

Wetlands as early warning (eco)systems for water resource management

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Abstract

This paper describes a case study which investigated impacts of a change in catchment land use from natural grassland to commercial forestry on the hydrological regime and distribution of vegetation in a small hillslope seepage wetland near Nottingham Road in the KwaZulu-Natal Midlands. Hydrological modelling was used to estimate the reduction, following afforestation, in surface and subsurface stormflow runoff provided to the wetland by its catchment. Stormflow runoff was shown to have decreased substantially following afforestation, and since the wetland had no input association with a stream or river, its reliance upon surface and subsurface runoff derived from its catchment was considered to be high. Zones of wetness within the wetland were delineated based on edaphic characteristics. Wetland vegetation was classified, using TWINSpan, into 7 communities. After comparing the edaphic-defined and floristic-defined boundaries of the permanent to semi-permanent wetland zone it was discovered that the area of permanent to semi-permanent wetland vegetation had decreased from its pre-disturbance (edaphic-defined) extent. Implications for water resources management are considered, with particular attention paid to determining the Ecological Reserve for wetlands, and the potential role that wetlands could play in providing an early warning of hydrological change in a catchment.

Keywords: wetland ecology, delineation, water resources management, Ecological Reserve

Introduction

Due to their dependence on water (Mitsch and Gosselink, 1993; Brinson, 1993), wetlands are highly susceptible to degradation by water-development (Bernaldez et al., 1993; Diederichs and Ellery, 2001), land-surface-development (Gibbs, 2000) and landscape-management (Kotze and Breen, 1994; Whitlow, 1992) practices that alter their hydrological regime (Winter and Llamas, 1993). The historical perception that wetlands were wastelands (Maltby, 1986) has led to the exploitation, alteration and in many cases complete destruction of these valuable ecosystems, with an accompanying loss of associated ecosystem goods and services (Begg, 1986). It is now acknowledged that wetlands perform functions that make these ecosystems invaluable to the management of both water quantity and quality, and wetlands are consequently recognised as integral components of catchment systems (Jewitt and Kotze, 2000; Dickens et al., 2003). As knowledge accumulates around the development, vulnerability and value of wetlands, the call for their increased recognition in water resource management policy and practices becomes ever more strident.

Wetlands are transitional ecosystems (Cowardin et al., 1979) that occur along a soil saturation continuum between the extremes of dry land and permanently flooded areas too deep for emergent plants to grow (Kotze et al., 1994). Consistent with this continuum, wetland ecosystems characteristically display zonation of floristic and edaphic characteristics. The primary driving force behind this zonation is variation in hydro-period; the frequency and duration of saturation (Mitsch and Gosselink, 1993) or degree of wetness (Kotze et al., 1994), over the area covered by the wetland. Three distinct zones that vary in their degree of wetness can

be recognised in South African palustrine wetlands based upon edaphic and floristic characteristics: a zone in which saturation is temporary, one in which saturation is seasonal, and one in which saturation is permanent or semi-permanent (Table 1).

As transitional ecosystems, wetlands represent the aquatic edge for many terrestrial biota and the terrestrial edge for many aquatic biota (Mitsch and Gosselink, 1993). Thus, land-use practices that alter the balance between inputs and outputs of water to and from a wetland have the potential to shift the floristic characteristics of wetland zones along the continuum in a temporary/terrestrial or permanent/semi-permanent direction, in the event of water deprivation or addition respectively. While the response of floristic characteristics to a change in the local hydrological regime may be evident after one or two growing seasons, edaphic indicators of wetland environments are the result of many years of regular and prolonged saturation, and will reflect the former hydrological regime long after floristic characteristics have changed to reflect the current hydrological regime. Recognition of a mismatch between floristic and edaphic indicators can therefore be used as an early warning of wetland ecosystem abuse, and catchment water stress.

This paper describes a case of this nature near Nottingham Road in the KwaZulu-Natal Midlands where a small hillslope seepage wetland is located in a micro-catchment approximately 6 ha in extent that feeds a first order stream. Inspection of available aerial photography revealed that, at some point between 1989 and 2002, the landowner established a *Eucalyptus grandis* plantation that replaced all but a small island of the natural grassland that had previously characterised the vegetation of the upper catchment. The remaining island of grassland contained the wetland. Analysis of the floristic and edaphic characteristics of the wetland are used to illustrate how the impact of water deprivation on wetlands can be identified and used as an early warning of hydrological change in catchment management.

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