SOILS IN THE LAKE PEDDER AREA

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No systematic survey of soils in the Lake Pedder area was undertaken prior to flooding. It is assumed that the soils had similar characteristics to those which occur in neighbouring areas. The south west has a wide variety of soil types which have developed in response to the range of rock types, altitudes, vegetation communities, drainage and climatic differences. The most common aspect of the different soil types is a surface horizon dominated by organic matter in various stages of decomposition. The most widespread are peatlands with organosols which cover undulating terrain in response to very wet climatic conditions and may form on slopes of up to 40°. These are termed blanket bogs. They form under buttongrass moorlands, a vegetation type which dominated the plains around Lake Pedder prior to flooding. Organosols require a wet environment and a high water table for their development. In the south west they form under oligotrophic and ombrotrophic conditions. It is quite likely that some of the organosols in the Lake Pedder area are of considerable depth in places. It is unclear how the soils would respond to draining the lake and how physical and chemical soil conditions would affect revegetation. Further work in these areas is required. As peatlands are typically saturated environments it is possible that the area could be better suited to drainage than a similar area underlain by mineral soils.

Key Words: Australia, Tasmania, Lake Pedder, soils, blanket bogs, peat, organosols, flooding, impoundment

INTRODUCTION

The description of soil types presented here is based on information collected from similar sites in south western Tasmania. It is therefore assumed that soils around Lake Pedder had similar characteristics to those which occur in neighbouring regions. It is usually relatively easy to predict the soil types which occur in the south west based on the vegetation type, the geology, altitude, exposure and drainage. Most of the information presented below is a compilation of data from peatlands in the south west and from interpretation of aerial photographs taken immediately prior to inundation in 1972.

This paper will describe the soil types typically found in the south west, their distribution and their chemical and physical characteristics. It will also consider some aspects of peatland hydrology, the types of soil which are likely to occur below the present impoundment and how these may respond to drainage.

SOUTH WEST SOILS

Physical properties, distribution and formation

Very little work of a detailed nature has been undertaken on south west soils because it is relatively inaccessible and there is no agricultural interest in the area. The south west has been included in a number of generalised soil maps of Tasmania (Stephens 1941, Northcote 1962, Nicolls & Dimmock 1965 and Stace *et al.* 1972). Descriptions of the soils in the region are included in Walker *et al.* (1983) Cooper & Beattie (1986) and Pemberton (1989). Detailed soil investigations were undertaken in the mid reaches of the Gordon River as part of the Lower Gordon River Scientific Survey (Tarvydas 1978).

The south west has a wide variety of soil types which have developed in response to the range of rock types, altitudes, vegetation communities, drainage and climatic differences. For a general description of the soil types in the area see Pemberton (1989). The most common aspect of the soil types is a surface horizon dominated by organic matter in various stages of decomposition. The most widespread of the organosols (Isbell 1996) have formed under buttongrass moorlands, a vegetation type which dominated the plains around Lake Pedder prior to flooding (Macphail & Shepherd 1973). These peatlands, referred to as blanket bogs (Gore 1983), are not necessarily confined to the poorly drained depressions, often referred to as topogenous peats, but cover undulating terrain in response to very wet climatic conditions and may form on slopes of up to 40°. The south west has a cool maritime climate which favours blanket bog development (Thompson 1987) with a heavy, reliable rainfall of 3500 mm p.a. in mountainous areas (Pemberton 1989),

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decreasing to about 1600 mm p.a. towards the east and around the coast. Peat accumulation is also favoured by the high relative humidity (70-80%) and low evaporation rates (621 mm and 248 mm summer and winter averages at Strathgordon).

Typically organosols which develop under buttongrass moorlands on sloping sites are about 30 cm deep while the deepest occur in the most poorly drained depressions at the lowest altitudes. The deepest profile described is a 300 cm deep organosol at Birchs Inlet (Pemberton 1993). They form in areas from close to sea level to about 700 m and are usually covered by sedgeland and heath vegetation. The organosols consist of a number of different horizons. The surface, or fibric horizon, consists of relatively undecomposed organic material and is brown or black in colour while the hemic horizon consists of decomposed organic matter and is black in colour. Either of the horizons may be absent, the fibric horizon in poorly drained locations and the hemic horizon in better drained locations. Organic contents can vary from 25 to 80 % and mineral constituents consist of clay, silt, sand or gravel depending on the substrate. Raw material for peat growth is derived from plant litter, with contributions likely from rhizomes of various *Restio spp.* and *Gymnoschoenus sphaerocephalus*. Organosols typically have dense root mats particularly in the upper 20 cm of the profile.

Some aspects of peatland hydrology and chemistry

Peatlands consist of a surface layer of living plants underlain by typically saturated plant organic matter in various stages of decomposition. They are composed largely of water, often over 90% water by volume, which make them unique terrestrial ecosystems. The water to a large extent excludes the entry of atmospheric oxygen, inhibiting decay and acts as a preservative in most situations. In water saturated soils and sediments containing decomposable organic matter, oxygen is consumed by micro organisms faster than it can be supplied by diffusion from air leading to anaerobic conditions; it is this condition which retards the decay of plant matter (Shotyk 1992). Peatlands form in wet environments and a high water table is an essential condition for their development. The hydrodynamics of peat are complex and the Darcy flow equation, relevant to water flow in other geological materials, does not properly apply to decomposed peat (Daly 1994). Moisture content decreases with increasing humification as does the oxygen content (Shotyk 1992).

Blanket bogs in western Tasmania have formed under oligotrophic (nutrient poor), ombrotrophic (nutrients mainly from rainwater) conditions with minimal contribution from the inert substrates which cover vast areas of the region (Pemberton 1989). The lack of nutrients in the substrate appears to favour peat development. Peatlands in Tasmania are typically assumed to have a low nutrient status. Chemical analysis of organic soils from a limited number of blanket bog sites in the south west (Pemberton 1989) reveal relatively low levels of extractable phosphorous and extractable potassium at an average of 6 ppm and 120 ppm respective. Like most peatlands, south west organosols are acidic with pHs typically around 4.5 through the profile.

To adequately understand peatland groundwater characteristics in Tasmania, considerably more research is required. Pemberton (1994) investigated a number of these aspects at a high altitude site near Lake St Clair. A data logger was installed in a peatland site for a month and the following information was collected: temperature, conductivity, dissolved oxygen, pH and water table depth. It is certainly not clear whether findings at this site are typical of Tasmanian peatlands and there were some peculiar findings. These included diurnal water table fluctuations of 30 to 40 cm with the lowest readings around midnight and the highest around midday. This phenomenon could not be explained by precipitation and may be a result of evapotranspiration. The capacity to recharge the ground water each day is considerable and the source of the water is not clear. One possibility is that it is being recharged from a water source within the peatland or the water may have been derived from Lake St Clair although this is unlikely, the lake being about 200 to 300 m away and separated by numerous impermeable moraine ridges.

Dissolved oxygen results were extremely low at about 3% prior to a rainfall event and increased to 14% following the rain but decreased very quickly after the event. Dissolved oxygen is normally around 95% in rivers and creeks. The rapid decrease in dissolved oxygen after rainfall may be a response to biological activity. Ground water temperature fluctuates on a daily basis and reaches the highest values close to midnight and lowest values about midday. This reflects the lag time it takes the soil and water to warm up and cool down each day. Ground water pH is very similar to organic soil pH at Lake St Clair ranging from 4.7 to just over 5. The least acid conditions follow rainfall periods and are most likely a result of dilution from the rain which has a more neutral pH. Specific conductivity increased after rainfall probably due to the salts carried in rainwater.

SOILS OF THE LAKE PEDDER AREA

This section is written with the assumption that, apart from the erosion which has occurred around the edge of the current lake, inundated soils are still reasonably intact (Tyler *et al.* 1993, Tyler 2001).

Air photo interpretation suggest there are a number of different soil types which occur around Lake Pedder. The area is almost certainly dominated by peatland as the air photos, pre-flooding maps, scientific studies (Macphail & Shepherd 1973) and personal accounts of the area suggest a wet and very boggy environment.

Areas directly adjacent to rivers and creeks probably have fairly uniform sandy to silty mineral soils although they could be organic rich. Similarly the dune areas are likely to have uniform sandy soils perhaps with glacially derived quartzitic gravel at depth. Organic accumulation at the surface of these sandy units probably resulted in grey to black staining. If there were any breaks in sand deposition there may have been sufficient time for vegetation to become established and for soils to develop producing buried fossil soil or palaeosol horizons.

It is quite likely that the organosols in the Lake Pedder area were of considerable (>1m) depth in places. This is supported by Macphail and Shepherd (1973) who comment on the depth of peat in the area near Lake Edgar, particularly on the flat poorly drained part of the valley floor. The meandering Serpentine River which drained the lake did not have a very steep gradient and similar areas to the south east of the lake consisted of poorly drained undulating flats. The presence of numerous oxbow lakes and other small lakes support this suggestion. It is quite conceivable that the most poorly drained flats had organosols which may be as deep as those at Birchs Inlet, the deepest known peats in Tasmania (i.e. 3m).

There is no unflooded valley in the State with a similar landform and soil sequence although locations like the Davey River, Pocacker River and King William Plains have broad reasonably flat valleys, meandering river systems and have deep organic soils in places. Direct comparisons, as far as the soils are concerned, would have to be made with a fair deal of caution as altitudinal differences could be significant as far as organic accumulation is concerned. The deeper organosols at Lake Pedder in the flattest, more poorly drained locations are probably dominated by muck peat and could be at least 200 cm deep. Surface horizon are likely to consist of fibrous peat although these may be absent in places. Organosols on better drained country such as ridges and slopes are likely to have deeper fibrous surface horizons with much shallower, if they occur at all, muck peats at depth. These soils, on similar terrain in the south west are generally up to 30 cm deep. They are typically brownish red in colour in contrast to the black organosols which characterise the most poorly drained locations. The chemistry of both the "well drained" and poorly drained organosols are likely to be similar. Organic contents of surface layers may be as high as 85 % and these are likely to decrease with depth. pHs are likely to be in the 4 to 4.5 range. It is unclear what dissolved oxygen rates and nutrient levels are likely to be, but they will probably be low and similar perhaps to the levels quoted above.

Mineral soils formed on decomposed bedrock are restricted to small areas south east of the original lake. These will not be dealt with in detail. They have been derived from various Cambrian sediments and relatively unmetamorphosed Precambrian rocks. These consist of gradational or duplex profiles with loam to clay loam surface horizons and light clay to medium clay horizons at depth. These may have shallow organic horizons at the surface while underlying mineral horizons are usually yellow brown in colour.

SOILS AND DRAINAGE OF THE PEDDER IMPOUNDMENT

Drainage would expose soils to erosive forces of wind and water, but also from waves generated by wind on the lake as the levels were lowered. Where the country is flat and undulating there is a broad zone for waves to break and dissipate their energy, in contrast to steep country where wave energy and erosion are concentrated in a much smaller area and are more likely to cause degradation.

Soils and organosols in particular are vulnerable to physical disturbance if the vegetation is removed and if the roots are disturbed. If the roots remain intact, as proposed by Tyler *et al.* (1993) and Tyler (2001), they are likely to bind the soil to some extent, depending on the slope and other site characteristics. Tyler *et al.* (1993) and Tyler (2001) have also shown that decomposition of vegetation is incomplete and that immediately recognisable remains of original flora lie on the bed of the impoundment. This may assist in the protection of surface soils through the interception of rain drops and the deflection of surface water flow. If the lake is drained moisture from rainwater can assist to bind the soil by making surface horizons more cohesive. If organosols dry out a 1 to 2 cm crust typically forms and helps to protect or armour the soil surface. It could be that the crust prevents seedling establishment during very dry periods. However when it dries it cracks and this could provide a niche for seedlings. Cracks would also help to disperse surface water flow. These factors and the generally hummocky (Tyler *et al.* 1993) and undulating nature of the flooded country may ameliorate the impacts of erosion. However such a large expanse of exposed soils in a high rainfall and reasonably windy area could be a matter of some concern. A detailed survey of erosion status and hazards would be required prior to any proposal to drain the lake. This should include an investigation of whether there is any viable seed in the soil to assist in revegetating the area. This could be crucial in limiting revegetation costs.

Research would also be required to assess the physical and chemical nature of the inundated soils in comparison to soils in adjacent unflooded country to see if they are capable of supporting plant growth. Various planting techniques should be carried out on soils from unflooded and flooded areas to see whether plants can establish in the flooded soils and if they do whether they can attain reasonable growth rates. This should include an assessment of the affect recently accumulated, typically organic rich sediment (Tyler *et al.* 1993) may have on revegetation.

A detailed survey of the drowned landscape may be unnecessary if pre-flooding topographic sheets and air photos are deemed to provide sufficient information to assess land capability and erosion hazards during and following drainage. At certain levels rapid drainage may be preferable, for example to minimise damage to the dunes, whereas slow drainage may assist in maximising natural revegetation along lake margins but on slopes over about 10° this may present an erosion hazard with concentrated wave attack a potential problem. Barriers could be erected to protect the dunes from wave erosion.

Weeds are a potential problem although the threat of invasion may be limited by the infertile nature of the peat and its acidity. Weed problems have not occurred in west coast peatlands, large areas of which are exposed by fire in most years. Ziegler (1990) noted that the Scotts Peak and Gordon River Roads had sparse infestations of weeds which had not dispersed into undisturbed areas perhaps because of the nutrient status of surrounding soils and/or the distance from a major weed source. Competition from established vegetation may also be a factor. It does not appear that weeds are a problem in areas around the Gordon Impoundment which have been exposed for about fifteen years.

CONCLUSION

If the soils inundated below the artificial impoundment are still intact, the task on the ground would be more a case of stabilisation and revegetation rather than rehabilitation. It is unclear how the soils would respond to draining and whether the physical and chemical soil conditions, particularly in the short term, would permit revegetation. The current climate is more conducive to plant growth than the climate would have been following deglaciation 10,000 years ago and the more arid conditions which were typical of the mid-Holocene. As peatlands are typically saturated environments it is possible that the area would be better suited to drainage than a similar area underlain by mineral soils. That is, the physical and chemical condition of flooded organosols, particularly in a shallow lake situation, are likely to be similar to unflooded organosols. This is unlikely to be the case for mineral soils.

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