Properties, distribution and environmental hazards of South Australian coastal acid sulfate soils

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Abstract

In Australia, coastal acid sulfate soils (ASS) occupy an estimated 40,000km^2, underlying coastal estuaries and floodplains near where the majority of the Australian population lives. The spatial distribution and processes operating in ASS from temperate, Mediterranean climate regions are poorly understood, as are the environmental hazards they pose.

A study is underway in South Australia to better understand ASS processes and distribution. At Gillman, near Adelaide, bunds constructed across mangrove swamps nearly 50 years ago cut off tidal flushing and drained areas resulting in the formation of ASS. Several soil transects have been carried out to determine the location, depth and thickness of sulfidic materials and sulfuric horizons, and the height of the watertable. Conceptual cross-sections of these transects show a wide range of different types of ASS in the tidal mangrove swamps and adjacent bunded areas. This approach has identified the inherent risk of forming actual ASS is related to the thickness and proximity to the surface and watertable of the underlying sulfidic material, and the type of organic matter that they contain.

The morphological, chemical and mineralogical properties of soils occurring in the modern intertidal mangroves at Gillman and surrounding area indicate they have A1 horizons with more than 15% organic carbon (i.e. Histosols), which consist of sapric material (highly decomposed organic matter) and sulfidic material (Soil Survey Staff 1999). The A1 horizon is generally underlain by unconsolidated Holocene coastal marine sediments consisting of saturated, light grey, shelly and often silty or clayey sands. Consequently, these Histosols classify as Terric Sulfisaprists. When these Sulfisaprists were drained and oxidised, the organic carbon content declined and sulfuric acid was produced to form a wide range of actual acid sulfate soils with sulfuric horizons. Where the organic carbon contents are low (<6 %) the soils classify as Hydraquentic Sulfaquepts, Salidic Sulfaquepts (hypersaline soils) or Haplic

Sulfaquents. The schematic cross-section illustrates how carbonates in the Petrocalcic Xerochrepts are being dissolved by the development of immediately adjacent acid sulfate soils (Sulfaquepts). The calcium remaining after dissolution of the carbonates is retained in the system as authigenic gypsum crystals.

The sapric material identified in these soils is more finely divided and reactive than the coarser, “fibric” materials observed in tropical areas, where organic carbon decomposition rates are much faster. It is thought that the "sapric" materials in these South Australian soils form from the detritus of seagrass and mangroves in the Gulf St Vincent. Also, the intense reducing conditions (i.e. low redox potential or Eh values to -600 mv) occurring in potential ASS where mangrove dieback is present in the St Kilda area may be the result of increased nutrient loads (eutrophic conditions). These soil processes and materials must be better understood if effective approaches to management are to be developed.

The distribution of ASS in South Australia has also been investigated so that detrimental effects from future disturbance may be avoided. An inventory of ASS risk (with 9 ASS soil risk classes) in the form of classified maps for the South Australian coastline will be made available via an interactive GIS on the world wide web (http://www.atlas.sa.gov.au/). This multi-scale ASS atlas, is based on saltmarsh and mangrove habitat mapping by the South Australian Office for Coast and Marine (http://www.atlas.sa.gov.au/), mapped mainly from 1:10,000 and 1:15,000 colour aerial photography. ASS soil risk classes were developed using information gained from sampling along transects for which much detail of landform and vegetation was available. Linked to the ASS risk maps, Coast Protection Board ASS planning policy and assessment criteria are being developed for South Australia. It is expected that the outcomes from this study will provide a solid understanding of temperate ASS needed to manage similar soils elsewhere in southern Australia.

Reference

Soil Survey Staff (1999). Soil Taxonomy - a basic system of soil classification for making and interpreting soil surveys, Second Edition. United States Department of Agriculture, Natural Resources Conservation Service, USA Agriculture Handbook No. 436 pp 869.