Hydrology and Earth System Sciences, 8(6), *1217–1220* (2004) © EGU

Book review

An Introduction to the Environmental Physics of Soil, Water and Watersheds by Calvin W. Rose. Cambridge University Press, Cambridge, UK, 441 (+xii) pp.
ISBN 0 521 82994 1 (Hardback) ISBN 0 521 53679 0 (Softcover). Price: A$99.00 (Softcover)

Calvin Rose's new textbook *An Introduction to the Environmental Physics of Soil, Water and Watersheds* appeared in mid-2004, nearly 40 years after his highly successful *Agricultural Physics* (Pergamon Press, Oxford, 1966). Both books provide an introduction to environmental physics, addressing the physical science of land and water processes. The success of *Agricultural Physics* (which saw a second edition in 1979) has been largely due to its introductory and elementary nature, its writing style and its affordability. It has been widely used over the years by students and staff in many university courses in agricultural meteorology, soil physics, hydrology and environmental sciences.

I am sure that Rose's new textbook will be at least as successful as *Agricultural Physics* although at A$99.00 it is perhaps less affordable than Rose (1966) which I obtained in 1966 for 22s! The new book is still described as introductory but it goes well beyond providing basic physical knowledge required to understand land and water processes. It also describes numerous applications of such knowledge at a range of scales; provides an excellent introduction of the degradation of land and water resources, including soil erosion, contaminant transport and salinity, and it provides a scientific basis for many land and water management decisions.

Calvin Rose was appointed Professor of Environmental Sciences at Griffith University, Queensland, Australia in 1973, following a teaching career in East Africa (1954–63) and a research appointment in CSIRO (1963–73). He is now an Emeritus Professor in the Faculty of Environmental Sciences at Griffith University. Professor Rose has an outstanding international research reputation in environmental physics with particular interest in overland flow and the modelling of soil erosion and soil deposition. He has been a very effective university administrator and he is also a very accomplished teacher. His extensive teaching skills are clearly coming through in his latest book.

The underlying theme of *An Introduction to the Environmental Physics of Soil, Water and Watersheds* is to illustrate how a physical viewpoint plays a vital role in approaching the complex environmental issues associated with the use and management of land and water resources. The book may be broadly subdivided into three parts. The first part (Chapters 1–3) provides introductory chapters on soil development, physical soil characteristics, soil strength, mass movement of sediment, physical behaviour of soils and the behaviour of liquids. The second part (Chapters 4–9) deals with the fate and consequences of water falling on the land surface as precipitation and the subsequent processes of evaporation, infiltration, overland flow, streamflow and the subsequent discharge into rivers and lakes. Part 3 (Chapters 10–12) deals with the fate and consequences of water that infiltrates, its movement through the unsaturated and saturated zones and consequences in the form of salinity and contaminant transport. Some sections are more detailed than others, reflecting the author's expertise in erosion and sediment transport and in rainfall-runoff modelling.

The text provides the necessary physical knowledge and demonstrates how this knowledge may be applied to field data. Numerous examples are provided of quantitative approaches to major environmental concerns such as soil erosion, streamwater quality, salinity and contaminant transport. The book is generally well-written and well-organised, although the chapter titles could have been more informative. The different sections are well balanced and serve their purpose of providing introductions to various aspects of energy and water exchange at the land surface and important surface and sub-surface transport processes.

An Introduction to the Environmental Physics of Soil, Water and Watersheds provides a very attractive blend of introductory environmental science and environmental engineering, practical environmental problems and academic rigour. Of particular note are the treatment of spatial variability (infiltration rate, see Section 6.3; hydraulic conductivity, see Sections 10.3 and 11.4) and the section on scaling and scale effects (see pp. 307–310). Although the book's main emphasis is on environmental processes, it rightly stresses spatial variability in natural systems. Yet, it provides little insight in the area of environmental monitoring which must be of great significance in coping with spatial variability. There is little attention given to data limitations and errors and there is little discussion of experimental methods. Sampling techniques and network design are not discussed at all and I could find no mention of remote sensing methods.

The discussion of soil conservation methods and agricultural practices (pp. 301–307) is particularly welcome, although I would have liked to read more about 'sustainable production systems' (see p.144). Another strong feature is the treatment of the physics behind some measuring/ monitoring approaches (e.g. the falling-head permeameter (pp. 345–346), tensiometer (pp. 358–359), psychrometer (pp.158–159) and the Bowen ratio approach (pp. 171–172)) although this could easily have been extended to an improved coverage of soil moisture monitoring techniques such as TDR. I am particularly impressed with Chapter 3 on the behaviour of liquids and by how later chapters on overland flow, infiltration, sediment transport and water transport in the unsaturated and saturated zones draw on the earlier treatment of hydrostatics and hydrodynamics.

There are numerous quantitative examples throughout the text, although perhaps a clearer distinction could have been made in layout and/or font between the main text and the examples and their solutions. At the end of each chapter there are useful exercises. Answers to all exercises are provided in an Appendix and full solutions are available on the world-wide web. Both the examples and exercises greatly enhance the book's value for undergraduate teaching in environmental science and environmental engineering. The book also has clear and informative illustrations and the captions to the figures are generally self-explanatory.

Each chapter has its own list of symbols with generally a great deal of consistency between chapters and little confusion about their meaning. Notable exceptions include wave period (pp. 189 and 195), dynamic viscosity (pp. 96 and 267) and kinematic viscosity (pp. 96, 120 and 121). The lists of symbols unfortunately do not provide units nor dimensions. Do the symbols for the components of the surface radiation balance (pp. 162–168) conform with WMO recommendations?

Referencing throughout the book is somewhat dated. This is unfortunate when the book is to be used as an introductory text for undergraduate students. This is particularly noticeable for Chapter 5. It lists one post-1990 reference out of 20 publications and even that reference should have been 1955 rather than 1995! Why refer on p. 195 to Campbell (1977) when the more recent Campbell and Norman (1998) with the same title is far more readily available?

Internal cross-references to other chapters and sections in the book are generally adequate although some errors (which are undoubtedly due to last minute reorganisation) will need to be corrected in subsequent printings (e.g. p. 15: Chapter 11 should read Chapter 12; p. 47: Chapter 7 should read Chapter 8; p. 149: Chapter 11 should read Chapter 12). In addition the references to Fig. 6.5 and Fig. 4.6 on p. 226 are unclear, pp. 150 and 151 refer to a non-existing Table 4.2; and Fig. 9.2 on p. 352 should read Fig.10.2.

In conclusion, I have read this book with a great deal of interest: I have used it successfully in recent months in an undergraduate environmental engineering course dealing with landsurface processes. I have no doubt that it will be used widely by students, educators, environmental scientists/ engineers and agronomists. Calvin Rose is to be congratulated on this valuable new book.

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Forests at the Land-Atmosphere Interface. Edited by M. Mencuccini, J. Grace, J. Moncrieff and K G. McNaughton. 281pp. CABI Publishing (Wallingford), 2004: ISBN 0-85199-677-9, price £60.

This volume records the scientific presentations at the International Meeting on Forests and the Land-Atmosphere Interface in Edinburgh in September 2001, to mark the retirement of Professor Paul Jarvis (Department of Forestry and Natural Resources, University of Edinburgh). It commemorates his scientific achievements and his wide contributions to the various aspects of the subject and stresses Paul's prodigious output, his energy and tenacity and the scientific rigour he expected from colleagues in the way they first conceived their experiments and then conducted and reported them. It was pleasing that Paul's willing generosity towards other scientists in his field has been acknowledged and appreciated. .

The book is divided into six sections; Stomatal Function (chapters by Mansfield, Leuning *et al.* and Overdieck); Large-Scale Processes (Landsberg and Waring); Radiation Modelling (Medlyn, Jones *et al.*); Forest Meteorology (Lee, Stewart and Wang *et al.*); Carbon Sequestration (Cannell, Papale and Valentini, Whitehead *et al.*) and From Science to Natural Resource Management (Jenny Grace, Malcolm).

Under *Stomatal Functio*n, Terry Mansfield describes pioneering work over 100 years ago and extending into the 1920s which aimed to resolve fundamental questions about stomatal function. The paper provides a salutary message that the answers to some fundamental questions about stomatal behaviour remained unresolved for many years. Elegant model frameworks of the sort described by Ray Leuning and his colleagues will still benefit from new and detailed descriptions of the fundamental controls of stomatal response. The paper by Overdieck demonstrates stomatal responses to CO_2 levels, even in darkness, and confirms the continuing lack of a complete knowledge of stomatal behaviour.

In *Large-Scale Processes*, Landsberg and Waring illustrate that top-down models and flux measurements are complementary, emphasising as they do that models should have a role in enabling extrapolation to larger scales from very detailed flux measurements made at individual locations. Han Dolman and his colleagues give a clear exposition of the influence of forests on mesoscale atmospheric processes. Alan Betts' chapter reviews the nature of the diurnal cycle on land and makes a strong case that not only are diurnal cycles strongly related to surface processes but also that they can act as a check on the degree of reality that models represent. Frank Berniger's paper is concerned with forest processes at a time scale of months to years and addresses how these processes might be incorporated in model descriptions of shorter term flux measurements. Medium and long-term processes are likely to affect the carbon and water balances in datasets obtained by long-term flux measurements and an understanding of the processes is required to analyse the inter-annual variation of the stand fluxes. The impacts of feedbacks might be at the leaf level, through tree allocation of biomass and changes in stand structure.

In *Radiation Modelling*, Belinda Medlyn reviews of the development of the MAESTRO model, stresses the important role of Paul Jarvis in its early development and surveys the many uses to which MAESTRO has been put. Principally, it is a tool enabling researchers to test ideas and hypotheses. Lyn Jones and his colleagues present an analysis of how remotely-sensed canopy data might be used to give evaporation estimates. This work is still at an early stage and further information about this promising approach is awaited.

While micrometeorologists may be blessed with the good fortune to study evaporation from vegetation on extensive areas of flat land, in the real world vegetation is generally patchy and the terrain is rolling. In *Forest Meteorology*, Xuhui Lee presents an elegant analysis of the problems of horizontal eddy flux and flux divergence in such conditions and suggests that this area warrants increased research in the future. John Stewart, as the lead scientist in the benchmark Thetford Forest evaporation study, had the advantage that the forest he had chosen to study was flat and very extensive, so that the problems dealt with by Xuhui Lee were not of concern. John's paper gives an historical perspective on evaporation research up to and including the period of the Thetford Experiment which was in progress at the time of Jarvis's work at Fetteresso and David Ford's studies at Rivox. Usefully, John Stewart identifies areas where future research might be directed. These include stomatal controls and studies of the dependence of stomatal behaviour on soil moisture deficit. One of the key achievements by Paul Jarvis was the 'Jarvis' model. This model has been used very successfully to describe stomatal and surface conductances and their responses to environmental variables at the leaf or patch scale. Extending such models to landscapes may be problematic as shown by Ying-Ping Wang and his colleagues in their paper; they propose that area-weighted averaging can be used to scale maximum surface conductances to the regional scale.

In *Carbon Sequestration*, Melvin Cannell examines the relevance of land sinks within the Kyoto Process, which has many facets and appears very complicated. This presentation helps to identify outstanding or contentious issues related to land sinks for carbon dioxide. Artificial neural networks (ANN) are becoming widely accepted as a means to construct models with many interrelationships with a prevalence of non-linearities. Papale and Valentini describe the use of an ANN at the various European CO_2 flux sites and use it for predictions at the continental scale. In an international collaboration, David Whitehead and his colleagues describe a multi-layer canopy photosynthesis model and illustrate its value in revealing the relevance of within-canopy properties in two contrasting species stands.

In *From Science to Natural Resource Management*, Jenny Grace uses the specific example of the use of a branch model to predict log quality for the timber industry in New Zealand. In addition to a further acknowledgement of Paul Jarvis' achievements, the final chapter by Douglas Malcolm expands on the theme of the application of forest science to forest management. Douglas stresses that science should be not simply explanatory but should also be predictive and, therefore, more valuable to the end-user. This challenge should be accepted by emerging tree physiologists and this volume and Paul Jarvis' achievements should be a great encouragement to them.

The volume is well put together and is largely free from errors. There is inconsistency in that some chapters have abstracts and others not. I, for one, would have welcomed a chapter from the editors summarising the volume. While, neural networks (ANN) are becoming widely accepted as a means to construct models with many interrelationships with a prevalence of non-linearities. Papale and Valentini describe the use of an ANN at the various European CO_2 flux sites and use it for predictions at the continental scale. In an international collaboration, David Whitehead and his colleagues describe a multi-layer canopy photosynthesis model and illustrate its value in revealing the relevance of within-canopy properties in two contrasting species stands.

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