BOOK REVIEWS

PHYSIOLOGICAL LIMNOLOGY, by H. L. Golterman, published by Elsevier Scientific Publishing Co., Developments in Water Science No. 3, 1975. 489 p.

Dr Golterman's book presents an authoritative and up-to-date account of some important aspects of limnology, especially that of lake water chemistry. He devotes relatively little attention to the aquatic fauna and flora except when relationships are established between the chemistry and biology of lake waters. The role of phytoplankton and bacteria in the ecology of lakes is therefore given much more space than that of other aquatic plants and animals. However, many will agree with the author that, at present, a better understanding of lakes is possible in this way, for in his chapter on energy transport through food chains the author makes it clear that even the basic patterns of complete food webs in lakes are still far from being understood.

Although the book is a major work of 19 chapters, it is not wholly a review of present knowledge. The author draws heavily upon the scientific literature (over 800 authors are quoted) and upon his own extensive research in temperate and tropical lakes to provide evidence of how relatively few of the minor inorganic constituents of fresh waters are of overwhelming importance in controlling biological production in lakes. Although there is evidence that the concentrations of some major constituent elements such as Ca, Na, or Cl frequently determine the species of organisms that occur, Dr Golterman finds significant relationships between the supply to lakes of often trace amounts of P, N and Si and the major cycles of phytoplankton. He therefore devotes considerable attention to the sources, chemical interactions and metabolism of these elements.

The author admits that one of the pleasures of limnological investigation is from the strong interweaving of pure and applied research and so his views on lake eutrophication are especially interesting. He finds that a few lakes are naturally fertile, e.g. Lake George (Uganda) and Lake Kinnereth (Israel), but that most have become fertile through man's development of their catchments. It is true that much of the current biological production is supported by the recycling of nutrients within the lake basin, and the author indicates the extent of mineralization of sediments and plankton that takes place. However, in the long term, water fertility is largely

derived from catchment drainage and he justifies the importance here of N and P inflows by the presentation of numerous case histories of lake change over recent times.

The author is scrupulously fair in the presentation of data – perhaps almost to the point of ambiguity. He suggests, for instance, that the meagre standing crop of phytoplankton in Lake Edward (and to a lesser extent in Lake Kinnereth) is phosphate limited because the large phosphorus inflows are adsorbed on to clay particles and are therefore unavailable for plant growth. Later in the book, he warns readers that low phosphate concentrations in lake waters need not limit plankton production, for adsorbed phosphate on clays may became available to algae. Probably this illustrates the main characteristic of the book. Dr Golterman presents the available data and indicates his interpretation of them but does not exclude other interpretations. His book is therefore well suited to readers who already have a general knowledge of limnology (and of mathematics, for numerical data are included and handled wherever possible) and who have an interest in lake management. He freely admits that present knowledge is inadequate to cope with all cases of adverse lake changes. In fact, his advice to those faced with lake problems associated with progressive processes such as eutrophication is that procrastination is equally dangerous and that "action could well be pragmatic and not await research results".

G. R. FISH

GROUNDWATER POLLUTION, by J. J. Fried, published by Elsevier Scientific Publishing Co., Developments in Water Science No. 4, 1975. 330 p.

This is the fourth book in a Developments in Water Science series by Elsevier. The author is a professor of fluid mechanics at the University of Strasbourg and a scientific adviser at the Ecole Nationale Supérieure des Mines de Paris. The book covers theory, methodology, modelling and practical rules for groundwater pollution studies and is intended to appeal to engineers, students and applied mathematicians.

Chapter 1 is a very brief and general introduction. Chapter 2 introduces the theory of dispersion, including several different methods of deriving groundwater dispersion equations and the results of laboratory investigations into the magnitude and behaviour of dispersion coefficients. Much of this chapter, including figures, is taken verbatim from an earlier work by the author and M. A. Combarnous (1971) that appears in the Advances in Hydroscience

series of Academic Press. Chapter 3 contains a general discussion of the considerations and steps that are followed in a pollution study. The author suggests that pollutant travel distances relative to dimensions of the pollution source determine whether dispersive terms should be retained or discarded in the analysis, and this, in turn, determines the amount and type of field data needed to carry out a study. A number of experimental techniques to determine dispersion coefficients, porosities and seepage velocities in the field are described in chapter 4. It is pointed out that characteristic dimensions of the study region are an important consideration in choosing field techniques to determine these variables. In chapter 5 the author gives several finite-difference formulations and mathematical solutions that can be used for various pollution problems. An interesting discussion is also given upon the use of convolution/deconvolution methods to predict the response of a groundwater system to a pollution source. The author calls this a "black-box model", and it is worth noting that it can only be used for pollution studies if one or more input-response records for the aquifer are already available. Some case histories are described in chapter 6, and chapter 7 contains a quite general discussion of groundwater pollution analysis and management. Chapter 8 is concerned with some highly mathematical aspects of the inverse problem of determining dispersion coefficients from experimental data for diffusion equations that are similar to, but not identical with, the equation of groundwater dispersion. This chapter was apparently written to appeal to the mathematician, and readers who do not have a background in the theory of functional analysis will probably find most of the chapter incomprehensible. Chapter 9 contains an interesting and useful presentation of some principles, theorems and methods that are used in the numerical analysis of pollution problems. Brief descriptions of the difficulties of "overshoot" and "numerical diffusion" are given, but no indication is given of why or under what circumstances these difficulties tend to appear.

In conclusion, it can be said that the book was written to fill a gap in the literature that very definitely exists. Certainly, much of the material in the book will be considered worthwhile by engineers, students and applied mathematicians. On the other hand, the book also contains some shortcomings that are disappointing for a book of this price (US$39.75). For example, many of the references given at the back of the book do not appear to be referred to in the text, and a number of drawings throughout the text have been drawn carelessly.

B. W. HUNT

PRINCIPLES OF HYDROLOGY, Second Edition, by R. C. Ward, published by McGraw-Hill (U.K.), 1975. 367 p.

This revised and updated edition provides a useful increase in material reviewed and concepts presented, over its predecessor which was published nine years ago. As previously, the object has been to present "a non-mathematical treatment of 'pure' as opposed to 'applied' hydrology".

The organization of the book follows the conventional pattern of an introduction to the hydrological cycle in chapter 1, with the next seven chapters covering respectively precipitation, interception, evaporation, evapotranspiration, soil moisture, groundwater, and runoff. In this edition, however, Dr Ward has succumbed to a temptation previously resisted, and a ninth chapter entitled "The Drainage Basin" has been included. In some chapters entirely new material is presented, while in others, previously included material is now omitted (mainly details of some measurement techniques). The order of presentation has been altered within chapters and, for the most part, this assists in interpretation. The system of listing a bibliography at the end of each chapter has been retained and although there is considerable duplication among chapters, referencing is simple and direct. In this edition approximately one-third of the citations are of material published since 1966.

In chapter 1 a section on the systems approach to the hydrological cycle has been added, with a useful discussion of principles of systems analysis and the utility of the approach, particularly in assessing the effects of man on the hydrological cycle.

Chapters 2, 3 and 4 have only minor amendments. Some recently published results of experiments with raingauges in wind tunnels are included, and under "evaporation" the details of measurement using pans and atmometers are omitted – presumably because the material is easily available in great detail elsewhere, and these techniques are now of lesser significance.

Evapotranspiration, in a chapter separate from evaporation, is again treated in depth conceptually. The presentation is now more logical and new material on measurement by water balance and moisture flux techniques is included.

Chapters 6 and 7 are considered as subdivisions of the subsurface water field. In the former, the fundamental soil water–energy relationships are outlined and the concepts of potential-flow theory introduced. This is placed at the beginning of the chapter so that subsequent discussion of measurement, movement, and infiltration all follow with terminology fairly standard in subsurface

hydrology. Excellent use is made of recent theoretical and empirical results on soil moisture movement under various initial and boundary conditions.

Groundwater is similarly discussed in terms of potentials. Flow nets are introduced and examples of confined and unconfined flows, regional groundwater flows, and flows in coastal aquifers are explained and illustrated.

In discussing runoff, Ward has included a new section "The runoff process" in which the "Horton runoff model" and the "Hewlett runoff model" are described and compared. Variable source areas are discussed along with interflow and throughflow in terms of the principles established in chapter 6. It seems likely that this is the first general text in hydrology to include this theory of the runoff process.

The section on estimation, prediction, and forecasting runoff borders on 'applied' hydrology but is treated from the point of view of principles rather than recipes or procedures. A distinction is drawn between long-term yield forecasts and flood peak forecasting with, in the latter case, valuable examples from the recently published U.K. flood studies conducted at the Institute of Hydrology, Wallingford. Analytical methods of forecasting are discussed only briefly with the principles of statistical and graphical correlation, conceptual models, unit hydrographs and storage routing all mentioned.

Chapter 9 did not appear in the first edition and is an ambitious attempt at synthesis of all the elements and processes, discussed separately in the previous chapters, to demonstrate the "unity of the drainage basin". The author recognizes "that such is the complexity of the natural system that it is impossible to illustrate this unity, except by reference to specific examples". His examples are geomorphological unity as described by the basin and channel parameters associated with Horton, Strahler, and others, and hydrological unity in which land-use-change effects on the components of the hydrological cycle are discussed. Finally, a short section presents some definitions of models of hydrological systems.

The book is quite well illustrated, with 144 line diagrams – mostly redrawn from various acknowledged sources. Although there are fewer pages than the first edition, page size is slightly larger and print size slightly smaller, so that overall roughly the same volume of material is included.

As an introductory text in physical hydrology this book will be most useful for undergraduate students taking their first half or full course in general hydrology. Sufficient references are given to allow

the interested and able to delve more deeply where they wish. While "design" or "engineering" hydrology receives scant attention, the approach is sufficiently fundamental to suit engineering and science students alike.

D. L. MURRAY

THE HYDROLOGICAL CHARACTERISTICS OF RIVER BASINS AND THE EFFECTS ON THESE CHARACTERISTICS OF BETTER WATER MANAGEMENT, Symposium of Tokyo, December 1975. International Association of Hydrological Sciences Publication No. 117. 882 p.

This massive volume contains the 90 papers presented at the symposium in Tokyo, 1–8 December 1975. The symposium was organized by the Science Council of Japan on behalf of IAHS with the support of UNESCO, and was cosponsored by the Japanese Association of Groundwater Hydrology, Japanese Forestry Society, Japanese Society of Civil Engineers, and Japanese Society of Irrigation, Drainage and Reclamation Engineering.

"The symposium aimed at summarizing research results on representative and experimental basins obtained during the International Hydrological Decade and served as a forum for the exchange of ideas and information on better water management of river basins."

The papers fall roughly into three categories:

Subject A. (36 papers)

"Results of research on representative and experimental basins. This follows the Symposia of Budapest in 1965 and of Wellington in 1970 on Representative and Experimental Basins. Emphasis is put on new ideas, concepts, and methods and summaries of research results."

Subject B. (21 papers)

"Changes in the hydrological cycle as influenced by man's activities on water catchments, on agricultural land, and in urban areas. Stress is placed on concepts and methods of identifying changes, appraising the data thus obtained, and describing relationships among principal elements."

Subject C. (33 papers)

"Changes in hydrological conditions by civil engineering works such as storage dams, river improvements, and diversion of water from one basin to another, and the contribution of these changes from the standpoint of water management. Discussions are included

on the effects which civil engineering works have on flow conditions, such as river-bed configuration, on hydrological regimen in downstream reaches, and on groundwater conditions in areas downstream from these civil engineering works, as well as the contribution of these changes from the standpoint of water management."

The papers in the volume have originated from fourteen countries – the main source areas being Japan (35 papers), and the United States (18 papers). Canada, South Korea, and the USSR each contributed 7 papers.

It is obviously impossible to review each of the 90 papers here. Suffice it to say that the volume appears no better and no worse than its predecessors. Its value, however, will lie at least partly in the fact that it contains information and ideas from countries such as Japan and Korea, from which such data are relatively scarce. Most of the papers are in English, the remainder (4) being in French – abstracts in both languages are given for all papers.

The volume has been printed by an offset process using facsimiles of manuscripts as submitted by authors but the resulting lack of uniformity is not detrimental. Publication was prior to the symposium and participants received copies early, thus discussion contributions have not been included.

D. L. MURRAY

HYDROLOGY FOR ENGINEERS AND PLANNERS by Allen T. Hjelmfelt jr and John T. Cassidy, published by Iowa State University Press, Ames, Iowa, 1975. 210 p.

Any text which attempts to provide engineers and planners with an understanding of hydrology in 210 pages would seem destined for criticism on the grounds of inadequate treatment of the subject. This book is no exception.

It evolved from lecture notes used in a one-semester undergraduate course in hydrology and in the opinion of this reviewer, those lectures notes do not warrant publication in a hard-back form.

One fundamental question is whether or not the different needs of engineers and planners can be met by one text. This book provides for neither, for its attempt to include topics standard to most hydrology textbooks has resulted in superficial coverage. Graduate engineers and planners will find little in this text which will assist them with their real-world problems of, for example, allocating water or designing water resource systems and structures.

The authors have done themselves a disservice in the title they have chosen for their book. Had they called it "An Undergraduate

Course in Hydrology", this review might have been somewhat more favourable. Teachers who may wish to use this text for that purpose would be well advised to make their own assessments of its value compared to other more complete, if somewhat more expensive, books that are available to them.

J. A. HAYWARD

NEW ZEALAND LAKES, edited by V. H. Jolly and J. M. A. Brown, published by Auckland University Press, 1975. 388 p.

This book, which was compiled to bring together the available information on New Zealand lakes, contains 24 chapters on topics ranging from morphology and chemistry through plankton, macrophytes and invertebrate fauna to fish and birds. There are 28 contributors, and their varying approaches, some regional but covering a wide range of physical and biological characters ("Canterbury, Nelson and Westland Lakes"), others national but on sharply delineated topics ("Light Penetration"), make this a book to be read as a collection of papers, rather than as an integrated whole.

In general the chapters on physical and biological characters contain reviews of published information for the whole of New Zealand. Regrettably no such effort has been made for the water chemistry, and though the five varied chapters in this section are interesting and valuable, they fail to provide a broad view of regional variations within New Zealand, or of any features which may distinguish New Zealand lakes from those elsewhere.

The chapter on sport fisheries is notably narrow in approach. Are there rainbow trout in the South Island, and did the brown trout introduced there survive into the present century? You won't learn the answers from this book. Tighter editing may have produced some reduction of this chapter. Similarly, at a time when many of New Zealand's chemico-biological limnologists are struggling to impose their own trophic classifications on nature's lakes, and are strongly debating the positions of the non-existent boundaries between the discrete lake types, oligotrophic, mesotrophic and eutrophic, it seems inconceivable that a chapter could be headed "Classification" without addition of the necessary qualification that it was a classification based on origins of the lake basins.

The reader interested in the distribution of species of phytoplankton, zooplankton, macrophytes, benthic fauna and fish is well served in the text and by an index of scientific names, and there is a comprehensive bibliography. There is a general index and a glossary, from which one may learn something of the hindmost limbs of

the Asellidae, a family of Crustacea which find no place anywhere in the text, or that a corrie is a hollow in a mountainside. One searches in vain, however, for some common limnological terms (trophogenic, tropholytic, or euphotic regions, clinograde or orthograde depth profiles, compensation depth, internal seiche). These omissions reflect an ambivalence of approach that is the book's greatest weakness. The lack of introductory material may deter many laymen from reading it and, with major gaps in the treatment (bacteria, organic matter, primary production), make it unsuitable for use as a text, whereas the professional worker may find the glossary superfluous, and the shortage of original quantitative material disappointing.

In Europe and North America, limnology had largely emerged from the descriptive era into a stage of analysis and experimentation by the time when Jolly first recorded the presence of a thermocline in a New Zealand lake, Lake Hayes in 1952. Though much of this book is descriptive, a more dynamic approach is evident in several sections, notably those on production and biomass of zooplankton (which might have been discussed in more detail), nutrient factors limiting phytoplankton productivity (in a chapter on "Eutrophication and the Trout Environment") and chapters on "A Nutrient Budget for Lake Rotorua" and "Ecology of Macrophytes". There is, however, no evidence that we are yet approaching a time when large numbers of experimental and field observations can be used to formulate and test simulation models. In addition to being intellectually exciting, such models may provide a sound basis for the evaluation of management alternatives.

S. F. MITCHELL