Acid sulfate soils (ASS)

Acid sulfate soils (ASS) are a major threat to water quality in many areas of Australia and the world where acid-bearing sediments in former coastal wetlands and salt-marshes have been drained.

They are one of the main obstacles to coastal development either for agriculture or for urban expansion, because the extreme acidity of their runoff can potentially kill all the fish and water plants in the surrounding water. Sometimes the runoff also contains toxic metals such as arsenic and aluminium.

What are ASS?

Acid sulfate soils are naturally occurring soils, sediments or organic substrates (e.g. peat) that are rich in iron sulfides and are formed under waterlogged conditions.

Sometimes this happened millions of years ago, but many of these soils were formed in the last 10,000 years, since the end of the Ice Age, when the sea level rose 150 metres and flooded low-lying coastal regions worldwide.

Under the redox conditions of the flooded soil, bacteria need to extract oxygen from the iron oxides: the iron then combines with sulfur in the seawater to form nano particles of iron sulfide known as pyrites (FeS_2). As long as they remain undisturbed, these soils are relatively harmless but when the soil is drained, this pyrite is exposed to the air and becomes oxidised by a natural chemical process, helped along by certain bacteria. When it comes into contact with water again, the resulting iron sulfate can release huge volumes of highly toxic sulfuric acid.

Every time water flows through the drained sediments as a result of rain, flooding or drainage it collects a charge of acid which can make the runoff as low as two or three on the pH (acidity) scale. Very few living organisms can survive water as acidic as this, and large fish kills often result. These are a highly visible sign of acidity and usually cause great concern to local communities.

How bad are they?

Since 700 ha of land near Cairns, Queensland, was drained in 1976, CSIRO scientists estimate 72,000 tonnes of acid have washed into Trinity Inlet, south of the city. A flood on the Richmond River in northern New South Wales in 1994 is thought to have released over 1000 tonnes of sulphuric acid, 450 tonnes of aluminium and 300 tonnes of iron. This acidified 90 kms of the river for seven weeks, with pH falling as low as 2.6. In 1995, a massive fish kill occurred in the Pimpama River and estuary in Queensland after the breaking of an extended drought.

ASS are one of the main obstacles to coastal development because of the extreme acidity of their runoff

Where do they occur?

ASS occur all round Australia, from coastal Queensland and New South Wales to South Australia and north-west Western Australia, wherever the conditions are suitable for the formation of salt marshes. It is estimated Australia has about 40,000 square kilometres of these sediments containing a billion tonnes of potentially acidic pyrites.

Because of the rivers' high salt content, ASS also underlie lakes towards the lower end of the Murray-Darling system. Being bacterial in origin, they tend to form more readily under warmer conditions where plenty of organic matter is present, such as a mangrove forest.

ASS also occur over more than one million square kilometres worldwide, mainly in Asia, South America and Africa. They affect the delta regions of some of the world's

great rivers, where fertile soils have been drained for agriculture. In the case of Bangladesh and West Bengal (India), the water is also contaminated by toxic arsenic which dissolves out of the sediments through a similar biological-chemical process. An estimated 100 million people worldwide are being poisoned by drinking this water.

Impact of ASS

There are five main impacts from the draining of ASS:

1. Poor water quality accompanied by loss of amenity, damage to estuary environments and loss of wetland vegetation along with fish, bird, reptile and insect life.
2. Loss of fisheries, fish farms and agricultural production.
3. Acid corrosion of the concrete footings of buildings, bridges, drains and culverts, and damage to metal boats and structures, resulting in high maintenance and replacement costs and posing some physical danger to the community.
4. The need to rehabilitate disturbed areas to improve water quality and minimise impacts, which can add hundreds of millions of dollars to site development costs, as it often involves digging up and treating all the soil to remove the acidity.
5. There is some evidence that aluminium toxicity can cause mental impairment, stunted growth and dermatitis in humans if ASS-affected water is consumed.

These impacts often cause conflict between different groups in the community, such as developers, farmers, conservationists, fishermen and local government. The total damage and cost to development of ASS across Australia is thought to exceed $10 billion.

What can be done about it?

The National Strategy for the Management of Coastal ASS has four main goals:

1. To identify and map all the ASS-affected areas in Australia.
2. To avoid draining or developing these sediments, and to educate land managers.
3. To minimise disturbance of acid soils, or treat them, where development must occur.
4. To rehabilitate disturbed ASS so as to prevent large acid discharges.

Acidic soils can be treated in various ways to reduce the acidity, but this usually involves digging them up and treating each tonne of soil – a very expensive procedure which adds significantly to development costs. Increasingly, scientists have concluded, it is best to permanently re-flood the soils to prevent them forming fresh acid, and to minimise or treat acidic run-off.

CRC CARE's role

With the Queensland Department of Natural Resources and Water, CRC CARE has established a National Demonstration Site at East Trinity, near Cairns, in the world's largest demonstration of how to rehabilitate an acidic wetland. Here, by using the natural alkalinity of tidal water to reflood the sediments and by adding lime to control acidic discharge, researchers have made major strides in controlling the disaster.

A dramatic improvement in environmental condition has been achieved: mangroves and wetlands are returning, birdlife is flocking to the area and fish abound in creeks that once ran so acid that nothing could live in them.

Groundbreaking research is also underway at the site to understand the chemistry and biology of acid sulfate soils, with the aim of finding even better ways to manage them in future.

Sources:

- *CRC CARE*
- *National Strategy for the Management of Coastal ASS*
- *Queensland Department of Natural Resources and Water*
- *Southern Cross University*

Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE)

University of South Australia
Mawson Lakes
SA 5095 Australia

P.O. Box 486
Salisbury South
SA 5106 Australia

Tel: +61 (0) 8 8302 5038
Fax: +61 (0) 8 8302 3124
Email: admin@crccare.com
Web: www.crccare.com

CRC CARE is a partnership of organisations providing research, technologies and knowledge in assessing, preventing and remediating contamination of soil, water and air.

Established and supported under the Australian Government's Cooperative Research Centres Programme