western sand plains. These were a full but rewarding five days of fieldwork.

The group was shown areas that are emerging as priorities for future acid sulfate soil investigations and areas that could possibly become case studies for the National ASS Knowledge Project.

This opportunistic trip enabled fine tuning of the national atlas in some areas as well as highlighted the many and diverse areas where acid sulfate soils are being found within Tasmania. A substantial number of sites were also observed at 'inland' locations many kilometres from the coastline.

Whilst impacts to date from acid sulfate soils in Tasmania have been minor, this may change as development pressure increases especially in the coastal regions.

In Tasmania a new project is being developed to identify the priority areas that would benefit from more detailed acid sulfate soil investigations, as well as produce management guidelines to help developers, local government and other parties employ preventative management strategies.

For further information contact Rob Moreton on 03 6336 5441 or rob.moreton@dpiw.tas.gov.au

Benchmarking Tasmania's progress

As a component of the awareness workshops run in Tasmania during February, a benchmarking survey was conducted. The survey recorded stakeholders' knowledge, beliefs and attitudes towards acid sulfate soil.

The results clearly reflect where Tasmania is at in terms of understanding and managing acid sulfate soils and provide a valuable benchmark on which progress can be monitored. The survey conducted was similar in nature to the extensive investigation undertaken in NSW in 1998 and then again in 2002.

Findings include:

- 96% of participants had heard of acid sulfate soils before the workshops. This suggests there is a general awareness of acid sulfate soils in Tasmania. However this awareness has not generally progressed into detailed knowledge of acid sulfate soils. Just over half the participants had previously accessed information on acid sulfate soils.
- Acid sulfate soils could potentially be a highly visible issue in Tasmania. After the workshop 89% of participants felt they had seen acid sulfate soils in Tasmania. Over half the participants said they come across acid sulfate soils in their day to day activities.
- After attending the workshop, participants felt that acid sulfate soil is a priority issue for themselves, and potentially for the community. However they were unsure of how important acid sulfate soil was to their organisation. This is potentially an important aspect of managing acid sulfate soils in Tasmania. If stakeholders are unsure whether it is a priority, their involvement and knowledge will be dependant on their own interest.

Re-designing historical flood mitigation drains

In early 2000, members of the Rafferty Private Drainage Board became concerned about poor water quality discharging into the Macleay River from the Rafferty drainage system. The drainage system constantly discharged acidic (often <pH 4), iron and aluminium rich water during dry periods and black, low-dissolved oxygen water after heavy rainfall or flood events.

The soils of the area consist of a thin layer of alluvium and clayey peat over grey silty clays. The acid sulfate soil layer is extremely close to the surface, where during dry periods acid sulfate scalds develop.

Rafferty's Drain is an acid sulfate soil hotspot, draining approximately 20km^2 of backswamp and wetland area, average elevation 0.0m AHD and dissected by a 4km deep drainage channel.

Historical deep drainage system.

In August 2000, the Rafferty Private Drainage Board working with NSW Agriculture and Kempsey Shire Council, submitted a funding application to the ASSPRO program to assess the feasibility of modifying the existing drain.

By September 2002, a management plan was developed and adopted by the Rafferty Private Drainage Board. The plan recommended that 3km of the old existing deep drain be decommissioned and replaced by a wide shallow v-drain.

Further funds were sought in October 2002 through the ASSPRO program to implement the management plan. By June 2004 the old drain had been decommissioned and replaced by a 30m wide shallow v-drain. All connecting secondary drainage lines were reshaped and redirected to assist in efficient flood water removal.

New shallower drainage system.

To complete the project in 2005, funds were sought from the Northern Rivers Catchment Management Authority to install a tidal floodgate on the head works to improve water quality in the remaining section of the existing drain.

The project has been an opportunity to address both acid production and run-off as well as improve pasture production. The results have been very pleasing with improved water quality and increased wet pasture management.

Filling in the old drain.

For further information contact Ron Kemsley on (02) 6566 3248 or ron.kemsley@kempsey.nsw.gov.au

Vic update

State strategy for Victoria

A strategy to manage coastal acid sulfate soils in Victoria is being developed. Historically the disturbance of acid sulfate soils has not been a significant issue for Victoria. However increasing development and urbanisation of the coast is causing this to change. The increasing risk of acid sulfate soil disturbance and the need for a strategic approach to management has been identified. Development of the strategy will be guided by a steering committee which includes representatives from the Department of Sustainability and Environment, the Victorian Coastal Council, Department of Primary Industries and the Environment Protection Agency. Developing a state strategy will achieve the following:

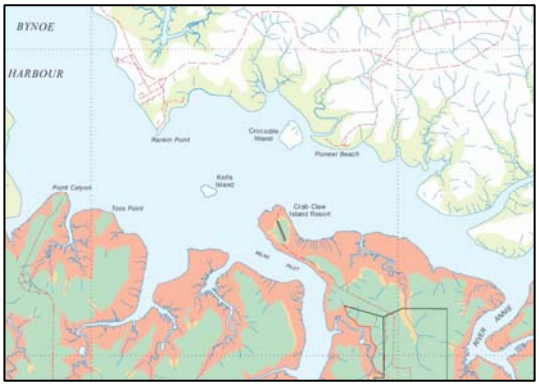
- an effective planning policy framework in Victoria that places emphasis on avoiding acid sulfate soil disturbance
- developing information and assessment requirements that lead to consistent investigations of acid sulfate soils in development approvals
- clear and agreed responsibilities for all aspects of coastal acid sulfate soils within government, including the management of intellectual property and improved access to shared data
- capacity building and awareness of appropriate decision makers, land managers and developers, and
- increased confidence in the accuracy and quality of acid sulfate soil investigations data for coastal areas at risk from development and land use change.

For further contact Rebecca Price on (03) 9637 8551 or rebecca.price@dse.vic.gov.au

NT update

Determining acid sulfate risk in the Darwin region

The Northern Territory, with funding support from the Australian Government, Department of the Environment and Water Resources, is developing an acid sulfate soil risk map for the Darwin region, incorporating both 1:25,000 soil and mangrove vegetation mapping. The two existing datasets will combine to produce a risk map extending from Bynoe Harbour in the south west to Cape Hotham in the north east, covering a coastline of about 1000km. The mapping will cover the Darwin Harbour, Shoal Bay and the Adelaide and Howard River floodplains. It will be the first product that accurately defines the extent of high risk areas in the region. This area coincides with major development pressures from aquaculture, industrial, urban and infrastructure development in the Top End.

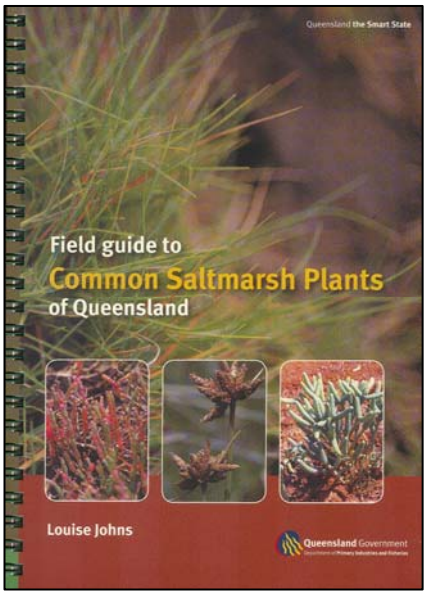


Combining mangrove mapping and soil mapping in the Dundee Beach area has produced a high acid sulfate soil risk

A review of historical soil profile descriptions and bore log data from across the extensive floodplain systems of the Howard and Adelaide River floodplains is also being undertaken. An initial review of this data has revealed useful information, such as depth to marine sediments, soil acidity at depth and sharp increases in sulfur. In the mangrove environment, the extent at which the underlying substrate, often ferricrete or coffee rock extends at shallow depths into these systems needs further investigation. A proposed sampling program involving transects across the floodplain and mangrove systems will provide additional data to support the mapping.

For further information contact Jason Hill on (08) 8999 4443 or jasonv.hill@nt.gov.au

Field guide to common saltmarsh plants of Queensland



Saltmarshes are important intertidal wetland plant communities containing diverse plant types ranging from succulents, grasses and low shrubs. They grow in the upper tidal zones between mangroves and more terrestrial vegetation.

The saltmarsh is home to many marine animals such as burrowing crabs, marine snails and juvenile fish and prawns. Apart from providing shelter, saltmarshes produce detritus or decaying plant material for release to the local food web. Many fish and prawn species migrate between saltmarsh, mangroves and seagrass habitats during their lifecycle so maintaining these links is vital for sustainable fisheries productivity.

Because saltmarshes are so important to fisheries productivity they are protected under the *Queensland Fisheries Act 1994* legislation.

A new publication titled 'Field guide to common saltmarsh plants of Queensland' has been produced by the Queensland Department of Primary Industries and Fisheries (QDPI&F), fisheries biologist, Louise Johns to assist in the identification and protection of these valuable plants.

The guide contains superb photographs of 32 different saltmarsh plant species with detailed descriptions, line drawings, flowering periods and distribution maps. It is extremely user friendly to ensure simple identification of saltmarsh species which will highlight the values of these important fish habitats. Although the guide specifically targets saltmarsh species found in Queensland many of the species listed are found throughout Australia.

QDPI&F hopes that the guide will educate people to value their fish habitats and the plants that live in them and is committed to ensuring these valuable communities survive for future generations.

To obtain a copy of this field guide you can fill out an order form on the QDPI&F website on the following link http://www2.dpi.qld.gov.au/fishweb/18539.html or call the QDPI&F Business Information Centre on 13 25 23 or 07 3404 6999.

Polychaete worms wreak havoc on water quality monitoring gear

Water quality monitoring in a tropical estuarine environment presents unique obstacles. Michelle Martens from Queensland Department of Natural Resources and Water, forwarded the photo below, showing polychaete worms that have been attaching themselves to water quality probes at East Trinity. The worms, which are from the same family as fan worms, clog and coat the probes affecting the accuracy of the readings. The worms were a problem during the last dry season in the more saline areas of East Trinity. Thankfully for the staff monitoring East Trinity, with on-set of the wet season the worms have disappeared. To think the worms had the hide to respire on the dissolved oxygen probe!

Polychaete worms attached to monitoring probes.

Qld local government ASS survey

The Qld Department of Primary Industries and Fisheries (DPI&F) is investigating the level of resources local governments use to manage acid sulfate soil in Queensland. Managing the impacts of acid sulfate soil on fish habitats and the health of fish stocks and fisheries resources are of direct interest to QDPI&F and fishing industry sectors.
The 2007 survey of Queensland local governments to be conducted from 11 May to 13 July will build on previous information gathered by the Local Government Association of Queensland in a survey undertaken in 2000 and a previous survey by QDPI&F in 2004.
Results will be a state-wide summary which will be tabled at both QASSMAC and NatCASS, distributed to all councils, and available on the QDPI&F and Queensland Acid Sulfate Soils Investigation Team (QASSIT) websites.

For further information contact Rebecca Batton on (07) 3239 0675 or rebecca.batton@dpi.qld.gov.au

Sulfidic sediments in inland systems - the Loveday Basin

Sue Welch, Sara Beavis, Luke Wallace and Paul Shand

A team of scientists are investigating the formation of inland acid sulfate soils in highly saline conditions. Inland 'sulfidic systems' can form as a result of activities associated with salinity management, such as saline disposal basins and drains. Compared to coastal acid sulfate soils, little is known about these inland systems. In order to manage or remediate such sites, a detailed understanding of processes controlling salt and sulfur geochemistry over different time scales, water regimes, and climatic conditions is needed.
The Loveday Basin, near Cobdogla SA, has been the focus of the CRC for Landscape Environments and Mineral Exploration (LEME) funded research project involving scientists from the Australian National University and CSIRO. The Loveday Basin was originally a natural wetland adjacent to the Murray River but has been used as a saline water disposal basin for thirty years. The saline water, sourced from irrigation return flows, is intercepted before it reaches the main drainage system, thus protecting valuable aquatic ecosystems.
In 2002, after below average rainfall, the site completely dried out forming deep cracks. When the site was flooded again, extreme variability in salinity and redox conditions occurred resulting in rapid accumulation of sulfidic material especially within the cracks.

continued over page

continued from over page

Surface of the Loveday Basin showing the well developed ped-crack structure associated with the intermittent wetting and drying of the basin. Sulfidic sediments form rapidly within the cracks.

This is important, since changing conditions controlled by climate management decisions, can be expected to result in further oxidation and risk of acidification due to the sulfidic sediments.
Results show that, conceptually, these areas are quite different from many of the coastal sites. Although there is abundant sulfidic material in the surface sediments (up to ~ 1 wt%) the basin has not become acidic during drying. Acid hot spots are present along the edges and in areas that experience intermittent wetting and drying, but the site as a whole is well buffered. Because the formation of sulfidic sediments is recent they have not yet lost the alkalinity generated by sulfate reduction, and there is a lot of primary carbonate that also helps buffer pH.
As long as the system remains closed the sediments should not become acidic when oxidised. This highlights the need to measure neutralising potential as well as the potential for acid generation to assess future impacts in saline basins.

For further information contact Dr Sue Welch on (02) 6125 3777 or swelch@ems.anu.edu.au

Jarosite a source of acidity in acid sulfate swamps

Lin C., Wood M., Haskins P., Ryffel T. & Lin J. (2004) Controls on water acidification and de-oxygenation in an estuarine waterway, eastern Australia. *Estuarine, Coastal and Shelf Science* 61:55-62

Oxidised acid sulfate soils may remain a source of acidity long after they have been disturbed. Apart from the acid removed with draining water, oxidisation products like jarosite can be a source of retained acidity within the soil profile. Iron reducing bacteria can convert retained acidity to water-soluble acid, as occurs in the hydrolysis of jarosite. The release of these previously retained sources can chronically acidify local waterways.
Analysis of soil and water samples taken from Rocky Mouth Creek on the north coast of NSW identified retained acidity as the major source of acid flows in the creek. Analysis showed the amount of water-soluble acid stored in the soil wasn't sufficient to maintain the long lasting acid flows recorded in the creek.
Rocky Mouth Creek is a drained distributary wetland that has had the tide excluded and been extensively drained for agricultural purposes. The study investigated the chemical and bio-chemical characteristics of acid and black water events which regularly occur in the creek. During the study there was little evidence to suggest the conversion of retained acidity caused low dissolved oxygen levels in the creek. It was felt other dissolved oxygen consuming processes were contributing to the low levels recorded, such as the decomposition of inundated vegetation.

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

Causes of estuarine deoxygenation

Eyre B. D., Kerr G. and Sullivan L. (2006) Causes of Deoxygenation in the Richmond River Estuary. Final Report to Environmental Trust. 2001/RD/60005.

Following a one-in-ten year flood in February 2001, 50km of the Richmond River estuary was closed to fishing. The estuary, located on the north coast of NSW, became completely deoxygenated. Dissolved oxygen levels less than 1 mg L^{-1} were recorded in the main channel and as a result a large fish kill occurred.

The large-scale deoxygenation event is thought to have been caused by two separate processes: the oxidation of monosufidic black ooze (MBO) in agricultural drains, and the decomposition of inundated floodplain vegetation.

The above study determined the contribution of these two processes to the overall deoxygenation of the estuary in 2001. This was done by developing an 'oxygen consumption budget', which assessed the proportion of oxygen depletion caused by MBO's and what was due to the decomposition of floodplain vegetation.

The decomposition of inundated floodplain vegetation is a major cause of de-oxygenation events.

The study found that the area of floodplain inundated in the 2001 flood had the potential to deoxygenate about 12.5 x 10^3 ML of saturated freshwater at 25^{o}C per day. That is sufficient to completely deoxygenate floodwater stored on the floodplain within 3 to 4 days. If all the MBO's, as recorded across 15 drains in this study, were rapidly oxidised it would deoxygenate about 49.6 x 10^3 ML of saturated water at 25^{o}C, which was about 10% of the initial one day peak flow (0.5 x 10^6 ML) of the February 2001 flood.

The study concludes that floodplain vegetation was the primary source of deoxygenated water and that oxidation of MBO's in floodplain agricultural drains may have been locally significant, such as in the Tuckean Broadwater. MBO's could have completely deoxygenated the peak daily discharge from Tuckean catchment during the February 2001 flood (approximately 16.3 x 10^3 ML).

It is thought that MBO's could significantly deoxygenate the estuary in the early stages of flooding, but they are probably only of secondary significance in the overall deoxygenation of flood waters in the lower Richmond River catchment and estuary.

The study suggests management options to reduce floodplain deoxygenation including:

- removing cuttings from slashed pasture and transporting off-site
- reducing slashed pasture windrow loads by using comb-type mowers
- returning areas of the floodplain to wetlands to allow the establishment of inundation tolerant vegetation, and
- retaining deoxygenated floodwaters in low-lying areas of the floodplain to allow oxygen consumption process to be completed before releasing this water back to the estuary.

Management options to reduce the formation of MBO include:

- reducing the nutrient availability in drains
- harvesting in-drain vegetation, and
- transporting the organic matter off-site and reducing drain depth.

A journal article describing the deoxygenation potential of the Richmond River estuary is available from the Information Officer on (02) 6626 1355 or christina.clay@dpi.nsw.gov.au

Fish find floodgates difficult

Kroon, F.J. & Ansell, D.H. (2006) A comparison of species assemblages between drainage systems with and without floodgates: implications for coastal floodplain management. *Canadian Journal of Fish and Aquatic Sciences* 63:2400-2417

A two-year recent study has confirmed floodgates reduce the number and diversity of juvenile fish and prawns using floodplain drainage systems. There are a number of different ways floodgates influence fish use of floodplain drainage systems.

- Floodgates are a physical barrier, excluding both tidal water and migrating fish and prawns. Very few juveniles or species that move throughout the estuary were recorded in floodgated systems.
- With the tide excluded, salinity within gated drainage systems decreases. More freshwater species were recorded in gated systems, compared to those without gates.
- In gated systems there are fewer mangroves and less seagrass, the favoured habitat of estuarine fish and prawns. Grasses, rushes and aquatic weeds grow abundantly, which provide little habitat and aren't suitable for breeding.
- Water within gated systems is usually high in nutrients; water samples taken throughout the study regularly recorded nitrogen and phosphorus levels above recommended habitat guidelines. Nutrients are likely to have originated from surrounding agricultural land, where the absence of any riparian zone means nutrients aren't filtered and are washed into the drain. Once in the drainage system, nutrients are concentrated by the lack of tidal exchange and flow. This most likely has flow on effects to the structure of the food web within gated systems, including the proliferation of aquatic weeds.
- All drainage systems monitored during the study were located in acid sulfate soil risk areas. Any acid flow that did occur during the sampling period didn't alter the species composition or abundance.

The study confirmed floodgate management is an important issue to the sustainability of estuarine and coastal fisheries. Floodplains contain essential fish habitat that sustains both recreational and commercial fishing.

This study was conducted on the Clarence River, NSW's largest coastal river system. The Clarence has an extensive floodplain, 2,100 km^2 in total and supports one of the largest estuarine fisheries in NSW. The estuarine prawn fishery is valued at $2.3 million, comprising ~75% of the value of the state's total estuarine prawn fisheries catch.

Active management of floodgates during non-flood periods will reduce their negative impacts. Opening floodgates allows juvenile fish and prawns to access drainage systems and improves the water quality and habitat conditions within them.

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

Australian Government

ACID SULFATE SOILS
information and awareness

Editor details

Chrisy Clay
National Acid Sulfate Soil Information Officer
NSW Department of Primary Industries
Wollongbar Agricultural Institute
1243 Bruxner Highway
WOLLONGBAR NSW 2477
phone: (02) 6626 1355
email: christina.clay@dpi.nsw.gov.au

ASSAY is a free newsletter funded by the Australian Government through the Natural Heritage Trust.