BOOK REVIEWS

GROUNDWATER POLLUTION IN EUROPE. Proceedings of a conference organized by the Water Research Association in Reading, England, September 1972. Edited by John A. Cole and published by the Water Information Center, Inc., Port Washington, New York, 1974. 547 p.

Faced with offensive debris, man has always been tempted to burn it, drown it or bury it. Clean Air Societies have put the lid on the first alternative, environmentalists and vigilant fishermen have restricted opportunities for the second, leaving disposal at or beneath the ground as the favoured alternative. Any subsequent breakdown of waste is accomplished largely by water movement – infiltrating rainfall or circulating groundwater. As the waste products of an expanding industrial society are dumped in increasing amounts, so do the risks to the world's freshwater resources – surface and underground – also increase. Pollution of groundwater is an insidious, unseen process, and its effects can be long-lived. Hydrologists are aware of this, and work towards quantifying the risks involved and towards identifying the greatest dangers. Unfortunately, much of this work is either unpublished or circulated in a geographically restricted fashion. *Groundwater Pollution in Europe* makes certain that a collection of papers first issued to participants at a 1972 Reading conference, and since edited and regrouped by John Cole, finds its way to a larger audience. The editor does not claim "a complete coverage of the European situation" but the volume does contain sections on most aspects of groundwater pollution as well as a long review of case histories.

New Zealand's Quaternary aquifers are, on world standards, highly permeable and are thus susceptible to higher-than-average rates of pollutant movement. It is therefore alarming to contrast the expensive aquifer-protection measures outlined for Europe with the essentially laissez-faire attitude in New Zealand. For example, one paper discusses how costly groundwork and continuously pumped wells designed to lower the water table are used to prevent or contain petroleum contamination of minor groundwater aquifers in Switzerland; in contrast, little thought has been given to similar measures to protect the major groundwater reservoir beneath Christchurch. It is true that New Zealand's lower population density makes it less vulnerable to disastrous pollution, but perhaps contingency plans should be in hand for areas at special risk.

Urban refuse pits as pollutant sources are given some attention in the collected papers. In the United Kingdom, in particular, mil-

lions of dollars are currently being spent in assessing the risks to groundwater posed by industrial waste dumps. Industrial wastes constitute a less formidable problem in New Zealand, but we would be wise to formulate now some universal standards of land-fill siting. This might require some form of classification of wastes, and some policing to ensure that hazardous wastes are not dumped illegally in sites judged suitable only for relatively harmless fill.

Nitrate pollution of groundwater from heavy stocking and from agricultural fertilizer is discussed. In view of known increases in nitrate in some shallow New Zealand groundwaters, perhaps the acknowledgment recorded during discussion "that there was no time to be lost pinpointing the causes of major increases in nitrate contents, and remedying these if possible" is equally applicable here.

Comments and discussion on the impact of pesticides and herbicides on groundwater pollution are also relevant to our own situation. If we can continue to avoid injection of liquid wastes through deep wells – "sweeping dust under the rug" as it has been called – hopefully the several papers on deep-well waste disposal will not attain such relevance.

One of the most difficult tasks facing groundwater hydrologists is to forecast the direction and velocity of pollution spread from known sources; indeed, in heterogeneous aquifers it is difficult even to devise rational monitoring systems towards this end. No textbook can possibly lay down hard-and-fast rules for all conditions but the collected papers here reviewed cover such a wide range, and are so practically oriented that they must provide a valuable guide to those concerned with protecting groundwater quality anywhere in the world. They include "state of the art" papers on groundwater geology, chemistry and microbiology, specialist papers on artificial recharge, computer simulation and tracer techniques, and record examples of aquifer quality changes following pollution by seawater, by agricultural fertilizers, by petroleum and petrochemical leaks, or by liquids from refuse pits. The book is recommended as a valuable reference for practising hydrologists.

D. D. WILSON

MULTIOBJECTIVE OPTIMIZATION IN WATER RESOURCES SYSTEMS by Y. V. Haimes, W. A. Hall and H. T. Freeman, published by Elsevier Scientific Publishing Company, Developments in Water Science No. 3, 1975.

This book presents the Surrogate Worth Trade-off (SWT) method of optimizing a number of non-commensurable objectives.

Large-scale problems with several objectives have previously been solved by expressing the various decisions in the same units, for example money, and then optimizing a single objective function, in this case minimizing total cost or maximizing monetary benefits. Multiobjective optimization provides a tool by which the decision maker can compare a number of objective functions measured in different units, for example economic efficiency measured in monetary units and environmental quality measured in units of pollutant concentration, in order to obtain an optimal total decision.

Chapter 2 contains brief discussions of various methodologies by which the decision maker interacts with multiple-objective problems before introducing the SWT method in Chapter 3.

The SWT method is described as having the advantage, among others, that the decision maker can make a trade-off between increments in the value of each of the objectives rather than their absolute values. This is purported to be an easier and more realistic mode of interaction between the decision maker and the optimization process.

Fundamental concepts in multiple-objective problems are defined in Chapter 1 and the application of the SWT method to static and dynamic problems occupies Chapters 4, 5 6 and 7. Chapters 9 and 10 contain applications in the field of water resources and water quality. The remainder of the book treats the concepts of sensitivity, stability, risk, and irreversibility, and outlines further development of the SWT method.

The mathematical development of the subject is rigorous and makes use of vector and set notation. The reader is assumed to be familiar with the mathematical concepts inherent in single-objective optimizing such as duality, Lagrange multipliers and the Kuhn-Tucker conditions, to mention a few. Continual reference to a simple two-function two-variable problem is a definite help in assimilating the concepts, but the nonmathematical reader would have difficulty in distilling an understanding of the subject from the relevant portions of the text. The particular typeface used in this book is also a little daunting on first impression.

This is a useful book for the water-resources system analyst, but the general hydrologist may wish to wait for a simpler explanation of what it is all about.

V. J. BIDWELL