Guest Editor's Preface

Groundwater Processes in Land and Water Salinisation

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As Guest Editor, I am pleased to present this Theme Issue on "Groundwater Processes in Land and Water Salinisation." The articles are the work of members of the International Association of Hydrogeologists (IAH) Working Group on Groundwater-Related Salinisation and are intended to provide a state-of-the-art review of the most important aspects of salinisation studies that are within the scope of the science of hydrogeology. I thank Fereidoun Ghassemi and Kenneth S. Johnson for their help with the concept of the Theme Issue, and I further acknowledge the contributions of about 20 authors and 30 reviewers. Because of space limitations for this issue of the journal, some contributed papers have been held over for publication in subsequent issues.

Salinisation is the process by which concentrations of soluble salts in soils increase to the point where plant growth is adversely affected. Secondary salinity is human induced and is commonly related to irrigation. When poorly drained soils are irrigated, waterlogging results, and this leads to an increase in salt concentrations. Salinisation may also result when the water table of saline groundwater rises to within one meter of the root zone.

Dryland salinity occurs in non-irrigated areas. This type of salinity develops in landscapes that have been disturbed by clearing or other activities that interfere with the water and salinity balance. Commonly, dryland salinity is a hydrological response to the replacement of deep-rooted crops by those that use less water. Consequently, groundwater recharge increases and water tables rise. Both soil and stream salinity may increase when the water table is within a meter or two of the surface, as a result of increased evapotranspiration or direct evaporation.

The human-induced salinisation of land and water resources is a serious and growing problem in arid and semi-arid regions, and it now affects many countries. The problem is aggravated by such activities as the clearing of land for agriculture and pasture, the development of irrigation schemes without adequate drainage, and the construction of reservoirs in areas with saline groundwater.

In their recent book, Ghassemi and his colleagues (Ghassemi et al., 1995) describe the global and historical dimensions of the salinisation problem. Presently, the world loses about 10 ha of arable land every minute, and of these, 3 ha are lost by salinisation. About 45 million ha out of a total 227 million ha of irrigated lands is affected by salinity problems, and the agricultural production losses caused by the degradation of such large tracts of land amount to tens of billions of dollars per year. In addition, dryland salinity is increasing at a rapid rate in many semi-arid regions.

In Australia, salinisation is part of the nation's most serious environmental problem, land degradation, and it threatens the sustainability of agriculture and the quality of major surface-water resources. About 5 million ha of land is affected, and the situation is worsening. A major concern is that a large part of Australia's major agricultural region, the Murray-Darling Basin, is affected by both secondary and dryland salinisation. This process has caused huge production losses and also a serious deterioration in the water quality of Australia's largest river system.

Other countries known to be affected by salinisation are Argentina, Azerbaijan, Brazil, Canada, Chile, China, Egypt, India, Iran, Israel, Kazakhstan, Morocco, Oman, Pakistan, Paraguay, Peru, Russia, South Africa, Spain, Thailand, Tunisia, Turkey, Ukraine, Uzbekistan, and the United States. The problem is also known to have affected ancient civilisations in Mesopotamia, the Indus River basin, and China. The processes of salinisation are reasonably well understood, but the integrated management of land and water resources needed to combat the problem is presently lacking in most of these countries.

This Theme Issue of *Hydrogeology Journal* includes case studies from the semi-arid zones of Australia, Canada, and South Africa. The serious threat that salinisation poses to agriculture and ecosystems in Western Australia is reviewed by Richard George and his colleagues. They emphasise that salinity management must be based on a sound knowledge of hydrogeological systems. Their research offers a gleam of hope for the future.

Also in this issue, the complex hydrogeological processes causing dryland salinity and the origin of the salts are the subjects of a detailed local catchment study in New South Wales by Ian Acworth and his colleagues. R.C. McKenzie and his colleagues show how measurements of salinity by an electromagnetic-induction meter are being used to develop salinity-management strategies in Canada and Australia.

John Bradd and his co-authors used statistical techniques in conjunction with GIS to map dryland-salinity hazard on a regional scale in the state of New South Wales. Robert Eilers and his colleagues demonstrate the potential for GIS to assist

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the rapid assessment and monitoring of salinisation in another very large region, the Canadian prairies. The use of groundwater simulation models and their linkages to salinity-management strategies are the subjects of a detailed regional study in Western Australia by Jay Gomboso and her colleagues.

The complex processes causing irrigation-induced salinity in the Western Cape Province of South Africa were studied on a regional scale by J. Kirchner and his co-authors. Steven Tickell evaluates the likelihood of dryland salinity developing in the Northern Territory, Australia, using GIS to map zones of relative hazard.

Large tracts of the Earth's most productive lands are dead or dying, together with their streams. The work of hydrogeologists is vital. We are needed to research the problems and to contribute to strategies for amelioration. Our skills are also needed to raise public awareness of the seriousness of the threat to the Earth and its land and water resources, and to support those who are trying to address this devastation.

Reference

Ghassemi, F., Jakeman, A.J., and Nix, H.A., 1995, Salinisation of land and water resources: Human causes, extent, management and case studies: Sydney, University of New South Wales Press, and Wallingford, CAB International, 526 p.