Book Review: Snow and Glacier Hydrology

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Books

Snow and Glacier Hydrology

By Pratap Singh and Vijay P. Singh. Dordrecht: Kluwer Academic, 2001. xvii + 742 pp. US$265.00, £165.00 (reduced prices for orders of 6 or more). ISBN 0-7923-6767-7.

The study of snow and glacier hydrology has long been in need of a general text. Classics such as the *Handbook of Snow* by Gray and Male (1981) and *Dynamics of Snow and Ice Masses* by Colbeck (1980) have filled this role but are now 2 decades old and out of print. Edited volumes (eg, Sharp et al 1998; Hardy et al 1999) address the subject but are compiled conference proceedings rather than coherent texts. Other recent texts on snow and glaciers (Bennett and Glasser 1996; Benn and Evans 1998; Jones et al 2001) do not direct their attention specifically to the hydrology of these systems. The publication of the book *Snow and Glacier Hydrology,* therefore, provides a welcome contribution to this subject. This book focuses on a mountain engineering hydrology approach to snow and glaciers and is most suited to the needs of the practitioner working on the water resources of high-altitude and high-precipitation systems.

After an introduction the book is organized into 4 main sections: (1) Properties and measurement of snow and snow cover, (2) Snowmelt and its estimation, (3) Snowmelt runoff modeling and forecasting, and (4) Hydrological aspects of glaciers. The beginning is more of what one would expect in a general introduction to water resources, dedicating a great deal of space to defining hydrology and aspects of world water supply, such as large lakes, groundwater, and oceans. The introduction to snow and ice that follows is tenuously connected to the general introduction and is quite dated: for example, the most recent reference on snow-climate interactions dates from 1989. The snow and glaciers section of the introduction is focused on the high-mountain case.

“Atmosphere and its components” is the first chapter in “Properties and measurement of snow and snow cover.” This chapter goes well beyond the expected subject matter of atmospheric properties, snow crystal formation, orographic effects, and surface winds to describe rainfall distributions, snowmelt chemistry, and mountain winds. The next chapter, “Properties of snow and ice,” provides a light treatment of the structural, mechanical, thermal, and optical properties of snow. The chapter “Measurement of snow” compiles well-known material. The next chapter, “Measurement of depth, water equivalent and area of snow cover,” discusses standard techniques as they were understood 40 years ago, with added material on snow metamorphism. No discussion of the variability of snow water equivalent, vegetation effects, wind redistribution, or sample size is included.

The section “Snowmelt and its estimation” surveys primarily empirical techniques but begins with a chapter on energy exchange processes. The material on sensible and latent heat transfer does not consider the essential stability corrections required to make legitimate use of the aerodynamic formula provided over snow (normally stable) and then slips into the standard degree-day melt factor equations. The final chapter in this section is on general streamflow hydrograph characteristics. The material draws heavily on the US Soil Conservation Survey methods of the 1970s.

The section "Snowmelt runoff modeling" begins with an initial discussion of temperature and precipitation variation with elevation and then focuses on storage potential in snow. The first chapter is spoiled by a deeply misguided fieldwork problem set, in which 20 kg of snow from a 2-m-deep pack is mixed with 100 kg of water at 20°C; the student is to calculate the density, water equivalent, and ice content using the volume of sample, 0.1 m^3, and the resulting temperature, 15°C. Not only are the quantities suggestive of an unnecessarily difficult calorimetric method field experiment, but the results also suggest a physically impossible snowpack with a liquid water content of 87.5% and a density of only 200 kg/m^3. The next 80 pages cover the routing of meltwave movement through snow. The section ends with a discussion on 5 operational snowmelt models.

The final section, "Hydrological aspects of glaciers," starts with a short chapter on glacial characteristics and mass balance, which provides a useful if slightly dated introduction to the difficulties of measuring and explaining glacial dynamics. The next chapter on glacial melting returns to the previously discussed aspects of temperature variations with elevation, snow albedo, temperature index melt methods, and snowmelt models. The subsequent chapter on glacial storage and drainage characteristics is quite dated. The simple mixing model approach to hydrograph separation quoted in the chapter has been superseded by approaches that consider the role of active geochemistry in interpreting glacial hydrochemistry to determine englacial hydrology. The chapter on erosion and sediment yield contains a review of glacial sedimentation and general sediment hydrographs. The section on glacial hydrology ends with a general hydrology section on streamflow measurements and stage–discharge relationships.

The book is large and must be approached with caution because of its variable depth of subject treatment, patchy coverage of the topic, occasional errors in references, frequently dated material, empirical approach, and lack of guidance on scientific principles. I cannot recommend it for undergraduate students. However, it may be suitable for the more experienced physical scientist or engineer who wishes to develop further expertise in mountain snow and glacier hydrology. It warrants a place on mountain research library shelves and can serve as part of an advanced entry point to the subfield and particularly as a basis for further reading in this subject.

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