Coastal Backswamps:
Restoring their values…

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Backswamps - before drainage

When the Europeans first settled the east coast of Australia, they found many backswamps along the floodplains. Coastal backswamps are the lowest lying areas of a coastal floodplain, generally below mean high tide.

Water cycle

Wet/dry cycle
In most years, backswamps experienced a natural wet/dry cycle according to seasonal rainfall and evaporation. The ecology of backswamps has evolved to cope with these conditions, with wetland or dryland plant species colonising the backswamp margins according to longer-term seasonal conditions.

Natural Drainage
Backswamps generally held waters for 3-6 months during and following the wet season. This, combined with the thick vegetative mulch overlying peaty topsoil, helped prevent soil drying out and acidifying.

Backswamps naturally produce humic acids associated with the decay of organic matter. The formation of such acid is generally not a threat to the environment. When backswamps became very dry during severe droughts, they may also have produced some sulfuric acid.

The original backswamps provided wetland areas with good water quality and abundant bird life. (Smith. B)

Fauna and flora

Backswamps were important habitat and nutrient sources for aquatic life, both within the swamp and in the channels that linked them to the estuary at higher flows. Backswamps were major habitat and nursery areas for many fish species.

Backswamps were also prolific areas for duck and other water birds. Landholders enjoyed the abundant waterfowl and fish that provided food for the table as well as employment for professional duck hunters and fishermen.

Management then

Burning
Backswamps did burn pre European occupation, but at frequencies which left them with their natural vegetation cover of reed and rush largely intact. Because back-swamps were wet beneath the surface of the soil, fires burnt with low intensity and the valuable peat layers were retained.

Drought reserve
In the past, traditional upland grazing properties were run in conjunction with backswamps on a seasonal basis, as backswamps could carry high stocking rates during prolonged dry periods. Cattle were moved to backswamps in the spring to make use of the abundant growth at a time when spring droughts often limited upland pasture production.

Backswamps were historically used as drought reserve. (NSW Agriculture)

Backswamps today - after drainage

Drainage

Interference with the wet/dry cycle
Intervention in the natural wet/dry cycle of backswamps to try to make them permanently dry via drainage works has had negative impacts on the productivity of backswamps and associated waterways.

Flood mitigation and drainage
Flood mitigation and drainage schemes were designed to exclude nuisance flood and tidal waters from backswamps and to remove water as quickly as possible to minimise pasture and crop damage, particularly to dryland production systems after inundation. The extension of drains into backswamps has significantly increased the proportion of dryland pasture species in these previously seasonally inundated areas. These species are more susceptible to flood damage and associated generation and export of black water following inundation.

Surface drainage
With efficient floodgates and drains, most surface floodwaters are now removed within 6-10 days, and acid ground water can continue discharging for months. As a result of this drainage, the water that backswamps discharge into the estuaries is often of poor quality.

Drainage intensity
The potential for the generation and export of poor quality water from backswamps depends on the spacing, number and depth of drains as well as the tidal range at the floodgates. Farms that have only been drained to the edge of the backswamps produce better quality water than those where a deep drainage network penetrates through the lowest-lying land.

Nowadays, most backswamps have been extensively drained. (Tulau, M.)

A source of acid water
Most coastal backswamps are underlain with acid sulfate soils. These acid sulfate soils are normally waterlogged, which prevents the acid sulfate layers from oxidising. Overdrainage causes backswamps to dry and crack. This can cause them to produce large quantities of sulfuric acid when the underlying acid sulfate soils are exposed to the air. Acid products such as iron and aluminium from this source are of major environmental concern and contribute to serious loss of productivity in estuaries and backswamps.

Under certain conditions, acidification and the accumulation of highly soluble salts can occur at the surface as white or rusty-coloured salts. These acidic salts can wash into drains with first flush rainfall events. Groundwater however, is the major source of acidity, and can continue to seep directly into deep drains for prolonged periods. Once in the constructed drains, this acid can be carried directly to the estuary at a much greater rate and for a much longer period via natural drainage systems.

A source of black (deoxygenated) water
Black water occurs naturally in backswamps and is normally followed by a period of wetland recovery. However, artificial drainage has greatly increased the rate and overall amount of black water exported. Black water typically flows from drained backswamps for 1-2 weeks after a flood. Such water is generally non-acidic, has no dissolved oxygen and thus kills all aquatic fauna that cannot escape.

Black water is caused by the decomposition of plant material that is not adapted to inundation, as well as by chemical interactions between the iron-rich soil and water. The black sludge that accumulates in the bottom of drains can also contribute to black water.

Discharge of acid and black water from backswamps can be disastrous to the health of coastal rivers. (Tulau, M.)

Fauna and flora

Modifications to the drainage of backswamps alters water regimes and water quality. Acid conditions and the rapid drainage of backswamps has damaged many food sources and habitat values for aquatic life. The impact of acid drainage water on the fishery of estuaries can be devastating. Major fish kills, the decline in prawn harvest and the high mortalities in the oyster industry are characteristics associated with seasonal acid flows from drained backswamps.

Many backswamps are now almost devoid of bird-life because acid conditions limit available food sources. Rehabilitation of backswamps will likely result in the return of many waterfowl.

Vegetation changes

Before drainage, backswamps were often too wet for germination of tree seedlings. Now many former treeless backswamps have been invaded by species such as sheoak (*Casuarina glauca*) and broad-leafed tea tree (*Melaleuca quinquenervia)*. Other seasonal weed species that are unpalatable to livestock include smartweed and common rush.

Backswamps that are severely acidified often undergo major seasonal changes in vegetation cover. The death of water couch during dry times is an indication of severe soil acidification. This death of this plant is caused by the accumulation of acid and salt products at or near the surface carried upward by capillary action. The resultant acid scalds can persist and sometimes become permanent, especially if the overlying peat and topsoil are destroyed.

Structural damage

Fencing wire lasts only three or four years in backswamp areas, largely as a result of acid water. Concrete structures such as culverts, floodgates and bridges are also damaged by acid drainage water.

Seasonal burning of backswamps removes valuable organic layers. (Smith, B.)

Management now

Burning

Drainage has changed the traditional water regime of backswamps, making them drier. Thus, fires occur more frequently and burn hotter, deeper and longer. Frequent fires convert the reed and rush swamps into fresh meadow areas. In some instances, fires have killed all plant life, stripped away the peat layer and exposed acid sulfate soils, leading to extreme acidification and scalds.

Burning is still used in some backswamps to promote fresh pasture growth. However, many landholders no longer burn because of the risk of further damaging the peat layer. Reeds (*Phragmites australis*) and rushes, such as *Bolboschoenus fluviatilis,* which dominated extensive areas of backswamps before drainage, are very susceptible to fire. Heavy follow-up grazing after fire further damages reed communities.

Use of backswamps as drought reserve

Some drained backswamps can still support relatively high cattle stocking rates on a limited seasonal basis. Landholders with the right combination of wet and dry land can still bring their cattle to the backswamps, provided there is enough moisture carried over from the wet season, as the warm weather promotes prolific plant growth. When the swamps get too wet though, stock need to be moved to higher ground to prevent damage by trampling.

The more intensive the drainage and the more severe the acidification, the less reliable backswamps are as a drought reserve. Subdivision and the sale of upland properties has also left many landholders with limited flood-free land. This puts considerable grazing pressure on backswamps as landholders attempt to intensify drainage to allow them to be set-stocked as dryland production systems.

As a consequence, extensive areas of backswamps have been converted from domination by wetland species to dryland pasture species. This, in turn, increases black water and acid production. If grazed, it also increases pugging of soils and vegetation damage during wet seasons.

Cattle health can suffer if forced to drink acid drain water. Such water is commonly contaminated with high levels of acid, iron, aluminium and magnesium. Alternative water supplies may need to be provided. There is also concern about the impacts of cattle ingesting iron-coated pasture.

Do I have an acid problem in my backswamp?

Elevation

Coastal floodplain lands below high tide level may be an acid sulfate soils problem area. Extensive deposits of acid sulfate soils may be found close to the surface in low-lying areas such as backswamps. The Department of Land and Water Conservation has developed 1:25 000 acid sulfate soils risk maps for coastal areas that classify the acid sulfate soils risk.

Indicators

A number of features are indicative of acid sulfate soils. These only indicate the possibility of acid sulfate soils. Many of these can also be caused by other environmental factors, such as salinity. Laboratory soil or water analysis is the only definite way to confirm the presence of acid sulfate soils.

- ***Vegetation and scalds***
  Stunted or dead vegetation, acid scalds and poor vegetation regrowth indicate acid sulfate soil exposure. Acidification can also cause changes in the type of vegetation, with acid tolerant vegetation such as water lilies (in drains), sheoak, rushes and sedges becoming more common.

- ***Soils***
  Jarosite is a yellow mineral which forms in very acidic conditions, either on the soil surface or in a soil profile. Jarosite is one of the most conclusive field indicators that iron sulfides in acid sulfate soils have oxidised.

- ***Red staining***
  Typically, drains that develop a rusty red colour and accumulate black sludge (iron monosulfide) under the water are exporting acid to the estuary.

- ***Water quality***
  Crystal clear or blue-green water indicates the presence of soluble aluminium and iron which cause suspended sediment particles in the water to clump together and drop to the bottom.

Confirm the acid problem

Soil testing

Analysis of soils to determine their actual and potential acidity is the most definitive means of determining the nature and extent of acid sulfate soils. Advice on where to get soil tested can be provided by state government agencies.

Water testing

Regular measurements of pH (acidity) of drain water can confirm the presence of acid drainage water. A pH below 4.5 is of concern. If the pH falls below 4, acid sulfate soils are strongly implicated. The simplest way to measure pH is with low-cost pH strips or a hand held pH meter. As pH may rise to near neutral after rain, the best time to check for acid flows is 1-2 weeks after rain when surface drainage is almost complete, and ground water is entering drains.

Over several seasons, it should be possible to build up a picture of where the major acid sources are. Typically, acid comes from seepage through the sides of deep drains. Seasonal acid scald areas, normally found in the lowest-lying parts or at the edge of backswamps, can also be collection areas for acid.

What can I do on my farm?

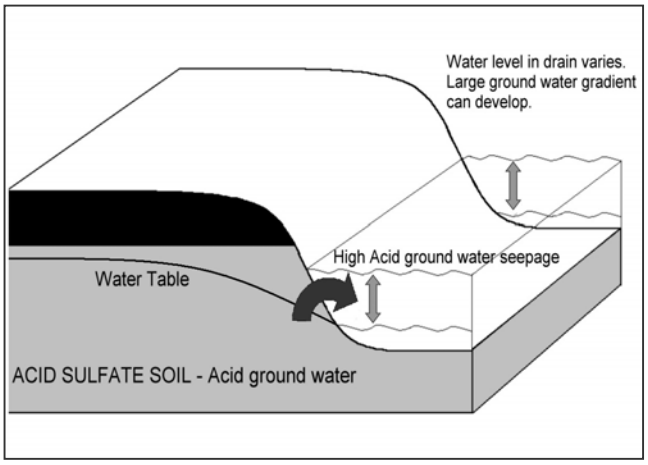
General drain management

Management should seek to mimic the natural cycle, avoiding extremes of prolonged wetness or dryness. It is essential that drainage schemes remove floodwaters to the edge of the backswamps as quickly as possible to minimise damage. However, the last of the drainage water needs to be managed in the backswamps on a controlled seasonal basis, to prevent pollution of the estuary with 'black water' and then 'acid water'.

In many respects, this rapid then slow system mimics natural wetland processes, where water remains in the backswamps for long periods, supports prolific growth of water-tolerant plants and abundant waterfowl, and slowly releases via natural drainage channels to estuaries. Prolonged inundation after major floods prevents the re-establishment of pasture species sensitive to waterlogging.

However, major floods can still kill backswamp vegetation from silt and prolonged inundation, regardless of drainage. In some circumstances, total drainage of surface water may be necessary to encourage seed germination if there is sufficient follow-up rain. Groundwater should not be drained.

The most effective means of minimising acid discharge is to isolate an area. This may require fencing and construction of low-cost water control structures in drains. The simplest such device is a dropboard culvert, which allows water to be held or released on a seasonal needs basis. Holding water in drains and on the affected scald area has been shown to be effective in reducing acid flows.



Seepage of acid ground water into drains is the major source of acid export (Johnston, S. NSW Agriculture)

Keep drains full

Research has shown that once the surface water has been removed, backswamps mostly dry by evaporation. However deep drains can intercept and store highly acid ground water long after surface water has gone.

Keeping drains full is the easiest way to prevent acid ground water seeping from the banks and eventually finding its way into the estuary. Dropboard culverts are an effective, low-cost means of controlling this. Full drains mean fewer problems with cattle bogging and livestock escaping from paddocks where drains are used as fences. Filling in deep drains and replacing them with shallow v-drains is, however, a more reliable and effective long-term solution.

Drain redesign

In recognition of the problem of acid export from backswamps, landholders have come up with valuable ideas to remove floodwaters without tapping acid ground water, such as:

- reinstate the natural drainage lines (veins) through backswamps and maintain them by slashing in the dry season;
- connect the natural veins to the main drains through the levees via redesigned v-drains that can also be seasonally slashed; and
- install dropboard culverts in v-drains to prevent saline water entering backswamps and allowing water to be held in the backswamps.

Flush drains with salt

In the lower reaches of the estuary, it may be possible to modify or manipulate floodgates to allow saltwater flushing of the drains. Seawater neutralises some of the acid because it contains carbonate. However, stripping estuarine waters of carbonate is a major concern because of the likely impact on marine organisms. At all times, a cautious approach is required to avoid saltwater overtopping backswamps and damaging pastures.

Self-regulating or manual mini-sluicegates allow better control of saltwater exchange in drains than raising floodgates. Leaky floodgates can help flush drains with salt water. Installation of dropboard culverts near the edge of the backswamp may be necessary to prevent seawater from entering the lowest-lying land. Maintaining a thick vegetation cover also greatly assists in preventing saltwater spreading into backswamps.

Drain cleaning

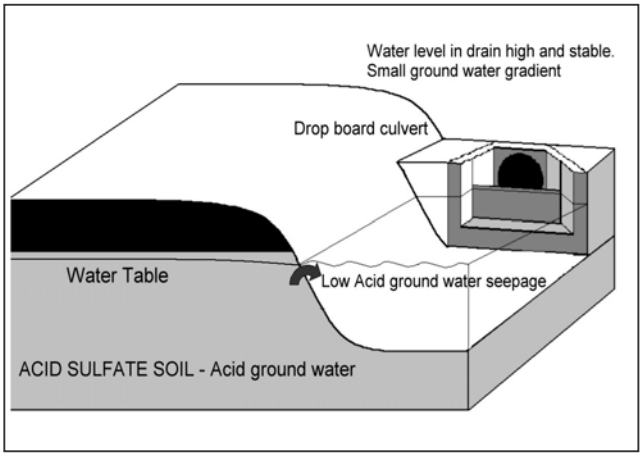
Removal of vegetation and sediment from drains that pass through acid backswamps can mobilise acid stored in drains as black sludge (iron monosulfide), and increase the rate of acid ground water seepage. This can cause a substantial increase in acid generation and discharge from backswamp areas.

Filling in or not cleaning drains in backswamps is being promoted as a responsible way to stop further acid export from overdrained backswamps.

Prepare for floods

Where possible, backswamps should be prepared for flooding by keeping them as wet as possible in the lead-up months to the wet season. This can be partially achieved by catching and storing storm-water, opening floodgates to allow freshwater in, controlling stocking rate and avoiding fires.

Gradually raising the water levels in backswamps, can encourage water-tolerant plants to grow taller, enabling them to better survive inundation with the onset of the wet season.



Installation of dropboard culverts allows water levels, gradients and acid flows in drains to be controlled.
(Johnston, S. NSW Agriculture)

Other management techniques

Grow wet pasture species
It is possible to change from dry pasture species, such as common couch, to water couch and soft rush by manipulating water levels. Backswamp vegetation is extremely responsive to natural rainfall and induced wetting, leading to rapid recovery of pasture and revegetation of seasonal scalds. Manipulation of wetness levels of backswamps is thus a valuable management tool.

Fencing and planting
Fencing and planting both sides of drains to completely shade drains and prevent weed growth has been effective in reducing the need to clean drains. The drains can become self-cleaning without sediment-trapping weeds.

Reed buckets and chemical sprays
Reed buckets and chemical sprays should be regarded as 'stop-gap' measures for maintaining drainage efficiency until shading, v-drains, dropboards and reinstated natural veins are operational. This is a more sustainable approach to drain maintenance because reed buckets can stir up sediments, so drains still require lime treatment and careful management of material removed. Reed buckets can de-water soil along the drain length, leading to acid water flows.

Fencing scalds
It is strongly recommended that stock be excluded from scalded areas. This will encourage re-vegetation of the area and build up the organic peaty layers. This helps protect the underlying acid sulfate soils from drying and reducing the accumulation of acid products on the surface. Spelling paddocks will encourage better grazing species, such as water couch.

A low-stocking rate (left) encourages tall vegetation in backswamps, which improves water quality. (Smith, B.)

Where can I get help?

Local council
Many drainage schemes are maintained by local government who may have experienced staff to assist with drain management problems. Council approval is normally required to undertake drainage modifications and maintenance.

State agencies
NSW Agriculture, Department of Land and Water Conservation and NSW Fisheries are actively encouraging modification to drainage design and management to improve water quality. Technical assistance and, in some instances, financial incentives/ assistance may be available to encourage change. Funding may be available to incorporated groups through NSW Agriculture's ASSPRO and the Department of Land and Water Conservation's 'Hot Spots' programs.

Other landholders
Landholders are a great source of local knowledge on how to tackle acid drainage problems and manage backswamps. Phone your local Department of Land and Water Conservation, NSW Agriculture or NSW Fisheries for details of other active groups of farmers.

Establish a landholder group
In many instances, landholders find it difficult to undertake modifications to the drainage scheme on their own because such action may impact on neighbours. The most effectively managed drainage schemes are those where the landholders have formed groups and have obtained external funding to re-design drains.

Other affected groups
Within most catchments, there are substantial numbers of professional and amateur fishers who are keen to work with landholders to try to improve water quality discharges from backswamps.

Finding a sponsor
Wetland Care Australia provides a service to landholders interested in modifying the management of backswamps. They will attempt to find sponsors for those landholders who may be interested in entering into a 'voluntary wetland management agreement'. Incentives are seen as an important ingredient for landholders to change the management and use of backswamp areas.

Case study
Good and bad floods.

Beneficial floods

Upper Belmore dairy farmer John Sillitoe has experienced many floods on his backswamps. If shallow flooding of backswamps occurs as part of normal seasonal rainfall, the muddy floodwaters and nutrients that cover the swamp to 60-90cm stimulate wetland processes as follows:

- Water remains in a natural swamp basin over water tolerant grasses.
- Water couch copes with this water level and in three to four days, grows through the water surface.
- Water couch grows fast, forming a large number of leaves and stems. Roots grow from the stems, and take up nutrients from the floodwater.
- Water couch grows so fast in warm, wet conditions that in a few weeks it forms a thick spongy carpet over the swamp.
- Water in the natural swamp basin is generally clear and cool because it is shaded by water couch foliage.
- Evaporation is reduced because the water is shaded and cool.
- The thick vegetation prevents water running freely from the swamps as the river levels drop, so floodwaters take months to recede.
- A thick carpet of water couch remains to protect the soil from evaporation, caused by wind and sun when all surface water has gone.
- Mulching of frosted leaves in winter keeps the soil moist.
- The floodwaters stimulate a cycle of high productivity, high organic matter cover of the soil, and minimal formation and export of acid.

Backswamps are well adapted to minor flooding (Smith, B.)

Backswamps can be devastated by major flooding (Smith, B)

Damaging floods

John Sillitoe has also observed that deep flooding of more than 2m, combined with drought, puts muddy nutrient enriched floodwater over water couch and a large areas of higher non water-tolerant grass. The impacts are devastating.

- Non water-tolerant grasses rot, deoxygenating the water and turning it black.
- Black water becomes warm and hot in the shallows.
- Water couch begins to die, first shedding leaves, then stems and sometimes even the root zone, adding to the black water.
- Little vegetation remains to stop the flow of water from the swamps, which dry in 1 to 2 months
- Lack of vegetation aids evaporation. The sun kills water couch roots.
- The river becomes salty without rain, and prevents floodgate opening which would allow tidal water to enter the backswamps.
- Swamp areas can dry out (as in the early 1990s) to the extent that deep wide cracks (50mm x 600mm) appear.
- Holding water on backswamps after a total grass kill produces a clear lake and prolongs rehabilitation time.
- Water couch regenerates from seed, so a warm moist seedbed is required.
- Freshwater is applied after germination, if possible, through the drains from river tides.
- Saltwater in the river at this stage is a disaster.

Deep prolonged flooding with the loss of groundcover and subsequent drying of the backswamps, occurred in the late 1980s and early 1990s (9 floods in 5 years), resulting in low soil pH and acid releases into the river system.

Further Reading

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- Smith R J (1999) Drain and Floodgate Maintenance Procedures. Clarence River County Council
- Woodhead et al (2000) Acid Sulfate Soils: Keys to Success. ASSMAC and NSW Agriculture

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Contact Details for further help

Clarence River County Council
http://www.crcc.nsw.gov.au/
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Department of Land and Water Conservation
http://www.dlwc.nsw.gov.au/care/soil/ass/index.html
Tel - (02) 6563 1212
Email - soils@dlwc.nsw.gov.au

NSW Agriculture
http://www.agric.nsw.gov.au/reader/8632
Northern area - Tel - (02) 6626 1355
Southern area - Tel - (02)6562 6244

Planning NSW
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Queensland Acid Sulfate Soils Investigation Team
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