Dryland salinity and agronomy in south-east Australia: groundwater processes or soil degradation due to intensive grazing and cropping?

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Abstract

In southern Australia, dryland salinity is perceived to be a serious threat to agriculture, infrastructure, river health, water supply and biodiversity and as such is given a high priority on the political agenda. Much funding has been directed towards secondary salinity mitigation and remediation activities that are based on the nationally accepted and promoted groundwater recharge/discharge model. This model advocates an excess of groundwater movement within the landscape, whereby increased ‘recharge’ on the hills following land clearing has created an increase in ‘discharge’ down slope. This model does not consider many other crucial natural and anthropogenic processes, particularly regarding soil surface processes such as degradation and erosion. In many environments and particularly in upland landscapes, it is inapplicable. This paper assesses the applicability of the rising groundwater model in these landscapes and discusses surface water processes with respect to dryland salinity outbreaks on the uplands of south-east Australia. The majority of dryland salinity occurrences on the Southern Tablelands of NSW are spatially limited and are associated with intensive grazing and/or cropping. This research indicates that dryland salinity expressions in many upland landscapes do not appear to be caused by rising groundwater tables. Evidence suggests that intensive grazing and cropping has caused severe soil degradation, thereby causing salinity outbreaks. Following stock exclusion, sites generally respond quickly and favourably, through native grass and tree regeneration. Such species appear to successfully tolerate increased salinity.

Key Words

Salinisation, transient salinity, surface processes, stock-grazing

Introduction

The rising groundwater versus the surface water salinity scenarios

The nationally promoted general model for the cause of dryland salinity invokes an excess of water movement in the landscape due to the clearing of trees from hills post European settlement (PMSEIC 1999); *the groundwater scenario*. This model has been refuted by a number of workers (e.g. Jones 2000; Dahlhaus et al. 2000; Acworth and Jankowski 2001; Wagner 2003; Bann and Field 2006). Jones (2000) argues that this model is fundamentally flawed and Bann and Field (2006) indicate a number of invalid assumptions upon which the model is based. This has major implications for agronomy and NRM activities utilising this model. A number of workers have indicated an opposing scenario whereby surface water and soil parameters are the cause of dryland salinity in upland landscapes (Dahlhaus et al. 2000; Jones 2000; Rengasamy 2002; 2006; Fitzpatrick et al. 2003; Tunstall 2004; Bann and Field 2006); the *surface water scenario*. However, although suggested as the predominant model in upland landscapes of SE Australia (Rengasamy 2002; Bann and Field 2006), this model is ignored for the majority of agronomy and natural resource management activities.

Effects of grazing

Grazing is the main disturbing force on soil surface conditions in SE Australia (Greene et al. 1994). This is predominantly due to the direct effects of grazing on soil physical properties, including soil compaction, physical disturbance and destabilisation of soil aggregates and reducing infiltration whilst increasing runoff and erosion (Greene et al. 1994; Yates et al. 2000). Stock have also been observed licking surface salt at salinised sites, which may contribute to erosion processes.

Study area and methodology

Over 200 sites exhibiting various degrees of salinity were inspected in SE Australia. Ten were chosen on the Southern Tablelands of NSW for intensive research into dryland salinity processes. A multidisciplinary approach was adopted, using biotic and abiotic methods, including soil surface and profile analysis, peizometer monitoring and various biotic surveys.

Results and Discussion

Most salinity outbreaks inspected were limited to less than a few hectares in size and are associated with intensive stock grazing. Many sites are cropped during the winter months. Salinised sites were not restricted to those that had been cleared, directly or on the upslope hills. Electrical conductivity measured with EM38 and EM31 instruments and a 1:5 soil:water mixture was highest at the soil surface and varied significantly both spatially and temporally, especially following rain. Piezometer installation indicated no direct evidence for shallow groundwater. Rather, results indicated lateral surface water movement within perched water tables upon relatively impermeable, clay rich B horizons. Scalds were associated with exposed, eroded, highly dispersible, sodic, bleached A2 horizons. Runoff was considerable, especially at higher elevations. Infiltration was highly variable but generally higher beneath trees where an A1 horizon was present. Soil microbial activity measured using bulk soil respiration and soil organic matter was substantially reduced at salinised zones.

Conclusion

The majority of dryland salinity occurrences on the Southern Tablelands of NSW are spatially limited and are associated with intensive grazing. This research indicates that dryland salinity expressions in many upland landscapes do not appear to be caused by rising groundwater levels. Evidence suggests that soil degradation associated with intensive grazing and cropping exposing naturally saline and/or sodic A2 and B horizons (Acworth and Jankowski 2001) is the primary cause of dryland salinity in SE Australia. This has major implications for agronomy and natural resource management activities.

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References

Acworth RI and Jankowski J (2001). Salt source for dryland salinity – evidence from an upland catchment on the southern tablelands of NSW. Aust. J. Soil Research, 39, 39-59.

Bann GR and Field JB (2006). Dryland salinity in south-east Australia: which scenario makes more sense? Proceedings Aust. Earth Sciences Convention. July Melbourne 9p. available at www.earth2006.org.au.

Dahlhaus PG, MacEwan RJ, Nathan EL and Morand VJ (2000). Salinity on the southeastern Dundas Tableland, Victoria. Aust. J. Earth Sciences, 47, 3-11.

Fitzpatrick RW, Thomas M, Davies PJ and Williams B (2003). Dry saline land: an investigation using ground-based geophysics, soil survey and spatial methods near Jamestown, South Australia. CSIRO Land & Water Tech. Rep.55/03. Adelaide.

Greene RSB, Kinnell PIA and Wood JT (1994). Role of plant cover and stock trampling on runoff and soil erosion from semi-arid wooded rangelands. Aust. J. Soil Research, 32, 953-973.

Jones C (2000). The great Australian salinity debate: Part II. Why the recharge-discharge model is fundamentally flawed. Stipa Newsletter, 14, 6-11.

PMSEIC (1999). Dryland salinity and its impact on rural industries in the landscape: Prime Minister's Science, Engineering and Innovation Council Occasional Paper No 1. DISR, Canberra.

Rengasamy P (2002). Transient salinity and subsoil constraints to dryland farming in Australian sodic soils: an overview. Aust. J. of Exp. Agric, 42**,** 351-361.

Rengasamy P (2006). World salinization with emphasis on Australia. Journal of Exp. Biology 57, (5), 1017-1023

Tunstall B (2004). What model for dryland salinity? Environmental Research Information Consortium Pty Ltd. Canberra. Available at www.eric.com.au.

Wagner R (2001). Dryland salinity in the south east region of NSW. MSc Thesis, unpub. CRES, ANU

Yates CJ, Norton DA and Hobbs R (2000). Grazing effects on plant cover, soil and microclimate in fragmented woodlands in south-western Australia: implications for restoration. Austral Ecology 25, 36-47.