



REMEDICATION OF DRAINED ACID SULFATE SOIL BACKSWAMPS IN NEW SOUTH WALES, AUSTRALIA - TECHNICAL AND POLICY RESPONSES

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BACKGROUND

Governments in NSW have had a long involvement in 'flood mitigation' and drainage of backswamps for agricultural uses (Tulau in press). Although scientists understood the dangers of draining acid sulfate soils (ASS) by the 1960s (Walker 1960, 1961, 1963), the construction of major drainage works continued until the late 1970s. It was not until the late 1980s that the inherent limitations in the capability of lower floodplain lands and backswamps were generally realised.

However, most backswamp land is now privately owned and managed for agricultural production including sugar cane, tea-tree, and dairy and beef cattle grazing. Landholders rely on an effective drainage and flood mitigation system for current agricultural production systems to continue.

APPROACHES TO MANAGING DRAINED AREAS

Government, industry and the community have hitherto generally sought solutions to ASS issues within a framework of maintaining current forms of land use and levels of productivity. Most attempts to address impacts in agricultural areas have revolved around floodgate management and modifications, and strategies to contain acid in the soil profile. However, with the benefit of several years' research and practice, it is now clear that many of the previously endorsed strategies have potential economic, technical and/or practical impediments.

Floodgate opening with lifting devices is intended to neutralise drain waters with bicarbonates from seawater. However, most ASS 'hot spots' are in an upper estuary position, with limited bicarbonates available (although improvements in other water quality parameters may accrue from manual floodgate opening). In fact, floodgate opening may increase the export of oxidation products. Furthermore, floodgate opening is often practised after local floods to facilitate the rapid drainage of backswamps. Consequently, rapid export of monosulfidic black oozes (MBOs), other ASS oxidation products, which should be biologically processed in backswamps, may occur. In many cases floodgates have remained

closed due to concerns that opening could cause land salinisation or undesired water table regimes.

Containment of acid in the soil profile by increasing surface drainage is also designed to reduce the export of ASS products whilst preserving existing land uses. In practice this strategy can only be applied where: responsive watertable control is practised (possibly involving irrigation and pumps); soils with low K_{sat} are present; laser leveling and drainage redesign is carried out (requiring substantial investment); and the crop can extract water from below the water table (since the strategy involves minimising infiltration). This remediation strategy has been implemented in sugar cane land at McLeods Creek, on the Tweed River floodplain. However, lack of precise watertable control may lead to the further acid. In silvicultural systems it is not possible to achieve control of watertable levels.

The above limitations have meant that the environmental outcomes from ASS remediation attempts have generally been marginal, incremental and subject to reversal.

A REASSESSMENT OF BACKSWAMP HYDROLOGY

Recent research suggests that remediation strategies that do not entail major changes to, or the removal of, drains, will not significantly impact on the pollution of receiving waters. It has been found that during post flood drainage, the majority of oxygen depleting contaminants are exported from backswamps via drains when water levels fall below local mean high water (Johnston 2001). The solution is to retain water in backswamps to this level and to increase the residence time of the waters in the backswamps. This has significant implications for the agricultural management of these areas. Further research has examined MBOs, an ASS oxidation product that accumulates in drains. MBOs may oxidise rapidly when disturbed, depressing dissolved oxygen to lethal levels (Sullivan and Bush 2001). MBOs are best avoided by infilling the drains to at least the top of the ASS layer. These processes were implicated in pollution of north coast rivers and fish kills in 2001. The common theme in both of these examples of research is the hydrologic functions performed by the drains.

A revised understanding of backswamp hydrology is critical. Drainage works shed surface waters so that, combined with evapotranspiration, drying out of sulfidic layers begins earlier in a seasonal cycle or drought, and lasts for longer. Therefore, oxidation products will continue to be generated unless watertable management mimics natural cycles at critical times of the year.

In summary, the retention of the current drainage system will continue to cause pollution of waterways until aspects of the natural hydrology of backswamps is restored, and these areas are able to perform their original functions with respect to maintaining water quality in river systems.

SUSTAINABLE LAND MANAGEMENT IN BACKSWAMPS - FRESHWATER PONDING

Landholders are more likely to change practices where agricultural systems are less profitable. Backswamp grazing of beef cattle in particular is often sub-economic, even without taking 'externalities' into account. Freshwater ponding in backswamps is the main ASS remediation strategy encouraged for grazing systems. It involves closing or modifying floodgates, constructing levees and/or installing dropboards in drains, resulting in generally

higher watertables and creating seasonal wet pastures at beneficial times of the year. Ponding is an ASS containment strategy - water is lost from the system primarily by evaporation.

The benefits of ponding may include: acid generation is reduced; acid released through floodgates is reduced; the concentration of acid released is minimised; acid ground water movement into drains is reduced; vegetation and organic matter cover of backswamps is increased; grazing production and habitat values of fresh meadow are enhanced; and vegetation survives inundation, so low dissolved oxygen problems in receiving waters are minimised (Paterson and Smith 2000).

POLICY TOOLS TO ACHIEVE CHANGES

Despite the benefits of high watertable pasture management, landholders have often been reluctant to change existing practices. Governments therefore need to explore new approaches to encourage adoption of higher watertable management. They have a number of options to achieve significant hydrologic and land management changes in backswamps, including: land acquisition; and statutory and non-statutory agreements possibly involving financial incentives.

Land has been acquired at a number of sites including Yarrahapinni on the Macleay floodplain, Hexham Swamp on the Hunter, and Partridge Creek backswamp on the Hastings. However, a number of important policy considerations that must be assessed before acquisition is practised on anything but a very selective and strategic basis, and it may be argued that governments have an obligation to trial strategies that are less disruptive to local socio-economic conditions before resorting to those that are likely to be more intrusive.

A landholder may agree to either lease land or to manage land or structures in a particular way in return for some form of incentive or reimbursement. This may be required in cases where water table modifications are likely to affect the agricultural productivity of the land. The basis of a contract would be a management agreement (see TPLUCC 1998), possibly including an ASS remediation plan. Matters addressed in a management plan may include stocking rates and seasonality, construction and operation of water control structures, and government support.

It now appears to be generally recognised that natural resource management will not be advanced to the degree required in the absence of some form of 'beneficiary-pays' mechanisms (Aretino *et al.* 2001). Incentives applicable to backswamp management may take the following forms: local government rating bonuses or rebates (Mobbs 1996); tradable rights systems, such as emissions rights; tradable development rights; income tax deductions, tax credits; and/or incentive payments (ASSMAC 1999; Young *et al.* 1996). For example, DLWC recently announced an Environmental Services Scheme, whereby participating landholders will be paid for delivering environmental services they produce. It is envisaged that eventually these will be converted into 'environmental credits' that can then be traded a market. The key challenge for governments now is to assist in the establishment of mechanisms to deliver the incentives required. A formula for the calculation of incentive payments has been suggested by WCA (2001) based on factors such as stocking rates, duration of stocking and gross margins. A further initiative that should be taken is the removal of perverse incentives, such as subsidies for levee construction.

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