

Peatland Biogeochemistry and Watershed Hydrology at the Marcell Experimental Forest

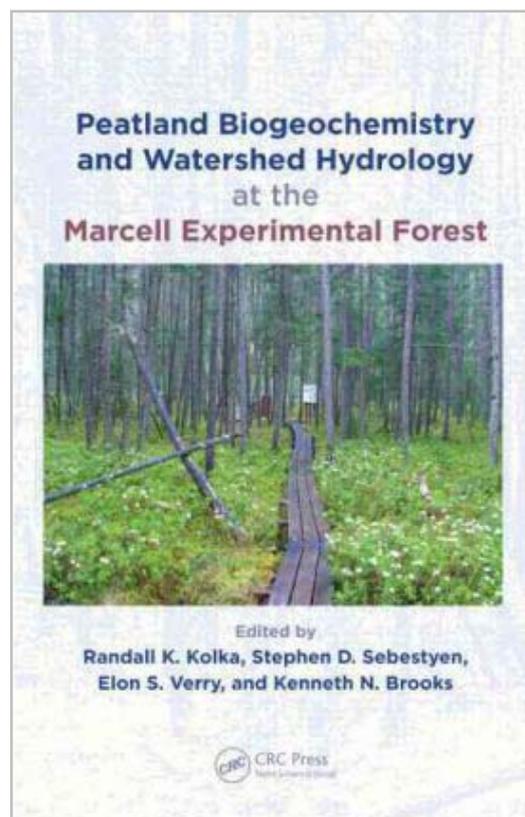
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The United States Department of Agriculture (USDA) Forest Service began establishing research sites to address large-scale problems of forest, range and catchment management (termed ‘watershed management’ in American English) soon after 1905 and their network of 81 experimental forests now spans North America from Puerto Rico to Alaska. The Marcell Experimental Forest (MEF), in Minnesota, is only one of them; but one with singular significance for peatland scientists. If the name is not immediately familiar, the clue you need may be the fact that it was selected in 1959 by Roger Bay and Don Boelter and became their primary research site; or perhaps that Bay and Juhani Päivänen (Finland) were collaborators; or that this is where Nancy Dise first reported winter emissions of methane from peatlands in 1992.

The book arises from a symposium held in Grand Rapids in June 2009 to celebrate the scientific legacy of 50 years of ecosystem research at Marcell. There are 15 chapters and 65 authors, covering topics from historical events leading up to establishment of the facility (Chapter 1) and fine details of the field laboratory and technical support provisions that are needed to maintain it (Chapter 2), to masterfully crafted reviews of the various research threads that have been pursued there over the last five decades. Although 50 years’ investigation at one location has enabled the collection of rare long-term records of e.g.

meteorological and streamflow data on the one hand (Chapter 2), this is only the backdrop to an evolving research agenda. Investigations carried out in the 1960s and 1970s aimed to determine peat properties and to understand and model peatland water and energy budgets, forest productivity and the hydrological effects of harvesting; whereas from the 1980s, the focus has shifted towards atmospheric deposition and peatland biogeochemistry, featuring especially mercury and carbon (Chapter 3).

I found the early chapters especially useful in building a much clearer picture in my mind of the context of Boelter’s widely cited hydrological work. The MEF comprises two separate units, the North Unit containing two of the eight experimental bog catchments and the South Unit containing the remainder, plus fen sites and the research centre itself. The bog catchments are not all contiguous, and at least some of them are much smaller than I imagined. The S2 bog—possibly the most studied peatland on the planet—is just 307 metres long and 107 metres wide (3.2 ha); it occupies an ice block hollow and around one-third of its catchment (9.7 ha); and the air photo on page 95 shows it as a striking ‘island’ of black spruce in a ‘sea’ of deciduous (birch/aspens) forest. Chapter 4 gives a seamlessly multi-disciplinary account of the three principal drivers (geology, soil development and regional palaeobotany) that have shaped this single landscape element over the last 12,000 years, based

on a combination of existing publications and previously unpublished data. The titles of the ‘research threads’ chapters that follow are:

5. Physical properties of organic soils;
6. Scaling up evapotranspiration estimates from process studies to watersheds;
7. Watershed hydrology;
8. Element cycling in upland/peatland watersheds;
9. Ecosystem carbon storage and flux in upland/peatland watersheds in northern Minnesota;
10. Carbon emissions from peatlands;
11. Mercury cycling in peatland watersheds;
12. Forest management practices and silviculture;
13. Hydrological responses to changes in forest cover on uplands and peatlands;
14. Effects of watershed experiments on water chemistry at the Marcell Experimental Forest; and
15. Multiple resource and hydrologic model for peatland-upland forests of the Northern Lake States.

This is certainly far from a ‘symposium volume’ collection of summarised presentations. Each chapter is a coherent and up-to-date multi-author review of the whole body of research that has been carried out within each topic area, with its own contents and reference lists, and with some useful summary sections (e.g. Chapter 4) and descriptions of standard analysis techniques (Chapter 5). Chapter 11 (on mercury cycling) and Chapter 10 (carbon emissions) reflect particularly large collaborations, being credited to 16 and 26 authors, respectively. It would be impossible to mention here all the ‘nice stories’ that are clearly and carefully outlined; I think everyone will find a relevant one. I noted particularly in Chapter 8 that, although the mire catchments are only partly peat-covered, streamflow is generated primarily from their peatland/wetland portions; and the causative relationship between decreasing inputs of sulphuric acid and increasing total-carbon losses in streamflow reported from Europe did not operate at Marcell as the US acid rain problem was solved post-1980. Of course, this underlines the immense importance of the Marcell resource in that there must be few other sources of good-quality data for rigorous retrospective testing of such ‘new’ hypotheses. On the other hand, a caveat about generalising too far from observations at a single site comes up in Chapter 9, where we learn that the peatland contribution to the global CH₄ budget was originally over-estimated by an order of magnitude because emissions at the MEF are some 10–30 times those from other peatlands in the temperate-boreal transition, boreal and subarctic zones. In Chapter 15, the importance of the long-term dataset is again underlined, this time for

supporting the development of integrated catchment response models (for hydrology and water quality); and I was fascinated by the story of PHIM, SET-WET and their offspring WET-HAWQ (all acronyms for models).

In general, everything has been carefully edited and some trouble has been taken to explain obscure terms; for example, on page 100, the phrase “stagnant ice cored the topography” is immediately qualified with “(lay buried in the sediment)”. But I did note occasional lapses in copy editing, such as spurious words and punctuation marks that seemed more frequent in Chapter 4 than elsewhere. The mistakes in Latin nomenclature on pages 120–121 (including *Sphagna magillanicum* for *Sphagnum magellanicum*) come as a surprise, especially as they are interspersed with correct spellings. The book is, understandably, written in ‘American’ so readers should be alert to the equivalence of e.g. ‘watershed’ and ‘elevation’ to ‘catchment’ and ‘altitude’ in English usage; and resilient to apparently random losses of ‘al’ from the ends of adjectives (e.g. “geologic, hydrologic, paleobotanical, and current botanical” on page 94 and “ontogenic, phytosociologic, chemical” on page 129). A new term for me was ‘tricontinental divide point’ for a location where three river basins meet (page 95).

There are ample illustrations throughout and although—perhaps for purposes of cost limitation—some are rather small and all are monochrome (line drawings and photographs), most are clear. An exception is Figure 4.4 (page 97), in which I found it impossible to distinguish between some of the grey shades representing different rock types.

The broad relevance of this book is reflected by the fact that it has three Forewords, written from the perspectives of (a) the Research and Development Office of the US Forest Service, (b) scientific research, and (c) watershed management. From my own perspective, I cannot improve on Nigel Roulet’s comment in the second of these, that “one cannot read this book without really appreciating and respecting just how important the research at the MEF has been as a foundation for much of peatland science, particularly from a watershed perspective ... it would be fair to divide the thinking on peatland hydrological processes and biogeochemistry to before and after MEF”.

This book should be read—and frequently returned to—by everyone with interests in either peatland or forest processes (or in both). It is perhaps on the expensive side for undergraduate purchase and, therefore, also a ‘must’ acquisition for libraries supporting peatland courses.

Olivia Bragg, February 2013