

Peatlands: Evolution and Records of Environmental and Climate Changes

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and W. Chesworth (editors) (2006)

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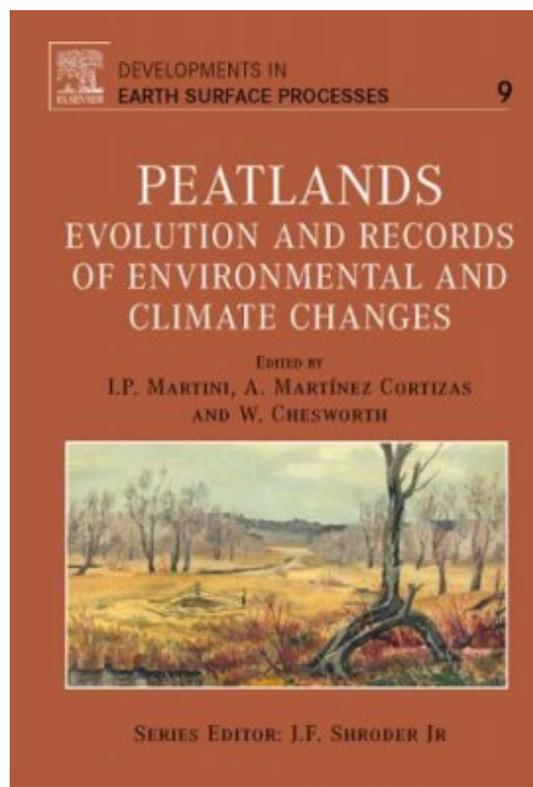
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This is Volume 9 of the Elsevier *Developments in Earth Surface Processes* series, described by John F. Shroder Jr. (Editor-in-Chief) as a treatise on “phytogeomorphology, the specific plant-landform portion of biogeomorphology”. The Foreword describes it as “a work of collected papers ... an important and up-to-date aggregation of material useful to geoscientists and bioscientists”. It contains 22 consecutively numbered chapters (essentially individual papers) arranged in four Sections:

- A. Peatland basin analysis: evolution and structure (6 chapters);
- B. Selected characteristics of peat and peatland environments (9 chapters);
- C. Peatlands as multi-signal archives of environmental changes (5 chapters); and
- D. Direct human impact on peatlands (2 chapters).

There are 54 authors and, for a volume produced under predominantly North American editorship, their geographical distribution is rather interesting. Most are from the UK (13) and elsewhere in western Europe (23), eight from Argentina, eight from North America and two from Australasia.

Chapter 1 is extremely useful. It introduces what is meant (here) by the term ‘peatland’ and summarises the entire volume, with editorial commentaries, in just 13 pages. As always, terminology proved troublesome; but the editors

have been fairly successful in their aim to devise a system that “most people can agree with”, and do point out where alternative meanings may exist. The practice of providing a synopsis of what the reader can expect continues throughout Sections A–D, each of which begins with a short note outlining what it contains.

Section A deals with the evolution and structure of “selected peatland basins”. The first of these is the northern circumpolar region, north of latitude 40 °N in North America and 50 °N in Eurasia. Authors Tarnocai and Stolbovoy give a general compilation of information from North America, Russia and Finland about the different peatland classification schemes and the way that peatland development and accumulation processes vary across the transition from intermittently frozen conditions into the permafrost zone. Although they conclude that climate change is likely to severely affect these northern peatlands, the implications for their estimated 257 Gt carbon store are extremely uncertain; and the possibility that warming peatlands could yet save the earth is not eliminated by the observation that the rate of peat growth (i.e. carbon fixation) increases after thawing of permafrost. The next chapter contains the senior editor’s own account of peatlands in the vast (325,000 km²) Hudson Bay Lowland of central Canada; which includes data on stratigraphy,

chemistry and carbon emissions collected over a period of around 40 years. The focus then shifts to the mountains of Galicia, northern Spain, where 10,000 ha of blanket bogs, raised bogs and fens akin to those occurring elsewhere along the Atlantic seaboard of Europe have been described, and on average apparently accumulate carbon faster (per unit area) than boreal mires in Canada (Pontevedra-Pombal *et al.*); and thence to Tierra del Fuego, the southernmost inhabited region of the world, for two accounts encompassing the extent and geomorphological placement of Fuegian peatlands and their palaeoclimatic/palaeoenvironmental information content (Coronato *et al.*, Rabassa *et al.*). Finally, Sue Page leads on the lowland peatlands of south-east Asia, where the majority of the earth's 50–70 Gt of tropical peat carbon is to be found.

The selection of locations covered seemed, at first, quite bizarre; but the realisation slowly dawned that they are 'outlier' parts of the world where the study of peatlands has fairly recently reached a stage at which good information on their evolution and structure is available and yet still newsworthy. They also encompass some major geographical contrasts amongst peatlands, hopping from the senior editor's own boreal 'patch' to some of the most southerly temperate-northern-hemisphere bogs, then to one of the few southern-hemisphere land masses offering parallel conditions, and finally to the tropics.

Section B is thickest of the four, and the introductory note tells us that the selected characteristics covered are principally geochemistry, microbiology and hydrology. The first chapter, authored by the remaining volume editors with Eduardo García-Rodeja, establishes a geochemical framework in terms of the 'redox-pH' approach'. The workings of the Pourbaix (Eh-pH) diagram, and how peatland environments sit within it, are explained in detail. The most important conclusion for this volume is that the approach provides a first-line defence against choosing an undesirably mobile proxy element as a basis for reconstructing past environmental conditions. The geochemistry content is completed by chapters on the weathering of inorganic matter deposited on bogs (Le Roux & Shotyck), the molecular chemistry of decomposition as revealed by pyrolysis (Buurman *et al.*), decomposition trends and the nature of inorganic fallout in bogs from Sweden to Tierra del Fuego via Ireland (Franzén), and the consequences for bog plants of increasing levels of atmospheric nitrogen deposition (Bragazza). Microbiology is covered in a single chapter entitled "microbial diversity in *Sphagnum* peatlands" by Gilbert & Mitchell which also touches on the functional importance of microbial communities (e.g. nutrient recycling and

methane production), introduces the microbial loop, and considers practical applications which include—but are not restricted to—palaeoecology. The hydrology theme is introduced by Joe Holden's overview of recent developments in understanding of peat hydrology, based mostly on his experience of blanket peat; and continues with a review of more than 25 years' investigation of groundwater-peatland interactions in the glacial Lake Agassiz and Albany River peat basins—two of the largest in North America—led by Paul Glaser. The final chapter is an account of slope instability and mass movements in peat deposits by Dykes & Kirk.

Thus, Section B presents the current positions of numerous eminent researchers in a wide range of peatland-related disciplines; each of which is perhaps relevant, at least in a broad sense, to the theme of Section C—archival value. Section C itself is strongly slanted towards the pollutant archive. The introductory note tells us that the proxy elements considered are mostly lead (Pb) and mercury, but there is also an account of halogens in mires which is apparently the first general treatment of this topic. Opening the Section, Tim Mighall *et al.* use the peat record to illuminate the history and impacts of the metallurgical industry in the British Isles, illustrating predictive as well as interpretation-testing applications of bog archives in archaeology. Bindler & Klaminder then take the discussion beyond peat, complementing its record with data from soils and lake sediments to strengthen understanding of the history and implications of metal deposition in Sweden; the running header for this chapter is "lead in Swedish peat, lake sediments, and soils", which perhaps gives a more accurate indication of content than the title. The halogens contribution from Biester *et al.* follows. Here, we discover that the formation of organo-halogens in the acrotelm and their subsequent accumulation in peat may not be the end of the story for chlorine, bromine and iodine deposited on peatlands; since it is becoming clear that complex microbe-mediated cycling occurs, introducing the possibility that bound halogens will be re-released under some climate-change scenarios. In the next chapter, the same lead author pursues a similar thesis for mercury, whose records in peat show poor correspondence to those in lake sediments. It seems that climate-induced changes in biogeochemical cycling could also cause the release of accumulated mercury from peat into aquatic environments. Finally, Malin Kylander and colleagues return to lead (Pb); providing insights into long-term (including 'pre-anthropogenic') patterns of atmospheric deposition, the tools that are used to decipher the bog record, and some applications.

I noticed in this Section that the acrotelm-catotelm concept seems still to be found useful in understanding geochemical cycling and accumulation processes in peatlands, despite the crescendo of criticism in Holden's contribution to Section B. In fact, the evidence presented might be interpreted to indicate that the concept works for both hydrologist and geochemist at smaller (microform/microtope to mesotope) scale and in more-intact, more predominantly peat-forming systems; but that it is an insufficient basis for interpreting mesotope-to-macrotope (hillslope) scale hydrology in substantially degraded systems. Further insights into the degradation undergone by blanket peat when it is severely drained can be found in Chapter 22 (Section D).

Section D contains just two chapters focusing on problems associated with the drainage and utilisation of peat by human beings. For the first of these, Joe Holden joins forces with Stuart Lane and two others to explore the impacts of artificial drainage on runoff production and water quality (again in UK blanket peatland) and the implications for peatland restoration. In the second and final chapter, a four-strong team from the University of Padova (Italy), led by M. Camporese, report on their investigation of subsidence in peatlands that have been converted to agricultural use around Venice. Their field experiments, data analysis and predictive modelling indicate that the cumulative subsidence due to human intervention over the last 70 years amounts to 1.5–2 metres; that microbial peat oxidation has caused ongoing settlement at a rate of at least 2 cm yr⁻¹ during the last 20 years; and that the peat layer should disappear within the next 50 years or so if current management is continued. Predictably, and as in the many other historical and present-day examples, negative impacts on environment and economy are expected.

The text ends there. The rest of the book consists of a 22-page glossary and a 15-page subject index. I briefly tested the latter ('carbon storage') unsuccessfully in search of the difficult sentence "For example, more carbon is stored in the world's soils – including peatlands, wetlands, and permafrost – than the one exists in the atmosphere" that I jotted down without reference at some point in

my reading; it's in there somewhere. But in general, the book seems well edited with only a smattering of mistakes such as 'typos'; although my error-spotting threshold was deliberately set high because every paper has, of course, been 'Americanized' to some degree. This was not generally a problem, except that students should perhaps be reminded that a North American 'watershed' is equivalent to an English 'catchment' before reading the hydrological (sorry, hydrologic) chapters. I did think, on page 431 (para. 2, line 6), that two archives were more likely to be used in a 'complementary' fashion than in 'complimentary' mode in either language; and I wondered whether the simple relationship between pe and pH mentioned on page 176 (five lines up from the bottom) should actually be the relationship between pe and Eh. There are some excellent micrographs, notably in Chapter 11 and Chapter 13, and the quality of the predominantly 'black-and-white' illustrations is generally good. The full-colour vegetation map of the Albany River study area (Figure 15.2) comes as a surprise, but presumably would not have been decipherable in monochrome.

So who should read this book, and how? It has a geochemistry bias, but covers so much more. Although the editors seem to have worked hard to fit a structure around the sometimes quite disparate topics, the volume is probably best regarded, primarily, as exactly what it says in the 'packaging'—an important and up-to-date aggregation of material useful to (all) geoscientists and bioscientists and particularly to those with peatland interests. Cover-to-cover reading is heavy going. On the other hand, I anticipate that I shall need to refer to this book time and time again in the future. It is a large and polished collection of state-of-art contributions from a star-studded cast of authors spanning a wide range of disciplines. All of the material could be relevant, in one way or another, to any avenue of peatland investigation. All serious peatland researchers (who don't already have an author's copy) will want one; and most peatland courses and laboratories will need library copies, which are likely to be mined for information repeatedly in years to come.

Olivia Bragg, August 2011