Journal of the Royal Society of Western Australia, 88:77–79, 2005

Fire and wetland soils and sediments on the Swan Coastal Plain: an Introduction

P Horwitz[1] & R Smith[2]

[1]School of Natural Sciences, Edith Cowan University
100 Joondalup Drive, Joondalup, WA 6027.
[2] Fire and Emergency Services Authority
480 Hay Street, Perth, WA 6000.
✉ p.horwitz@ecu.edu.au; RSmith@fesa.gov.wa.au

Manuscript received: August 2005; accepted: September 2005

Abstract

This Special Issue of the Journal deals with the interactions between fires and wetlands, focusing on particular wetland soils and sediments of the Swan Coastal Plain bioregion that have a propensity to burn. In doing so, contributing authors cover the type of information required to understand those influences, like the nature of the soils and sediments themselves, the implications of the fires for environmental, social and economic values, and how the fires might be prevented.

Keywords: fire, organic soils, climate change, groundwater decline, fire suppression

Introduction

The topic of fire and wetland soils and sediments might seem odd at face value. Organic-rich soils, often called 'peats', are formed mostly under permanently saturated conditions and these are precisely the conditions that should make their combustion difficult. While wet organic soil can combust, and burn for long periods of time at high temperatures, they only do so only under rare conditions of ignition. However, if the soils dry out, they become much more susceptible, and the hundreds if not thousands of years of accumulated organic material stored in the wetland sediments can become regularly exposed to the direct effects of a fire. The topic therefore raises issues that are both specific and general. The fact that wetland soils and sediments (in particular those that are organic-rich) are becoming more vulnerable to fire on the Swan Coastal Plain, highlights the changing nature of its environment as land use changes from bushland, silviculture and horticulture, to peri-urban development, accommodating urban expansion.

These circumstances of vulnerability currently operate on the Swan Coastal Plain, and invoke the following important considerations:

- the climatic conditions that lead to a drying of wetland soils instead of them being subject to winter inundation and summer saturation;
- added reasons for the groundwater decline such as groundwater abstraction for silviculture, horticulture and domestic urban use; and
- the proximity of susceptible wetland soils and sediments to areas of human habitation, and human sources of ignition.

The impacts of fires in organic-rich soils cover issues of biodiversity, air quality, water quality and risk to humans including fire and emergency personnel, and risk to property.

The topic extends from fire management to human health, water quality, land use, urban development and climate change, and the case study of the Swan Coastal Plain is therefore useful to similar scenarios being encountered in other parts of Australia and the world.

Fire suppression and research needs

Bush fires that occur in the dry organic-rich soils have the potential to burn for extensive periods, burning through the soil on the surface or as a subterranean fire. If subterranean, the fire will generally require the break of the season, and for substantial winter rains, to raise the soil moisture content to a level that will suppress the burning fire. As these fires are frequently subterranean, fire fighters can have difficulty in identifying the area that requires suppression, until the fire comes to the surface.

These types of fires are occurring in discontinuous remnant areas, and environmentally sensitive zones, within the Swan Coastal Plain, the most densely populated area within Western Australia. Flora and fauna contained within these remnant areas are potentially at threat of local extinction if they are subject to burning and subsequent soil loss, water quality changes or hydrological change.

Bush fire suppression in wetlands provides the fire responders with significant conundrums. These are, the fire itself, if left to burn it can cause social problems through the smoke that is generated for extended periods, and the potential safety problems, where the subterranean fires are not always visible to the naked eye. If fire suppressants are used they may adversely affect biodiversity in the wetlands and adjacent areas. If a machine is used to create a physical break there are potential implications for acidification of the soil and also the obvious physical impact that occurs.

Preventing the soils from burning therefore is the preferred method of protecting the organic soils. This is a very complex option as it is dependent on preventing bush fire arson, accidental fires or escapes from burning in adjacent areas. Managing and controlling human behaviour by its very nature is complex.

For all these reasons a research focus on fires in wetland soils and sediments, and their management, is timely.

Past research

While some scientific information on the biology, composition and location of wetlands with organic-rich soils and sediments on the Swan Coastal Plain is available, there are a number of gaps. Indeed the history of this scientific information is interesting. Early research centred around the description of soils for agriculture, and Teakle & Southern's (1937) treatise on the occurrence and properties of peats and other poorly drained soils understandably focused on coastal areas of southwestern Australia, estimating then that upwards of 5% of the coastal sandhill zone could be classified as these types. These authors appeared to be well aware of peat fires:

> *The burning of peat lands is practiced universally where agricultural development is being attempted, and a light surface burning is found to be beneficial to the succeeding crops. Deep burning is very deleterious and any burning causes the waste of valuable peat, lowers the surface, restricts the way of life of the formation, and enhances engineering problems.* (p. 336).

Later, Simpson (1939) documents the effects of a fire in diatomaceous earth at Spectacles Swamp, south of Perth, including comments on the stratigraphy and the geochemistry of the soils. Intriguingly, both Teakle & Southern (1937) and Simpson (1939), mentioned the potential problems with acid waters associated with these types of soils.

During and after the Second World War wetlands seemed to have received substantially less attention until the late 1970s. Even then, and throughout a period in which increasing attention was focused on wetlands of the Swan Coastal Plain (see for instance, Semeniuk 1987, Balla 1994, Hill *et al.* 1996, Davis & Froend 1999), little or no effort was devoted to the description of organic-rich soils or sediments *per se*, or highlighting their vulnerability to fire. While the effects of fires may have been obvious to those with a trained eye (see Semeniuk & Semeniuk, 2005, this issue), the issues remained obscured until the connection between drying of wetland soils and sediments and both acidity (Sommer & Horwitz 2001) and vulnerability to fire (Horwitz & Benier 2003) were raised explicitly following severe drought in the mid-late 1990s.

Subject matter covered in this Special Issue

The Fire and Emergency Services Authority of Western Australia (FESA) and Edith Cowan University (ECU) identified a need for closer attention to the issues noted above from their perspectives of fire prevention and response, and wetland research and management expertise, respectively, sharing a common concern over the potential adverse effects bush fires may have on the very important scattered remnant organic-rich soils and also the built and natural environment communities on the Swan Coastal Plain. The partnership was both relevant and fruitful: joining together to facilitate a workshop in March 2004 that had specialist guest speakers and an audience of participants from key fire, land management, local government and community representatives. These proceedings are the result.

In order to place the organic-rich soils and sediments of the Swan Coastal Plain in an international context, Pemberton (2005, this issue) gives an overview of distribution and formation of peatlands in Australia, as well as their biodiversity and geodiversity values, and general classification of such soils. In a landmark paper on the subject, Semeniuk & Semeniuk (2005, this issue) describe aspects of the organic carbon content, mineralogy, geochemistry and biochemistry of wetland soils and sediments. They argue that along with their hydrology, the potential of the soils and sediments to combust is relative to annual water table fluctuations and longer term climatic patterns, the distribution of flammable material across a wetland, and the nature of stratigraphic interlayering along wetland margins. These issues are then overlain at broader scales by the distribution of wetland sediment types both across the Swan Coastal Plain and along the climatic gradient of the length of the Swan Coastal Plain.

The next three papers focus on the effects of fire in these soils and sediments. Horwitz & Sommer (2005, this issue) review national and international literature to demonstrate the potential for fire to alter the physical and chemical attributes of surface water and groundwater. They describe pathways of influence including catchment effects from runoff and deposition, atmospheric effects (the return to ground of volatilized reactive and particulate compounds), and the rehydration of burnt or overheated soils. Superimposed on these effects are the water quality responses to the trophic consequences of a fire. In addition, fire suppression activities like water bombing, fire retardants and ditching and flooding, all have water quality consequences. In a paper on biodiversity values of organic rich wetland soils or sediments, and focusing mostly on the better known biotic groups like the invertebrates, Pinder (2005, this issue) argues that most species inhabiting wetlands with peaty sediments of the Swan Coastal Plain will be widespread and occur in other types of wetlands on the plain and usually elsewhere. However, he suggested that for a range of species that are otherwise rare or otherwise absent on the SCP, such wetlands provide moist refuges in a generally xeric region. Particularly important habitats include the springs which have mounded accumulations of organic matter.

In their review of air quality following a fire in a peatland, Hinwood & Rodriguez (2005, this issue) describe the constituent characteristics of peat smoke (gases include carbon monoxide, carbon dioxide, nitrogen oxides, sulphur oxides, carbonyl compounds, polycyclic aromatic hydrocarbons and other irritant and hazardous volatile organic compounds). The authors present a review of information available on adverse health effects, notably respiratory diseases and symptoms, and highlight a need for more appropriate epidemiological data to be gathered.

Added to these issues are the practical ones of dealing with a fire in a peatland. In a paper from a fire manager's perspective, Jones (2005, this issue) describes the specific dangers and logistic difficulties associated with managing such fires, highlighting matters such as access to the wetland and the fire, inappropriate equipment, and the possibility of injuries for firefighters.

The papers presented at the workshop allowed participants opportunity for around-the-table discussions to address key questions concerning fire protection and fire prevention for these organic rich soils and sediments, and these recommendations are found in the workshop summary paper, the final paper in this issue.

References

Balla S A 1994 Wetlands of the Swan Coastal Plain (Vol 1). Their nature and management. Water Authority of Western Australia and Department of Environmental Protection, Perth.

Davis J & Froend R 1999 Loss and degradation of wetlands in southwestern Australia: underlying causes, consequences and solutions. Wetland Ecology and Management 7: 13–23

Hill AL, Semeniuk CA, Semeniuk V & Del Marco A 1996 Wetlands of the Swan Coastal Plain, Vol 2A, Wetland Mapping Classification and Evaluation, Water and Rivers Supply Commission and Department of Environmental Protection, Perth.

Hinwood A L & Rodriguez C M 2005 Potential health impacts associated with peat smoke: a review. Journal of the Royal Society of Western Australia 88: 133–138

Horwitz P & Benier J M 2003 The effect of artificial maintenance of water levels on the aquatic invertebrate fauna of Lake Nowergup, with notes on the water quality and sediments. Report to the Water and Rivers Commission, Government of Western Australia. Centre for Ecosystem Management, Edith Cowan University, Joondalup, Western Australia.

Horwitz P & Sommer B 2005 Water quality responses to fire, with particular reference to organic-rich wetlands and the Swan Coastal Plain: a review. Journal of the Royal Society of Western Australia 88: 121–128

Jones W 2005 Peat Fires: the dangers from a Fire Manager's point of view. Journal of the Royal Society of Western Australia 88: 139–142

Pemberton M 2005 Australian peatlands: a brief consideration of their origin, distribution, natural values and threats. Journal of the Royal Society of Western Australia 88: 81–89

Pinder A M 2005 A review of biodiversity in wetlands with organic sediments on the Swan Coastal Plain, Western Australia, with an emphasis on aquatic invertebrates. Journal of the Royal Society of Western Australia 88: 129–132

Semeniuk C A 1987 Wetlands of the Darling System – A geomorphic approach to habitat classification. Journal of the Royal Society of Western Australia 69: 95–111.

Semeniuk V & Semeniuk C A 2005 Wetland sediments and soils on the Swan Coastal Plain, southwestern Australia: types, distribution, susceptibility to combustion, and implications for fire management. Journal of the Royal Society of Western Australia 88: 91–120

Simpson E S 1939 Spectacles Swamp, Mandogalup. The effects of burning on the soil. *Report of the Department of Mines for the Year 1939*. pp 147–148. Government of Western Australia.

Sommer B & Horwitz P 2001 Water quality and macroinvertebrate response to acidification following intensified summer droughts in a Western Australian wetland. Marine and Freshwater Research 52: 1015–1021.

Teakle L J H & Southern B L 1937 The peat soils and related soils of Western Australia: notes on the occurrence and properties of peats and other poorly drained soils in the south west coastal areas of Western Australia. Journal of Agriculture WA 14: 332–358.