

INTERACTION BETWEEN GROUNDWATER AND SURFACE SYSTEMS IN NORTHERN VICTORIA



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Bibliography.

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INTERACTION BETWEEN GROUNDWATER AND SURFACE SYSTEMS IN NORTHERN VICTORIA

By Dr Phillip G. Macumber

DEPARTMENT OF CONSERVATION AND ENVIRONMENT

FOREWORD

This publication by Dr Phil Macumber is the culmination of 25 years' work on groundwater / surface water interactions in Victoria, written around the occurrence, character and movement of water and salt in the landscape. It is a landmark publication providing a technical basis for understanding the processes and trends occurring within the groundwater systems. While initially written as a PhD thesis, it has been subsequently expanded to incorporate more specific details on technical aspects of salinity control.

The work examines the hydrological and environmental instability in the landscape and details the hydrodynamic, hydrochemical and geomorphological interrelations which are both responsible for determining the nature and distribution of salt in the landscape and are in turn themselves modified by that interaction. The report is particularly significant in that it focuses jointly on groundwater and surface waters. Historically, these two systems have been studied independently by researchers from different disciplines.

The clear message to emerge is that the management of streams, wetlands, irrigation areas, and environments in general, requires an understanding of the role of groundwater systems and their influence on surface processes. It follows, that for the development of meaningful management strategies, surface water systems and groundwater systems must be considered as being part of a single integrated water resource. With the advantage of hindsight, there is no doubt that some of today's salinity problems in Victoria could have been avoided if this close association had been appreciated when irrigation areas were being initially developed.

The study also provides a model for the formation and distribution of copper, lead, zinc and other sulphide ore bodies in salt lake settings. A better understanding of the formation of these ore bodies has far reaching implications for the exploration of new deposits.

While the area examined is northern Victoria, the principles and processes apply generally for much of Australia. It is a contribution which even before its publication is widely acknowledged as providing a significant advance in the understanding of the movements of salt and water in the landscape.

Dr Macumber has made an enormous scholarly contribution to our knowledge of an important element of the Australian continent. In very recent years, this has had a major impact upon the response of Australian society to salinization. It is a model of scientific discovery and its diffusion, which stands as a splendid example to all. The Department of Conservation and Environment is proud to have made this work available to a wide audience.

PREFACE

Across much of Australia we are today experiencing a wide-ranging and fundamental shift in environmental equilibrium brought about by the impact of European man on what was previously a largely untouched landscape.

A major factor in this shift has been the large-scale clearing of trees from both the highland areas and the plains. This has led to vastly increased runoff from the catchments, resulting in accelerated erosion and sedimentation in differing parts of many drainage basins. However, perhaps the most drastic changes stem from increased infiltration, which has mobilized large volumes of salt stored in groundwater catchments and raised water tables over extensive areas, causing severe salinization in many parts of southern and eastern Australia.

Late last century, salinity first appeared as a significant problem in the Kerang irrigation district, situated in the Loddon Valley of northern Victoria; some eighty years later it is now accepted that a major environmental problem exists not only in the Loddon Valley but in virtually all the irrigated lands and much of the dryland country of northern Victoria. Today, virtually all of the lower central Loddon Valley has a high water table, and is varyingly saline (Macumber, 1978a); in the adjacent Shepparton irrigation region water tables are steadily rising, and are within two metres of the surface over an area of 100,000 hectares, i.e., about one fifth of the region (Trehalla and Webster, 1978). Further west, in the Mallee, rises in saline water tables are evidenced by the salinization of depressions (Rowan, 1971; Macumber, 1978c, 1980, 1983a) and stock dams, and by the cutting of roads. Dryland salting is also widespread on the slope country (Jenkin, 1979), and rapid deterioration is occurring along the edge of the Riverine Plain, adjacent to the highlands.

While the recent appearance of salt in the landscape has had a marked effect on the environment, saline zones were already in existence in parts of Victoria prior to European settlement. For instance, salt was once regularly harvested in the Kerang district, while in the Mallee there are large numbers of salt lakes and large areas of saline gypsum flats. Excellent examples are seen in the Pink Lakes, Lake Tyrrell, and Kow and Raak plains areas. An examination of these areas shows that highly saline zones are an essential component of the northern Victorian landscape, and that the extent of the naturally saline area has varied considerably throughout the ages.

The widely observed effects of the shift in environmental equilibrium since the coming of the Europeans provides perhaps one of the most complete records of how the interplay of the various physical and biological factors influences the landscape. Since these processes are still strongly active, it permits a rare opportunity to study the various hydrological thresholds influencing this equilibrium. This is not simply an academic exercise: much effort has already been spent on treating the symptoms of change without any firm evidence that the salinity problem is being contained, or even slowed, let alone reversed. A clear understanding of the basic processes involved is essential for an overall view of what is happening and why.

While studies of the presently occurring events are essential, the broader temporal perspective provided by the study of palaeoenvironments is also of great value. Based on the stratigraphic, biostratigraphic, geochemical, and geomorphic evidence of earlier naturally occurring cycles of environmental change, palaeoenvironmental studies greatly broaden our perspective of present-day changes, and may, in certain instances, provide added credence not only to our interpretations of presently occurring events but also to our predictions of the direction and extent of future environmental changes.

With a view towards gaining a fuller understanding of the influence of regional groundwater systems on the environment, this work embarks on a broad study of aspects of the hydrogeology of northern Victoria, with emphasis placed on the groundwater systems and their interactions with surface waters.

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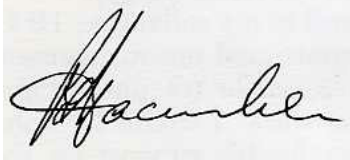
This thesis represents the culmination of a lengthy period of research, during which there were many long and stimulating discussions with colleagues in the Department of Minerals and Energy. I wish to thank Bill Esplan, former Head of the Groundwater Section; John Talent, now Associate Professor of Geology at Macquarie University; Richard Lakey, John Leonard, Mick Malone, Young Nahm, Mark Reid, Mirko Riha, Andrew Shugg, Graham Stewart, and Rob Williamson from the Groundwater Section; John Knight, former Director of Geological Survey; and Peter Kenley, former Assistant Director. Rob Williamson and Richard Lakey also advised on the computer programs used in analysing chemical data. I am greatly indebted to Tony Paskevicius, Trevor Ingram, and Doug Stone, without whose assistance the program could not have been carried out.

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A handwritten signature in black ink, appearing to read 'Macumber', is written over a light grey rectangular background.

Phil Macumber