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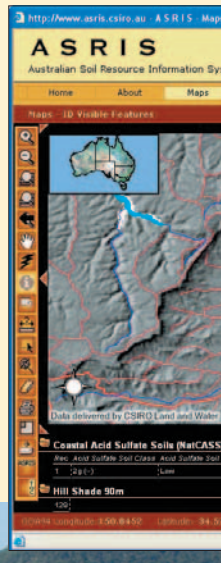
A national atlas of acid sulfate soils

In nature, some things are best left alone, buried well beneath the surface. But housing, marina and infrastructure developments frequently disturb coastal acid sulfate soils and sediments, sometimes with disastrous consequences. Now a national atlas is providing a clearer picture of the extent and severity of this phenomenon along Australia's coastline. **Clare Peddie** reports.



The ASRIS project will provide detailed, up-to-date national soils data compiled from multiple layers of maps and other inputs. Also integrated with Google Earth, the web-based facility provides a vital and accessible reference. CSIRO Land and Water

Below: A view over Wollongong, south of Sydney. Australia's coastal lowlands and floodplains have widespread acid sulfate soils that are vulnerable to disturbance. This area of the NSW coast is identified by ASRIS as being at risk of environmental damage through the acidification of soils if coastal development occurs without appropriate management. Rainforest Agencies

Fish kills, mangrove dieback, algal blooms and many other environmental problems can often be traced back to one thing: the disturbance of coastal acid sulfate soils. Thankfully, the risks posed by these soils can now be properly identified and managed.

The first stage of a national atlas of acid sulfate soils was recently uploaded to the Australian Soil Resource Information System website (ASRIS). In addition, web-based mapping and resource manager tools were officially launched in April by Senator Ian Campbell, Minister for the Environment, and Mr Peter McGauran, Minister for Agriculture, Fisheries and Forestry.

According to Senator Campbell, 'The web-based tool for coastal managers will be vital in helping to better manage coastal planning and development.

'The systematic mapping pinpoints the danger zones for acid sulfate soils, showing where to avoid development and where soils will need special treatment.'

Over the next two years the atlas will be further developed as the team improves map boundaries and adds a database (stage 2). The third and final stage will incorporate information about inland acid sulfate soils, with support from the CRC for Landscape Evolution and Mineral Exploration.

Stage 2 is due for completion in 2008 and stage 3 in 2009.

The problem with acid sulfate soils

Acid sulfate soils either contain sulfuric acid or have the potential to form sulfuric acid when exposed to oxygen in the air.

These soils occur naturally in both coastal (tidal) and inland or upland (freshwater) settings, as a consequence of the deposition of large amounts of organic matter, such as decaying vegetation in a waterlogged setting. Waterlogged wetlands and mangroves are ideal for the formation of sulfide-containing minerals, predominantly iron pyrite (FeS_2) in sulfidic material, which can react with the oxygen in the air to form sulfuric acid (sulfuric materials).

'Left undisturbed, these soils are harmless,' says Dr Rob Fitzpatrick, Research Leader with CSIRO Land and Water. 'But when excavated or drained, the acid drains into waterways, or reacts with carbonates and clay minerals in soils and sediments to form sulfates – liberating dissolved iron, calcium, magnesium and other elements such as copper.'

The atlas has revealed that previous estimates of the amount of land involved were too conservative. More than 75 000 square kilometres of coastal acid sulfate soils fringe the continent, containing well over two billion tonnes of the potentially dangerous sulfidic material. Of greatest concern is the 1 000 km² of land that is most likely already disturbed and acidified (containing sulfuric material).

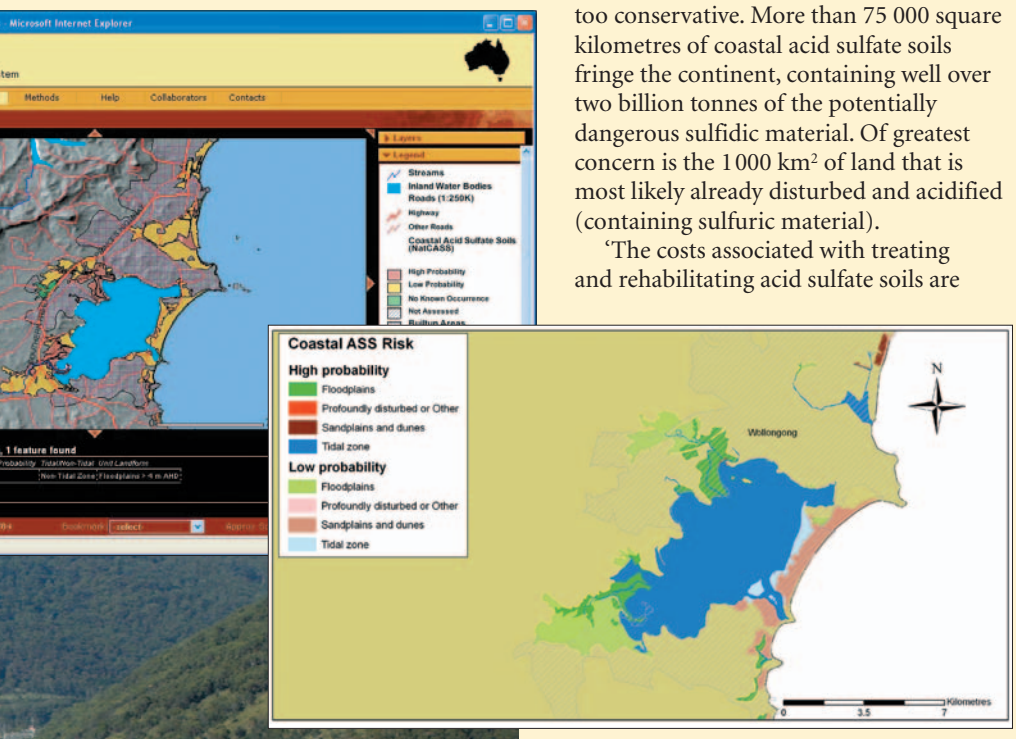
'The costs associated with treating and rehabilitating acid sulfate soils are enormous,' says Fitzpatrick. 'In the past, many urban development and infrastructure projects have either stalled or been abandoned altogether. And millions of dollars worth of corroded infrastructure has had to be replaced.'

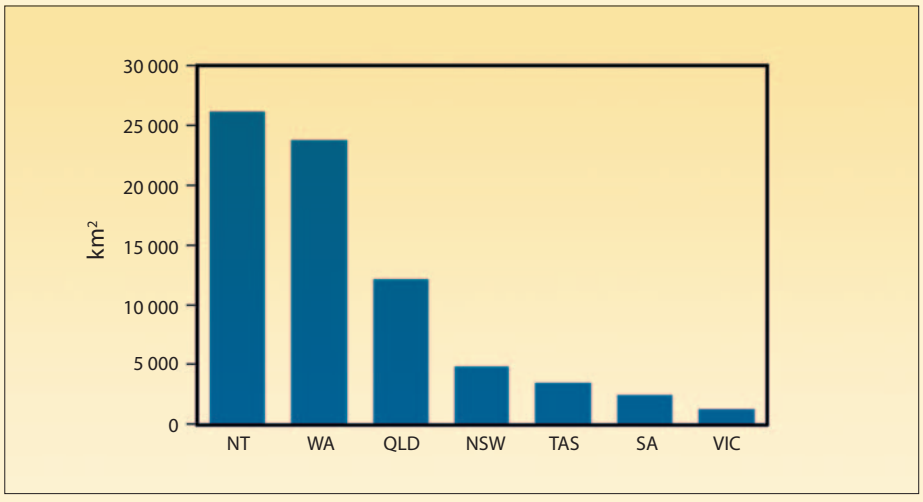
'The systematic mapping pinpoints the danger zones for acid sulfate soils, showing where to avoid development and where soils will need special treatment.'

Acid corrosion and soil subsidence damages infrastructure such as roads, concrete and steel pipes, buildings, bridges and culverts. For example, the Tweed Heads Shire Council spent $4 million to replace infrastructure lost to corrosion. The treatment and management of acid sulfate soils costs $180 million per year in Queensland. More than $2 million per year is lost through fish and oyster deaths in New South Wales.

The environmental consequences of acid sulfate soil disturbance can be highly costly too – in more ways than one. As Fitzpatrick explains, 'A rush of acidic water into estuarine or coastal waterways leads to significant kills of fish, crustaceans, shellfish and other aquatic organisms. Even if they are not killed straightaway, these creatures are left more vulnerable to infection and disease, either through direct exposure to acid, or the associated heavy metals, aluminium, iron and manganese. Acidic water containing dissolved iron and silica may also trigger algal blooms.'

'The aquaculture industry suffers, tourism suffers and the economy suffers. And the impact on biodiversity – both plant and animal – can be irreversible, because the acidic scalds or drain spoils are





More than 75 000 square kilometres of coastal acid sulfate soils fringe the continent. Shown here: current estimates of land areas of acid sulfate soils in each Australian state. CSIRO Land and Water

A view of dead mangroves and contaminated water at Gillman, South Australia, seen from atop the artificial embankment, which was constructed in the 1950s to prevent tidal flooding and reclaim land for grazing. See the profile diagram below. CSIRO Land and Water

either devoid of all vegetation or suitable only to acid-tolerant species.'

Raising awareness of a national issue

For over 20 years Fitzpatrick and the team at CSIRO Land and Water have worked hard to understand acid sulfate soils, challenged and fascinated by their many, varied forms, yet determined to identify, characterise, map and monitor them. They learned to identify and characterise the soils on the spot in many different environments, using specially adapted tools and techniques, modelling risk potential and predicting responses to future land management scenarios.

Beyond the scientific community, awareness of the acid sulfate soils issue peaked in the late 1980s when they were shown to be responsible for a massive fish kill in the Tweed River.

Regional Director of the NSW Department of Primary Industries, John Williams, explains, 'We'd had fish kills in the past and people were attributing those to chemical outflows from agriculture. But we gradually came to realise that was not the case, and it was acid outflows from these drained soils that was the problem.'

Local authorities in New South Wales and south-east Queensland were forced to consider the management of acid sulfate soils earlier than their colleagues in other states.

'In NSW, on the northern rivers, the major developments affecting soils were more related to agriculture and drainage for agricultural purposes, whether for the cane industry or the grazing industry,' says Williams.

'However, in south-east Queensland the disturbance of acid sulfate soils was more likely to be associated with the built environments such as around the Gold Coast and Sunshine Coast and places like that.'

Williams chaired the NSW Acid Sulfate Soils Management Advisory Committee and the working party that drafted the national strategy. He is now Chair of the National Committee for Acid Sulfate Soils (NatCASS), formed to implement the strategy.

'We were concerned that this was potentially a very significant problem nationally, and the fact that you'd sat down and worked out a strategic approach did not guarantee that the ideas in that strategy would automatically be implemented. It was our job to follow that up.'

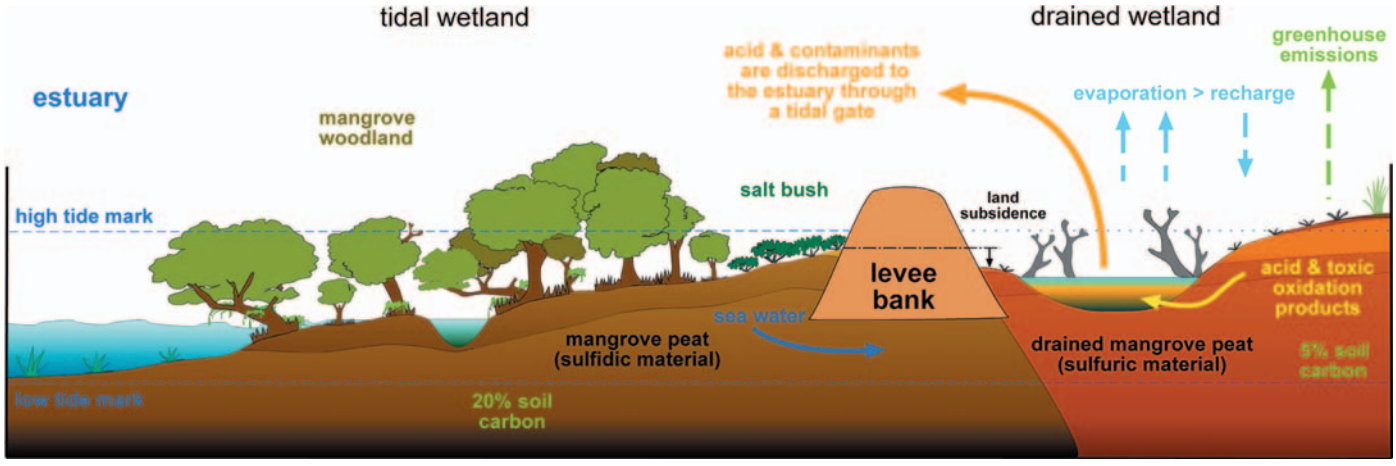
According to Williams, the strategy has a number of elements, but the first thing to do was understand the nature and distribution of the problem. 'That's certainly where the atlas is an important tool', he says.

Tools for developers and land managers

While some risk mapping had been undertaken in various locations around Australia, there was a lack of consistency and many large gaps. Dr Fitzpatrick was keen to develop a standard approach and find new ways to bridge these gaps.

In collaboration with the National Heritage Trust and the Coastal Protection Branch of the South Australian Department for Environment and Heritage, the CSIRO team had produced risk maps of the entire South Australian coast (2002–03).

So a proposal for national risk mapping of acid sulfate soils was put to NatCASS,



A typical cross-section of coastal soils, representing the Barker Inlet at Gillman in South Australia. When normal tidal dynamics are interrupted by a man-made wall (levee bank), or sulfidic soils are disturbed, acid sulfate soil problems are created. CSIRO Land and Water

An excavation and construction site near Adelaide, showing darker sulfidic material (buried acid sulfate soil) at the foundation level. CSIRO Land and Water

and later funded by the National Land and Water Resources Audit. CSIRO led the project, working closely with state government departments and land managers.

Using the Geographic Information System (GIS), the first stage of a national atlas of acid sulfate soils was assembled from published coastal acid sulfate soil maps and other data (land systems, marine habitat, elevation, tidal, estuarine, climate, vegetation and remotely sensed data). Stage 1 now contains all existing electronic map information on Australian coastal acid sulfate soils – complete with a common legend and plain English descriptions. It is essentially a first pass attempt to collate all available information and present it as a single, unified coastal atlas of acid sulfate soils.

'Information had been gathered by the different jurisdictions and states,' explains Williams, 'but what the national atlas has done is to take those pieces of information and put them into a uniform format; to give us a better picture, nationally, of all of that information that was sitting out there, but was not collated and wasn't giving us a clear picture of the scale, size and magnitude of the problem.'

Coastal planning

Local and state governments around Australia are beginning to respond, producing planning policies and guidelines mindful of the risks associated with acid sulfate soils. Some are more developed than others.

It is hoped that a national atlas of acid sulfate soils will enable informed risk management, both in terms of the maintenance of existing development and the assessment of future development proposals.

Dr Fitzpatrick adds, 'These soils are so complex, we are still learning and there is lots of work still to be done. NatCASS is helping to ensure that we all work together on this and share new information with each other. It's very important; there is a lot at stake.'

More information:
To view the mapping and web-based tools: www.asris.csiro.au

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