Geophysical Research Abstracts, Vol. 7, 05787, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05787

Salinity hazard assessment in Australia: factoring in accelerating anthropogenic impacts in dryland landscapes

K.C. Lawrie, J. Clarke and **A. Fitzpatrick**

Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), c/o Geoscience Australia, Canberra, ACT 2601, Australia. ken.lawrie@ga.gov.au

Existing salinity hazard and risk maps in Australia's dryland landscapes are weighted towards present-day climate data and use of surface datasets. They are limited in accuracy and reliability by a paucity of sub-surface geospatial (regolith and salt store) data, a general lack of temporal data and limited conceptual groundwater process understanding, inadequate data on land use and other anthropogenic factors influencing recharge characteristics, and the lack of consideration of local climate, predicted climate change, and regolith variability (Lawrie & Williams, 2004). Other factors not generally taken into account include Cenozoic basin morphology, and the extreme spatial variability in hydraulic properties of aquifers and aquitards in Australia's ancient and complex regolith landscapes (Lawrie *et al*., 2002).

For sub-catchment scale management interventions and asset protection, the fundamental problem remains the lack of key datasets at appropriate scales. A paucity of sub-surface spatial data restricts the applicability of these methods to broad catchment scale planning, and a general lack of temporal data severely restricts risk predictions at all scales (Lawrie & Williams, 2004). Most methods fail to incorporate groundwater process understanding, also limiting utility for risk prediction. The reliability of these predictions is usually not stated, however some may only have 5-20 % confidence levels for some existing salinity/water table hazard maps (Lawrie *et al*., 2003).

Most recently, climate corrections to hydrographs for salinity and water table hazard predictions are being made (Reid, 2004). This is important, however the exercise is typically limited by the lack of continuously monitored hydrograph records (e.g. most $<$ 30 years in Victoria). Corrections using historical precipitation and other groundwater level data are less reliable, and are further complicated by the fact that climate is only one of several factors that may be influencing water table levels (and water quality). For example, the impacts of irrigation and groundwater extraction may be very significant in both recent and historical times, and need to be considered in any holistic assessment of dryland salinity risk in some catchments, particularly in eastern Australia (Lawrie & Williams, 2004).

Furthermore, corrections to take account of the composition of regolith materials may be important, particularly in areas of rapidly rising groundwater where regolith materials may not be fully saturated (Lawrie *et al.*, 2002). Zones of variable saturation that preserve different pore fluids of different compositions and age are now recognised (M. Lenahan, pers. com., 2004). Moreover, studies in the last few years have shown that Australia's Cainozoic regolith basins typically have an increasing cross-sectional area as palaeo-valleys have filled with sediment (Lawrie *et al.*, 2000; 2002). In these basins, groundwaters within adjacent regolith units can have different standing water levels on account of different storativities and hydraulic conductivities (Fitzpatrick *et al.*, 2004). Sediment-fill within these regolith landscapes typically changes in composition with time, and this also influences storativity and hence the interpretation of groundwater level changes in hydrographs. These factors are all likely to be significant in producing more reliable salinity hazard and risk predictions (Lawrie *et al.*, 2003).

Similarly, in many upland landscapes, significant landscape disequilibrium over prolonged periods has led to a poor reliability in the use of present day landforms and models based on the use of digital elevation models (DEMs) and terrain indices to predict sub-surface regolith landscapes, salt stores and groundwater movements (Lawrie *et al.*, 2004). In upland landscapes especially, post-European changes in land use/vegetation are likely to have impacted significantly and variably on hydrogeological and salinisation processes through soil loss and consequent changes in recharge/soil infiltration characteristics, hill-slope runoff characteristics and in-river morphology, soil biological activity, and soil and regolith geochemistry.

Further complexity in modeling salinity risk is introduced with predictions of accelerating climate change in Australia (Pittock, 2003; Hennesy, 2003; Hennesy *et al.*, 2004). These studies point to a significant warming, a decrease in precipitation, and an increase in evaporation in many areas of southern Australia over the next century and beyond unless greenhouse gas emissions are significantly reduced. Recent climate change is already affecting many physical and biological systems, especially in the SW, and this 'hot and dry' event in the winter rainfall regions is likely to have further significant impacts on human and natural systems (Hennesy, 2003; Hennesy *et al.*, 2004).

Recent climate warming has been attributed to global increases in CO_2 levels (IPCC, 2001), and this event is superimposed on a post-1840 dry cycle in Australia, the previous Holocene climate record being generally wetter in Australia (Williams, 2001). The predicted change will result in a climate different from that generally reconstructed for the Holocene and late Pleistocene in Australia, where increases in salinity levels in our SE Australian riverine systems appear to correlate with colder dry events rather than a hot dry climate (Lawrie & Williams, 2004). It is therefore likely that the impacts of salinity in our natural systems over the next century and beyond in SE Australia may be quite different to those events recorded in the late Quaternary geological record. The rates of change and the ability of our natural systems to respond to these changes remain problematic.

In conclusion, a number of factors not traditionally considered are likely to be significant in assessing groundwater changes in Australia. If it is recognised that these issues are significant within any catchment, then it is argued they must be accounted for or at least provision for their effects made, in salinity hazard /risk predictions. It is argued that clear articulation as to limitations of the hazard/risk maps is essential to (1) provide greater clarity of the limitations of existing constructs to land managers and policy developers (2) provide funding bodies with clear guidelines on data gaps and the implications of these funding and investment strategies that may be limited by data availability. These data limitations have importance for broader NRM issues such as the monitoring and assessment of catchment condition, biodiversity/ecosystem protection and for assessing the limits of groundwater resource exploitation.

Acknowledgements

This paper is published with the permission of the CEOs of CRC LEME and Geoscience Australia.

References

Fitzpatrick. A., Lawrie, K. C., Clarke, J., Coram, J., Wilkinson, K. & Herczeg, A., 2004. Mapping ‘nested’ groundwater flow systems, aquifers, water tables and salinity systems in the Lower Balonne, SW Queensland. *Aust. Soc. Explor. Geophys. Conference*, 2004.

Hennessy, K., 2003. Climate Change and its predicted effects on water resources. In *“Water, the Australian Dilema”. Proceedings of the Annual Symposium of the Academy of Technological Sciences and Engineering, 17-18th Nov., Melbourne*.19p.

Hennessy, K., Page, C., McInnes, R., Jones, J., Bathols, D., Collins, D. & Jones, D., 2004. *Climate Change in New South Wales. Consultancy Report to New South Wales Greenhouse Office*, CSIRO Publishing, 45p.

IPCC (2001) Climate Change 2001. Synthesis Report. *Contributions of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. World Meteorological Organisation and United Nations Environment Programme.* Cambridge University Press, 397pp.

Lawrie, K. C., Munday, T. J., Dent, D. L., Gibson, D. L., Brodie, R. C., Wilford, J., Reilly, N. S, Chan, R. A. & Baker, P. 2000. A 'Geological Systems' approach to understanding the processes involved in land and water salinisation in areas of complex regolith- the Gilmore Project, central-west NSW. *AGSO Research Newsletter*, 32, p. 13-32, May 2000.

Lawrie K. C., Pain, C. F., Gibson, D., Munday T. J., Wilford J. & Jones G., 2002. Regolith – a missing link in mapping salinity processes and predicting dryland salinity hazards. In Phillips, G.N. & Ely, K.S., (eds.), *Victoria undercover: Benalla 2002 Conference proceedings and field guide: collaborative geoscience in northern Victoria.* p. 167-173. CSIRO Exploration and Mining.

Lawrie, K. C., Please, P. & Coram, J., 2003. Groundwater quality (salinity) and distribution in Australia., 2003. In "Water, the Australian Dilema". *Proceedings of the Annual Symposium of the Academy of Technological Sciences and Engineering, 17-18th Nov., Melbourne*.

Lawrie, K. C., & Williams, M. A. J. 2004. Improving salinity hazard predictions by factoring in a range of human impacts in the context of climate change. In Roach, I (ed.) *CRC LEME Regional Regolith Symposia, 2004.* p. 198-202.

Pittock, A.B. (ed), 2003. *Climate Change: An Australian Guide to the Science and Potential Impacts.* Australian Greenhouse Office, Canberra, 239 pages.

Reid, M., 2004. What is the groundwater record telling us in northern Victoria ? *Salinity Solutions Conference, Bendigo, 2004.* Abstracts**,** p.38.

Williams, M. A. J., 2001. Morphoclimatic maps at 18 ka, 9 ka & 0 ka. In: J.J.Veevers, *Atlas of Billion-year earth history of Australia and neighbours in Gondwanaland* . GEMOC Press, Sydney, 45-48