



Book review

Encyclopedia of Soils in the Environment (4 volumes), D. Hillel, J.L. Hatfield, D.S. Powelson, C. Rosenzweig, K.M. Scow, M.J. Singer, D.L. Sparks (Eds.), 2005, ISBN 0-12-348530-4, Elsevier Academic Press, Amsterdam, Hardbound, 2119 pp., US\$1,095.

Although the study of soils goes back to the beginnings of sedentary agriculture, soil science as an independent discipline started somewhere in the mid-nineteenth century after it was given a name: *Bodenkunde* in German and *Pédologie* in French. Soil science made rapid developments. In the late 1920s, E. Blanck of the University of Göttingen published the *Handbuch der Bodenlehre* (Blanck, 1929–1932). A massive work of 10 volumes compiling and summarising what was known then about soils, written by a dozen or so German scientists, and a few Austrians, Hungarians and Swiss (Hans Jenny). The volumes deal with all aspects of soil science including soil genesis and cartography, weathering and climate, zonal soils, soil physics, chemistry and biology, soil fertility and management. The 10 volumes cover 5428 pages, weigh 9.5 kg and fill 31 cm of shelf space. A monumental reference work, outdated, but unsurpassed.

It has been talked about for a while but, now, it has been published: a new encyclopædia of soils— not quite so massive as Blanck's *Handbuch der Bodenlehre* but perhaps equally impressive and comprehensive. This encyclopaedia has 4 volumes, 2119 pages, weighs 6.8 kg and occupies 15 cm of shelf space. It contains 267 entries (articles) on soil science and related subjects. Fundamental and applied aspects of soil science are treated.

Is the *Encyclopedia of Soils in the Environment* really an encyclopaedia? Any layman would probably say yes looking at the four glowing red covers with

gold lettering—that is certainly how an encyclopædia should look. But when considering the length of an entry, it is doubtful as the average entry is a mini-review or article of about 8 pages, and not a concise and informative 300-word piece of information.

1. Foreword, preface and user guide

The *Foreword* is by Jeffrey Sachs, Director of the Earth Institute at Columbia University and special advisor to the United Nations Secretary-General on the Millennium Development Goals. Sachs stresses—like in other recent reference works—that there are three main challenges that warrant the need for thorough soil scientific knowledge: feeding the world population, environmental degradation, and anthropogenic climate change. He is well-served by this encyclopædia and except for detailed entries on food production, degradation as well as climate change are treated in various entries.

The *Preface* by the editor-in-chief Daniel Hillel is very readable and contains well-expressed ideas and notions about soils and soil science. Hillel encourages parents to let their children play in mud and notes that many people live in the artificial environment of a city and they are insulated from direct exposure to nature. Detachment has bred ignorance, and out of ignorance has come the delusion that our civilisation has risen above nature and has set itself free of its constraints, according to Hillel. Is this an explanation for the decline in soil science departments and number of soil science students? Perhaps, but in any case it is well said and quotable.

Then follows a guide how this encyclopædia should be used. The first way is through the contents list at the beginning of each volume. Synonyms (for example *Precision agriculture* see *Site specific soil*

management) are dealt with as in other encyclopædia. The second entrance possibility is through cross-referencing and at the end of each entry there is a section: *See also*. For example in the entry *Micro-nutrients* there is reference to the entries: *Fertilizers and fertilization*; *Iron nutrition*; *Nutrient availability*. This draws the reader to articles where the topic is discussed in greater detail, to parallel discussions in other articles, or to material that broadens the discussion. The third way is through the index of 82 pages in volume 4 and I guess that this is the easiest way to find information. In this Google era where so much information is a few clicks away, I must admit that an index (Help, there is no CONTROL F-function!) appears somewhat cumbersome but I photocopied the index to speed up searches. Unfortunately, no author subject index is included. There is very little cross-referencing between entries. For example, in the text of the entry *Vadose zone, hydrological processes* there is reference to other entries like *Infiltration* or *Evaporation*. That is very useful particularly in the paper version.

2. What is in it?

The 267 entries are written by 374 authors and about one to three eminent, well-established authors are listed per entry. Most entries have a similar layout: introduction, main sections with some tables, graphs, and diagrams; sometimes a summary and list of technical nomenclature at the end, followed by further reading containing 5–20 references. The entry *Neutron scattering*, for example, starts with an *Introduction* followed by *Theory and Instrumentation*, *Field Methodology*, *Calibration*, *Applications*, *Safety and Care*, *Future Use* and *Further Reading*. At the end of the article there is a cross-reference to four other entries: *Time domain reflectometry*; *Water content and potential measurement*; *Water cycle*; and *Water potential*. In this entry there is one picture, a few equations, one table and four figures. It contains just the sort of information needed for an encyclopædia entry. With few exceptions, the quality of the figures is good; some are duplicated in colour in the middle of each volume.

Some entries have more articles. *Nitrogen in soils*, for example, has articles on *Cycle*, *Nitrates*, *Nitrifi-*

cation, *Plant uptake*, and *Symbiotic fixation*. The entry on *Nitrates* is a good read, particularly the section on nitrate and health where the authors emphasise the poor evidence (if at all) for carcinogenic effects of nitrate in drinking water or vegetables. That should be compulsory reading for policy makers especially those on manure legislation, but also for some other authors in this encyclopædia (e.g. the entry on *Nutrient Management*).

Soil classification is fairly well-covered and focuses mostly on *Soil Taxonomy* although there are entries on *FAO* (oddly not *World Reference Base*) and the Russian system; other national systems are not included. Of the 12 *Soil Taxonomy* orders strangely only *Inceptisols* has a separate entry. In the entry *World Soil Map* *Soil Taxonomy* is used throughout and for each order and suborder estimates of areas occupied in the world are given.

Some entries are better than others and I much enjoyed reading the entries on *Cation exchange*; *Clay minerals*; *Food-web interactions*; *Fractal analysis*; *Greenhouse gas emissions*; *Infiltration*; *Isotopes in soil and plant investigations*; *Metal oxides*; *Organic residues decomposition*; *Precipitation–dissolution processes*; *Radiation balance*; *Remediation of polluted soils*; *Salinity management*; *Tensiometry*; *Zero-charge points*— to name a few. Also the entry on *Darcy's law* and *Enzymes in soil* are nice examples. It is a bit hard to tell what makes a good entry for an encyclopædia but it is probably the combination of plain language, a didactic approach to an argument and scholarly depth. Just like teaching.

It is easy to criticise but there are a few things that deserve mention. Some entries have very little soil in them like: *Agroforestry* (despite the volume of soil research conducted); *Plant growth promoting bacteria*; *Archae*; *Energy balance*; *Nematodes* (why nematodes, and not a separate entry on earthworms which we all love so much?); *N Symbiotic fixation*; *Nuclear waste disposal*; *Penman–Monteith equation*; *Precipitation*; *Watershed analysis*; *Septic systems*; *Stress–strain and soil strength*. Somehow I felt that is a missed opportunity as some of these topics are useful in a comprehensive work like this. They may be too much on the margins of soil science interest (meteorology, plant physiology).

Some entries are meagre: *Crop residue management*, *Weed management* and *Range management*.

Some have chunks of text that have appeared elsewhere (not really a problem if written by the same author), and some entries are not really up-to-date like *Climate change impacts*. I also missed a few things like ripening in *Alluvial soils* and on the Birch effect in the *Soil bacteria* entry. On page 438 (Vol. I) I read that the geographic distribution of soil types is related to the distribution of climatic zones. That should have been weeded out; also for example that the soil pattern in North America has no link with latitude because of the rainfall gradient perpendicular to the latitude (proxy for temperature). Overall, I detected very few printing errors; some were in the list of references and included misspelling of names.

There is a North American flavour to this encyclopædia (see also Table 1) and some entries on more applied aspects have a sole USA focus: *Application of soils data*; *Crop rotations*; *Drainage, surface and subsurface*; *Dryland farming*; *Morphol-*

ogy; *Water induced erosion*; *Phosphorus in soils*; *Sustainable soil and land management*. They contain little relevant information for those working or interested in other parts of the world. In these entries, research work from other parts of the world is neglected. The entry *Nutrient Management* is about farming in the developed world and excess applications of manure and inorganic fertilisers, nothing on nutrient management in Sub-Saharan Africa where the need for proper nutrient management is so pressing. *Cultivation and tillage* and *Subsoiling* are all about tools for tractors—well suited for farmers in the developed world but not so useful for the majority of the farmers in this world. For reasons mentioned in the *Preface* as well as the *Foreword* it would have been more correct if some entries would have had a global outlook.

Some overlap between entries which is unavoidable, for example what is presented in *Essential*

Table 1
Breakdown of editors, authors and biographies per country

Country	Editors	%	Editorial Advisory Board	%	Authors	%	Biographies	%
USA	5	83	7	39	228	61	11	65
UK	1	17	3	17	24	6	4	24
Netherlands			2	11	10	3	1	6
Czech Republic			1	6	0	0		
Brazil			1	6	3	1		
Switzerland			1	6	3	1		
Italy			1	6	8	2		
Germany			1	6	13	3	1	6
Israel			1	6	14	4		
Canada					14	4		
New Zealand					13	3		
Australia					11	3		
Spain					4	1		
India					3	1		
Mexico					3	1		
France					3	1		
Russia					3	1		
Philippines					3	1		
Portugal					2	<1		
Belgium					2	<1		
Austria					2	<1		
Turkey					2	<1		
Taiwan					2	<1		
Jordan					1	<1		
Greece					1	<1		
Syria					1	<1		
Singapore					1	<1		

elements and *Macronutrients* and *Micronutrients*. Some entries bear odd titles like *Forest soils*, *Grassland soils*, *Paddy soils* and *Mediterranean soils*. That may mean something to the laymen but for a soil scientist these are almost meaningless and should not be used as they single out only one of the factors of soil formation. For the same reason we do not use steep land soils, basalt soils or very old soils. Also the entry *Spatial patterns* is not exactly what you would expect as it is about biological properties and processes and their patterns. Three entries deal with spectroscopy and provide detailed and technical information, no entry on NMR or synchrotrons is included.

3. Biographies

A fascinating part of the encyclopædia is the inclusion of 17 biographies of: E.C. Childs, E.W. Hilgard, S.B. Hooghoudt, H. Jenny, C. Kellogg, D. Kirkham, J.B. Lawes and J.H. Gilbert, J. von Liebig, J.G. Lipman, W.C. Lowdermilk, C.F. Marbut, H.L. Penman, L.A. Richards, S.A. Waksman, J.A. Wiltsoe and W. Gardner. An interesting list and most entries are informative and put the developments of concepts, theory and practice in soil science in a historical context. More than half of the biographies are from soil physicists or pedologists and the list is not a true reflection of the tycoons that made soil science. There are no biographies of giants like V.V. Dokuchaev, E.C.J. Mohr, E. Buckingham, W.L. Kubiena, J. Prescott, P. Vageler or J.R. Philip, to name a few.

The biographies are mostly written by colleague soil scientists so there is lots of praise and hallelujahs that affect the readability. Several of the biographies read like obituaries but we all know that detachment of subject generally improves the objectivity and readability. It is good to know how scientific thinking developed and contributed to advancements in soil science but some distance is essential. The only exception to the praising biographies is that of Justus von Liebig where he is more or less accused of plagiarising the law of the minimum first postulated by Karl Sprenger. Moreover, the authors highlight von Liebig's slightly unbearable character (as *Nature* wrote on von Liebig "...hot-tempered, spiteful and insidious...but a master at realizing when a quarrel might get out of hand"). Accusations of von Liebig's

plagiarism have been published before (van der Ploeg et al., 1999) although much of it is downplayed in the biography of Justus von Liebig from 1997 (Brock, 1997). I guess other soil scientists biographed in this encyclopædia had interesting characters too but that remains unremarked upon.

There is an entry on *Women in soil science (USA)*. I thought gender was not an issue in soil science but, apparently, there is a need to emphasise the role and achievements of women in our discipline. Scientific writings can do without political correctness and fashion. Many women in soil science in the USA are mentioned. The entry is a bit trivial in my opinion and has been published elsewhere. It might have been better to include biographies of some of those women who have made a huge contribution, tycoons like, for example, J. Döbereiner or M.M. Kononova.

4. Authors and editors

In total 374 people wrote contributions steered by 6 editors and 1 editor-in-chief. It is hard to imagine coordinating such an effort without e-mail. It is roughly the number of manuscripts that an average soil science journal chews through per year. A breakdown of editors and authors per country is given in Table 1.

Most authors and members of the editorial advisory board are from North America, specifically the USA. This may reflect the network and preference of the editor-in-chief, the willingness and availability of US soil scientists to contribute, or some other reasons. One could argue that in this age of electronics it would not have been too difficult to spread authors a bit more evenly across the globe—provided there is merit in such spreading. Also most of the biographies in this encyclopædia are from US soil scientists although Jenny was Swiss born, Waksman, Russian and Wiltsoe, Norwegian.

5. Other reference books

As far as I know the first encyclopædia of soil science appeared some 25 years ago (Fairbridge and Finkl, 1979). Two volumes were envisioned but only Part I was published that dealt with Physics, Chemistry, Biology and Fertility and Technology.

There were 112 contributors; some of those have also contributed to the current encyclopædia.

The first major reference book appeared in 2000: *Handbook of Soil Science* (Sumner, 2000). The Handbook contains 57 articles (2110 pages) written by 146 authors; there was one editor-in-chief (Malcolm Sumner), and 8 associate editors that took care of 8 sections: soil physics, soil chemistry, soil biology and biochemistry, soil fertility and plant nutrition, pedology, soil mineralogy, interdisciplinary aspects of soil science, and soil databases. Articles are 30–60 pages each with an excellent index. There is no web version of this handbook. Two years later the *Encyclopedia of Soil Science* was published (Lal, 2002). It has contributions from over 400 authors. The encyclopædia has one editor-in-chief (Rattan Lal), an editorial board of 15 and 47 topical editors. The encyclopædia contains almost 1500 pages covering 360 entries; it has a web version where the entries can be searched and downloaded as PDF. Articles are about 3–6 pages. It is currently updated and a second expanded and fully revised edition with over 500 entries will be published late 2005. And then late 2004 the current *Encyclopedia of Soils in the Environment* was launched at the annual meeting of the Soil Science Society of America.

Table 2 compares some of the differences and similarities between these reference books. The *Handbook of Soil Science* (2000) has on average the longest articles whereas the *Encyclopedia of Soil Science* (2002) has the shortest entries with around 4

Table 2
Comparison between four soil science reference works

	Number of articles/ Entries	Number of authors	Number of pages	Pages/ article	Pages/ author
<i>The Encyclopedia of Soil Science. Part 1</i> (1979)	136	112	620	4.6	5.5
<i>Handbook of Soil Science</i> (2000)	57	146	2110	37.0	14.5
<i>Encyclopedia of Soil Science</i> (2002)	360	400	1476	4.1	3.7
<i>Encyclopedia of Soils in the Environment</i> (2005)	267	374	2119	7.9	5.7

pages per entry. More authors are generally needed when the length of article increases but their relative contribution decreases—more people doing less when writing more. This pattern was also found in the 2079 Geoderma papers published between 1967 and 2001 (Hartemink et al., 2001).

Three major reference works in four years filling 30 cm of shelf space, weighing over 12 kg and containing 5700 pages; almost as much as *Handbuch der Bodenlehre* from the 1920s, but with a few more authors. If it is a reflection of advancements in soil science then we could only be pleased. I am not sure whether that is the case; there is overlap between these three works, some authors appear in all three works sometimes saying the same thing. If anything can be deduced from these three works than it is that soil science has a very active publishing culture and there are several amongst us who are able to summarise, edit and absorb large chunks of soil scientific information. It also shows that despite the dwindling number of soil scientists in many countries, more and more is being published.

6. Different books, different uses

Reference works are indispensable. Peer-reviewed soil science publications are growing at a rate of 5–10% per year and for busy researchers and students it may be difficult to stay abreast of our paper production (Hartemink, 2002). An increasing amount of information about soils is available on the web. Some of it is peer reviewed, some of it is not and may be inaccurate or even nonsense. These reference works aiming at both professionals and non-specialists contain articles that are peer-reviewed, up-to-date and accurate. They have different uses and values. When looking for the meaning of a word or a short description, soil and environmental science dictionaries suffice (Gregorich et al., 2000; Lozet et al., 1991; Troeh and Donahue, 2003) or an online version (www.soils.org/sssagloss/) They have large amounts of entries so there is hardly a term used in soil science that is not listed in these dictionaries. For short explanations or to refresh knowledge the *Encyclopedia of Soil Science* (Lal, 2002) is useful; for more insight and detail the current *Encyclopedia of Soils in the Environment* is invaluable. For a thorough review

of a subject the *Handbook of Soil Science* (Sumner, 2000) should be read. So in a well-funded lab and department all these books need to be on the shelf; they will be used differently by different people. Of course the more comprehensively an entry is described, the fewer the entries per book.

References books, however brilliantly written or edited, have the disadvantage that our science progresses and that they sooner or later become out of date. The speed at which they become outdated is determined by how state-of-the-art the entries are, and the speed and rate at which developments take place in soil science. Web-based versions that are regularly updated and expanded are the answer.

Ideally, the articles of all these reference books are accessible through search engines like ISI Web of Science that search not only for title of the PDFs but also in the PDFs. And they should be cross-referenced. Well, that is the ideal and since these books are from different publishers that is so not likely to happen. There is also no guarantee that access and coupling of this information makes our science better or more advanced, it just makes it easier. Truly innovative ideas come irrespective of all these reference works.

The web version of the *Encyclopedia of Soils in the Environment* is accessible through ScienceDirect. PDFs of all articles are available. That is attractive and speeding up searches but I guess for laymen it may have competition from the popular wikipedia.org encyclopædia that is freely accessible on the internet. The soil articles that are currently found on wikipedia.org are informative and appear factually correct although they are not peer-reviewed. With increasing pressure on scientific publishers to reduce the prices of published work combined with reduced library budgets, initiatives like wikipedia.org and free on-line journals (e.g. PLOS) are likely to become more popular and win support from the scientific community. As telephoning the world is now possible free of charge through the internet so will scientific information be in the future. A bold prediction, but not unthinkable.

7. Some concluding remarks

This is the third soil reference work since 2000 and one wonders what initiated and spurred those three efforts: the end of the millennium, the digital

revolution, or a major generational change in our discipline. The baby boomers in our discipline are about to retire, made redundant and may feel the need to leave landmarks behind—landmarks in the form of thick books of knowledge. Another reason might be purely commercial competition between publishers. There is money in publishing books. We shall leave it to future generations to explain the publication of three major soil reference books in less than five years, intriguing though it is.

As with the other recent reference works this encyclopædia is a North-American effort and has a developed-world outlook. The vast majority of editors and authors are from the USA and that is somewhat reflected in the text, figures and examples. The price of this encyclopædia is such that it is unaffordable for individuals but let us hope the web based version will be available to all of us either through university and institutional libraries, as contributor, or through free access networks like AGORA for those working in the developing world. It is in the developing world where soil science continues to have a tremendous impact and that should not be forgotten as emphasised in the *Preface*.

For the soil science community this encyclopædia is a blessing. It contains a series of up-to-date and illustrated articles that are mostly well-written, and very useful to refresh knowledge or gain some new. It will be a standard reference book for years to come.

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