HYDROLOGICAL ASPECTS OF ALPINE AND HIGH-MOUNTAIN AREAS. Edited by J.W. GLEN. Proceedings of the Exeter Symposium organized by the IAHS International Commission on Snow and Ice with the support of UNESCO. IAHS Publication 138, 1982. 350 + ix p. US$30. (Order from: Office of the Treasurer IAHS, 2000 Florida Avenue, N.W., Washington, D.C. 20009, U.S.A.; or IUGG Publications Office, 39ter Rue Gay Lussac, 75005 Paris, France.)

Fulfilling what its title promises, these proceedings lift the reader to the highest mountain regions of the world, and to the sources of rivers that pass through much of civilization. The journey is to the Alps, the Carpathians, the Caucasus, the Rockies; the ranges of Scotland, Japan, Norway, New Zealand, India, Central Asia, and China; to the Karakoram; and up the slopes of Everest. This truly international adventure consists of 34 rather short papers (about ten pages each) on a variety of subjects, but never too far from a pervading and unifying theme — to predict the discharge of mountain basins. For this was largely a meeting of water resource people.

Although the co-convenors (Drs. Glen and Roots) divided the conference and its proceedings into seven parts, the reader quickly senses that the unifying theme overwhelms the division. In retrospect, perhaps it is the *size scales* of the problems and basins that form a more natural way to approach a discussion of these proceedings.

First prize for achieving the largest-scale study (global mountain hydrology) could be awarded to Dreyer *et al.*, who present part of their *World Atlas of Snow and Ice Resources*, which is being compiled by the Institute of Geography, USSR Academy of Science. Stream-flow maps on scales $1{:}10^6$ and $1{:}10^7$ are given for the Tien Shan, Pamirs, Hindu-Kush, Karakoram, and Canadian Rockies. On the large scale, the reader also finds contributions on satellite-aided hydrology by Rango and Martinec who extend the concept of "snow depletion curves", by Tom Andersen who uses image analysis to refine snow mapping for optimization of Norwegian hydro-power resources, by Kotlyakov and Krenke who made use of Soyuz-11 space imagery of seasonal snowlines, and by Tarar who first provides an overview of some hydrology problems in Pakistan, and then develops some predictive equations for the Upper Indus Basins from Landsat imagery.

Three contributions from the People's Republic of China (Kang *et al.*, Lai, Yang) show that it is possible to predict discharge from immense basins that have strong glacial components, and that it is possible to relate the dimensionless "coefficient of variation" of runoff to air temperature and other practical indices. These Chinese papers and the Soviet Tien Shan papers (Makarevich, Konovalov) convince the reader of the importance of the glacial discharge component (30 to 56% of the runoff) to Central Asia, especially during long arid periods.

Precipitation is clearly the dominant component in the monsoon-affected Himalaya. Higuchi *et al.*, explore precipitation patterns for some of the most extreme topography of the world in the Everest region. Bagchi shows how precipitation increases with elevation up to about 4000 m in the Western Himalaya near Manali, India, and then decreases with further elevation increase.

As the emphasis shifts from the Asiatic giant basins to the smaller experimental basins of the world, the reader may sense that loss of size is replaced by quality of data and attention to details. The work (Baker *et al.*) on the Vernagtferner, a ~10-km² experimental basin in the Austrian Alps, and on the 23-km² Peyto Basin in Alberta (Young) are careful, thorough, and well written analyses of discharge from smaller glacier basins. Using the concept of "linear reservoirs", Baker *et al.*, have succeeded in hourly predictions that have reasonable agreement with observations. Lundquist also uses "linear reservoirs" (in series and parallel) to model glacier discharge for hydroelectric optimization.

Prediction of basin snowmelt is addressed in papers by Bálint and Bartha (Danube and Tisza flow through Hungary), Fitzharris and Grimmond (New Zealand), Morris (Scotland and Switzerland), Pereira and Keller (Switzerland), and Martinec *et al.* (Switzerland). The last paper uses 15 years of isotope tracing data to support the startling conclusion that groundwater in long-time residence (~5 years) is *forced* to discharge during the relatively short period of snowmelt. Since the groundwater discharge is sometimes as high as 60% of the total discharge, a mechanism which explains how meltwater "forces" the discharge needs to be determined; this is a challenging problem for future research.

A contribution from the World Meteorological Organization (WMO) announces that results from a "World Cup competition" which sets 11 snowmelt models against six data sets is to be published shortly.

At a still smaller scale, the reader who is interested in the thermodynamics and physics of flow will find a collection of six relatively technical papers on flow processes through snow, firn, and glaciers: "Master plumber" Collins contrasts fast reservoir runoff through moulin-conduits with slower runoff through the firn-aquifer system; an excellent contribution by Oerter and Moser details the firn-aquifer system; Higuchi and Tanaka explain the parallel flow patterns in seasonal snow; Rau and Herrmann show that the snow-pack structure changes from a "stratified" media to a "homogeneous" media before the initiation of melt; Gurnell has observed "rapid flushes" of sediment in glacial streams, and concludes that even hourly discharge observations may be misleading; and Kazanskiy, citing Kazanskiy, expands earlier theoretical analysis by Kazanskiy on glacier channels.

That "mountain hydrology" is really a broad subject is underscored by some interesting papers on miscellaneous topics: Abe on alternate bars, Lakhera on erosion hydrology in the Himalaya, Nakawo and Takahashi on ablation under debris, Keller and Strobel on nutrient discharge, and Avdyushin *et al.* on cosmic ray measurement of water equivalent.

Last mentioned, but not least, is the single paper that emphasizes high mountain hazards — Hewitt's "Natural dam and outburst floods of the Karakoram Himalaya" — which provides a summary of 400 years of major disasters, and is based on 20 years of research.

Indeed, it was an international venture, but why was North and South American hydrology not represented in proportion to European and Asiatic studies? Surely, not because of a lack of problems. In the late spring and summer of 1983, just as these proceedings were distributed, rapid and unpredicted snowmelt filled dams on the Colorado River to beyond capacity; floodwaters poured from the Sierras onto some of the most precious agricultural land in California, and mud slides descended from mountain slopes onto developed areas in Utah and British Columbia. The streets of Salt Lake City turned into rivers; Hoover Dam overflowed; and transportation came to a grinding halt on the Trans-Canada highway for nearly two weeks.

Thanks to its indefatigable editor, John Glen, and others acknowledged in its preface, these proceedings were quickly distributed within a year of the Exeter, U.K., meeting. The best recommendation that can be given to any publication in these days of "fast track" science is that it is up-to-date.

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WORLD OCEAN ATLAS. VOLUME 3. ARCTIC OCEAN. Edited by S.G. GORSHKOV, Admiral of the Fleet of the USSR Navy. Original Russian-language edition published in Leningrad by USSR Ministry of Defence, Department of Navigation and Oceanography, 1980. Various unnumbered introductory and explanatory pages of text; 184 p. of maps, charts, and graphs; index; fold-out relief map of world ocean floor. Soviet price 25 rubles. Hardbound.

Edition reviewed here contains supplementary booklet in English (Introduction, Index) plus English-language title page and publishing data added by Pergamon Press, Oxford, 1983. Pergamon edition: original edition plus English-language supplement (xx + 41 p.). ISBN 0-08-028735-2. CAN$582.00.

This is the third atlas in a series on the world's oceans published by the USSR. The first dealt with the Pacific Ocean, the second with the Atlantic and Indian Oceans. *Arctic Ocean* is basically intended to enhance navigation and teaching, but it also will serve as a comprehensive source of data for a wide range of people interested in the physical components of the Arctic Ocean. Not only will a variety of technical and scientific students benefit from the atlas, but all those concerned with applied studies in the Arctic Ocean and adjacent land masses will probably make frequent use of its extensive materials. Pergamon Press has translated the atlas's table of contents, the descriptions which preface each of the major sections, and most of the index. To make effective use of the atlas, however, the user of each map needs to transliterate the Russian text and to translate the legends and related data. The Pergamon supplementary booklet contains neither a transliteration guide, a Russian-English gazetteer of terms appearing in the map legends, nor reference to appropriate Russian-English dictionaries and technical manuals. The Russian-language prose, however, is beautiful and precise throughout the atlas and should cause little difficulty for translation by readers who have a knowledge of related English technical terms in their own areas of expertise. For the generalist, *Arctic Ocean* provides an appropriate opportunity to become familiar with the Russian language and to acquire a broad understanding of many features of the Arctic.