

relevant terms prepared for the Institute of Permafrost in Moscow in the mid-1950s, he concluded that the terminology of the basic concepts was still in a state of flux and tried to clarify a number of discrepancies. Although Muller felt warranted to include an expanded glossary within the main text of the manuscript, French and Nelson, appropriately, have given it appendix status (p. 249–267).

Part 2, “Permafrost Science” (p. 23–79), is a state-of-the-art description of the origin, areal and vertical extent, surficial expression, and physical characteristics of permafrost. Because of the increase in research on permafrost that occurred in North America after WW II, Muller was able to add information from such scientists as A. Lachenbruch (ice-wedge polygons), A.L. Washburn (patterned ground), J.A. Pihlainen and F. Müller (pingos), R. Black and W. Barksdale (oriented lakes), and his student T. Péwé (permafrost terrain analysis). Nonetheless, his comprehensive treatment of permafrost research continued to be dominated by Russian materials. The two sections on “Ground Ice” (p. 33–47) and “Physical Properties of Frozen Ground” (p. 68–79) are quite thorough.

Part 3, “Permafrost and Engineering Problems” (p. 81–208), reflects well the objective of Muller’s involvement in permafrost research. As French and Nelson write, “There is...no doubt that frozen-ground engineering is the ultimate focus of the volume [and that] many of its parts read like a ‘how-to’ manual for engineering personnel” (p. ix). Muller treats such diverse engineering topics as logistics, drilling methods, roads and railroads, bridges, buildings, water supply, and sanitation as they are affected by conditions in the Arctic and Subarctic, and especially in those areas with permafrost. The discussion is guided by his notion that “once frozen ground phenomena are correctly understood, the design solution and construction problems become, for the most part, a matter of common sense” (p. 81).

The text is illustrated by 98 figures (his 1947 volume had 87) and 16 tables, which together occupy about 37% of the volume. The figures are generally understandable, although some of the legends are barely legible. Unfortunately a few numbering errors are present: e.g., on p. 46, Figure 18 should be 19, on p. 157, Figure 20 should be 21, and on p. 193, Figure 88 should be 93. Although there are a few typographical glitches (e.g., p. 63 and 112), the text reads smoothly enough.

During the two decades before Professor Muller set aside his manuscript, the permafrost community had evolved to such an extent that the timing seemed appropriate for closer collaboration among permafrost scientists and engineers. As a result, in 1963 the First International Conference on Permafrost was held in Purdue, Illinois. Si Muller attended that conference and speculation abounds about whether there is a connection between that event and his decision to set aside his manuscript.

The American Society of Civil Engineers (ASCE) deserves congratulations for bringing Muller’s manuscript out of hibernation after nearly half a century and agreeing to publish it—a great service to the permafrost community.

I recommend the book to all individuals who may be interested in cold environment landscapes and suggest that it be assigned reading for all students dealing with periglacial environments and cryospheric topics.

REFERENCE

- Muller, S.W. 1947. Permafrost or permanently frozen ground and related engineering problems. Ann Arbor, Michigan: W. Edwards, Inc. 231 p.

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AFTER THE ICE: LIFE, DEATH AND GEOPOLITICS IN THE NEW ARCTIC. By ALUN ANDERSON. New York: Smithsonian Books/HarperCollins Books, 2009. ISBN 978-0-06-157907-3. vi + 298 p., maps, notes, index. Hardbound. Cdn\$34.99, US\$26.99.

This book is not an easy read. Not that the writing is jargon-ridden, convoluted or dull—far from it. As befits a professional science writer (Anderson has held senior editorial positions with *New Scientist* and *Nature*), the author delivers crisp, fluid prose that keeps the reader engaged and turning pages. He summarizes with admirable precision the findings of a remarkable range of scientists and the views of northern politicians and activists but lets them convey their ideas in short but incisive quotations, rendered in plain, non-scientific language.

Rather, the difficulty with this fascinating read lies in comprehending and accepting its primal message: the entire Arctic—ecosystem, economy, and human population—is changing in fundamental ways; the changes are more far-reaching and rapid than previously thought; and they are well-nigh irreversible. Hence the title: *After the Ice*.

The opening is not auspicious: the author describes his first polar bear viewing on an initial trip north and his anger when informed that the bear was starving and probably wouldn’t “make it” because shrinking sea ice had reduced its hunting prospects. Happily, the threat of adding to the plague of “gee-whiz” accounts of the Arctic by wide-eyed newcomers immediately gives way to an impeccably researched and remarkably thorough account of the changes transforming the Arctic.

After the Ice is based on wide travels throughout the Arctic—to Svalbard, Ilulissat, Anchorage, and Grise Fiord, among other places—and to academic conferences and research centres across the globe. It is driven by a quest for understanding the complex environmental and political processes of the modern Arctic and a hope of discerning ways to ameliorate or at least accommodate the massive

changes occurring there. In the first goal, the book succeeds admirably; in the second, it offers precious little reason for optimism.

Chapters on geopolitics are solid but offer little that is new except in the fascinating account of the history and future of Norway's Svalbard Islands. Short accounts of the emergence of Nunavut, the tribulations of the reindeer-herding Nenets of Russia's Yamal Peninsula in the face of extensive gas developments, and international legal wrangling over ownership of the Arctic (especially the Arctic sea-bed) are worth reading, but it is in the treatment of the ice and the animals that *After the Ice* sparkles.

For a social scientist with superficial knowledge of either, the chapters on the ice—or, increasingly, the lack of ice—and the animals of the Arctic are at once the most fascinating and the most disturbing. The book's main message here (aside from ringing the alarm bells) is the need to reframe the scientific "problem" posed by changing Arctic ecology. For Anderson, the problem is "not that too little is known but that so much is known which has not been synthesized" (p. 9). His accounts of the complex processes of melting (and changing) sea ice, and of shifting patterns of currents, warming trends, and seasonal migrations, all producing profound alterations in entire ecosystems, are clear yet comprehensive, without becoming overly technical—the audience for this book is not the scientific community but a wider, concerned public. The book sets out the implications of warming/melting trends for all manner of Arctic marine life, from microscopic polychaete worms feeding in Arctic ice, to the appearance of killer whales in regions where sightings were once rare, if not unknown, to the colonies of sea birds threatened by changes to the food chain. Anderson demonstrates convincingly that "an Arctic that freezes over and melts again each year is a completely different place for the creatures and the people that live there now" (p. 97).

The three chapters on "Oil and Ships" are little short of mind-boggling with their accounts of massive, environmentally risky (and often inadequately regulated) oil and gas developments in remote and exceedingly sensitive parts of the Arctic. Events since the book was published suggest that even Anderson's more sanguine assessments of potential ecological disasters are problematic. In the wake of the Deepwater Horizon blowout in the Gulf of Mexico—a far less hostile environment than the Arctic—would he still write, contrasting the risks of tanker wrecks versus drilling operations, "Around a fixed well, an oil company can be well prepared" (p. 223)?

After the Ice is not an unrelieved litany of ecologically troubling, if not disastrous, developments. Among the hopeful possibilities are accounts of rehabilitation of the Siberian tundra (p. 243–244); the prediction that "very expensive [i.e., Arctic] oil will no longer make sense in a decade or two from now" (p. 260–261); and the implication of the estimate that one-quarter to one-half of Arctic warming is caused not by greenhouse gases, but by more easily controlled air pollution (p. 249). Ultimately, however, his assessment is gloomy: "We will see either a sustainable

Arctic or an abandoned Arctic...with every year of delay, we need ever stronger action, and the chances of success grow less" (p. 263).

Based as this book is on such extensive distillation of complex and unfamiliar processes and relationships, it is not surprising that the odd error has crept in: as of Anderson's time in Nunavut, there were two communities outside Iqaluit with populations over 2000, not 1000 (p. 30); the totting up of Inuit numbers across northern Canada leaves 22% unaccounted for. Given the apparent target audience, it is understandable, if still annoying, that Grise Fiord hunters are said to range "over an area the size of Connecticut" (p. 24), or that Nunavut is five times the size of California (p. 29). A more fundamental shortcoming is that the book relies far more on conversations with PhDs and scientists than on conversations with indigenous hunters or political leaders, though it is fair to note that Anderson has worked to include the experiences and perspectives of the people of the Arctic. Still, it is telling that such a book contains no extended discussion of traditional knowledge, nor does the term appear in the index.

Such quibbles pale in the face of the sobering analysis of this important book. This is popular science writing at its finest; it deserves wide readership.

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ON SEA ICE. By W.F. WEEKS, with W.D. HIBLER III. Fairbanks, Alaska: University of Alaska Press, 2010. ISBN 978-1-60223-079-8. xv + 664 p. maps, b&w illus, appendix, bib., index. Hardbound. US\$85.00.

The subject of sea ice has attracted many since ancient times. The early polar travelers and explorers observed and logged sea ice, mainly to avoid it when navigating through formidable frozen seas. As our knowledge of sea ice has accumulated, in particular after 1950, when the study of sea ice became widespread, curiosity about sea ice has gradually expanded into a fascinating world of science and engineering. Today, we have an unprecedented influx of observations and knowledge of sea ice, with advanced understanding of many aspects from the physical properties of sea ice to its impacts on global climate.

While occupying only about 7% of the earth's surface, sea ice has a profound influence on the polar environment. As ice freezes, it injects salt into the ocean, thus increasing its salinity and density. This process can lead to deep convections that profoundly influence the polar halocline and drive the thermohaline circulations of the ocean. Sea ice cover also reflects significant solar radiation back to space, modulates heat exchange between the ocean and the