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ENCYCLOPEDIA *of* SOIL SCIENCE

edited by

WARD CHESWORTH
University of Guelph
Canada

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ENCYCLOPEDIA *of* SOIL SCIENCE

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Encyclopedia of Earth Sciences Series

ENCYCLOPEDIA OF SOIL SCIENCE

Volume Editor
Ward Chesworth is Professor Emeritus of Geochemistry at the University of Guelph, Ontario, Canada. He co-edited Weathering, Soils and Paleosols, and three volumes of the annual Hammond Lecture Series broadcast in part by the Canadian Broadcasting Corporation: Malthus and the Third Millennium, Sustainable Development, and The Human Ecological Footprint. He co-wrote Perspectives on Canadian Geology. In 2003 he received the Halbouty Prize of the Geological Society of America, of which he is a Fellow.

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About the Editors
Professor Charles W. Finkl has edited and/or contributed to more than 8 volumes in the *Encyclopedia of Earth Sciences Series*. For the past 25 years he has been the Executive Director of the Coastal Education & Research Foundation and Editor-in-Chief of the international *Journal of Coastal Research*. In addition to these duties, he is Principal Marine Geologist with Coastal Planning & Engineering, Inc. and Research Professor at Florida Atlantic University in Boca Raton, Florida, USA. He is a graduate of the University of Western Australia (Perth) and previously worked for a wholly owned Australian subsidiary of the International Nickel Company of Canada (INCO). During his career, he acquired field experience in Australia; the Caribbean; South America; SW Pacific islands; southern Africa; Western Europe; and the Pacific Northwest, Midwest, and Southeast USA.

Professor Michael Rampino has published more than 100 papers in professional journals including *Science*, *Nature*, and *Scientific American*. He has worked in such diverse fields as volcanology, planetary science, sedimentology, and climate studies, and has done field work on six continents. He is currently Associate Professor of Earth and Environmental Sciences at New York University and a consultant at NASA's Goddard Institute for Space Studies.

Founding Series Editor
Professor Rhodes W. Fairbridge† has edited more than 24 Encyclopedias in the Earth Sciences Series. During his career he has worked as a petroleum geologist in the Middle East, been a WW II intelligence officer in the SW Pacific and led expeditions to the Sahara, Arctic Canada, Arctic Scandinavia, Brazil and New Guinea. He was Emeritus Professor of Geology at Columbia University and was affiliated with the Goddard Institute for Space Studies.

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Contributors

I. P. Abrol
Centre for the Advancement of Sustainable Agriculture
National Agricultural Science Centre (NASC) Complex
DPS Marg, Pusa
New Delhi 110 012, India
email: Iabrol@vsnl.com

Christine Alewell
Environmental Geosciences
University of Basel
Bernoullistr. 32
CH-4056 Basel, Switzerland
email: christine.alewell@unibas.ch

Gonzalo Almendros Martín
Center of Environmental Sciences
Soils Dept./Soil Biochemistry Lab.
c/ Serrano 115 dpdo
28006 Madrid, Spain
email: humus@ccma.csic.es

Olafur Arnalds
Keldnaholt
Reykjavik 112, Iceland
email: oa@lbhi.is

Emmanuelle Arnaud
(no address)

Richard W. Arnold
1145 Glenway
West Lafayette, IN 47906-2203, USA
email: CT9311@aol.com

M. A. Arshad
Agriculture Canada Research Station
Box 29
Beaverlodge, AB T0H 0C0, Canada
email: charlie.arshad@ualberta.ca

K. Auerswald
Lehrstuhl für Grünlandlehre, TU München
Am Hochanger 1
85354 Freising-Weihenstephan, Germany
email: auerswald@wzw.tum.de

Bryon W. Bache
The Chestnuts
The Green
Lolworth
Cambridge, CB3 8HF, UK

N. J. Barrow
22 Townsend Dale
Mt. Claremont
Western Australia 6010, Australia
email: nbarrow@bigpond.net.au

Valerie M. Behan-Pelletier
Agriculture and Agri-Food Canada
K.W. Neatby Bldg.
960 Carling Avenue
Ottawa, ON K1A 0C6, Canada
email: behanpv@agr.gc.ca

Friedrich H. Beinroth
Departamento de Agronomia y Suelos
Universidad de Puerto Rico
P.O. Box 9030
Mayaguez, PR 00681-9030, Puerto Rico
email: fred_beinroth@cca.uprm.edu

George R. Blake
2215 N 1400 E St
Provo, UT 84604, USA
email: blake001@umn.edu

Johannes Bouma
(no address)

Herman Bouwer
(no address)

Michael Brookfield
Department of Land Resource Science
University of Guelph
Guelph, ON N1G 2W1, Canada
email: mbrookfi@lrs.uoguelph.ca

Gaylon S. Campbell
Decagon Devices, Inc.
2365 NE Hopkins Court
Pullman, WA 99163, USA
email: gaylon@decagon.com

Marta Camps Arbestain
NEIKER
c/ Berreaga, 1
48160 Derio (Bizkaia), Spain
email: mcamps@neiker.net

G. E. Cardon
Department of Plants, Soils & Biometeorology
Utah State University, Ag. Science Building
4820 Old Main Hall
Logan, UT 84322-4820, USA
email: grantc@ext.usu.edu

Keith D. Cassel
Department of Soil Science
North Carolina State University
100 Derieux Street, Williams Hall
Raleigh, NC 27695-7619, USA
email: keith_cassel@ncsu.edu

Ward Chesworth
Department of Land Resource Science
University of Guelph
Guelph, ON N1G 2W1, Canada
email: wcheswor@uoguelph.ca

Brent E. Clothier
HortResearch Palmerston North
Private Bag 11030, Manawatu Mail Centre
Palmerston North 4442, New Zealand
email: bclothier@hortresearch.co.nz

Maurice G. Cook
Ecologistics Limited
Consultants in Environmental Management
3458 Leonard Street
Raleigh, NC 27607, USA
email: mgcook@mindspring.com

Miguel Cooper
Depto de Solos e Nutrição de Plantas, University of São Paulo
Avenida Pádua Dias, 11
13418-900 Piracicaba, Brazil
email: mcooper@esalq.usp.br

Randy A. Dahlgren
Land, Air and Water Resources, University of California
One Shields Avenue
Davis, CA 95616-8627, USA
email: radahlgren@ucdavis.edu

John W. Doran
School of Natural Resouces
University of Nebraska
119 Keim Hall
Lincoln, NE 68583-0934, USA
email: jdoran1@unl.edu

S. A. Ebelhar
University of Illinois
Dixon Springs Agricultural Center
Crop Sciences Division
RR1, Box 256, Simpson, IL 62985, USA
email: sebelhar@uiuc.edu

William Joseph Edmonds
1610 Kennedy Avenue
Blacksburg, VA 24060, USA

W. W. Emerson
(no address)

Hari Eswaran
USDA Natural Resources Conservation Service
1400 Independence Avenue (Room S-4836)
Washington, DC 20250, USA
email: hari.eswaran@wdc.usda.gov

L. J. Evans
Department of Land Resource Science
University of Guelph
Guelph, ON N1G 2W1, Canada
email: levans@lrs.uoguelph.ca

Rhodes W. Fairbridge
(deceased)

Steven B. Feldman
Consulting Mineralogist
238 West Main St.
Millbury, MA 01527, USA
email: zoeeko@verizon.net

Yucheng Feng
Department of Agronomy and Soils
University of Alabama
202 Funchess Hall
Auburn, AL 36849, USA
email: fengyuc@auburn.edu

Tiago O. Ferreira
Dep. de Ciências do Solo
CCA/UFC
Fortaleza, Brazil

Charles W. Finkl
Coastal Planning & Engineering, Inc.
CPE Coastal Geology & Geomatics
2481 Boca Raton Boulevard
Boca Raton, FL 33431, USA
email: cfinkl@coastalplanning.net

P. W. Ford
CSIRO Land & Water
GPO Box 1666
Canberra, ACT 2601, Australia
email: philip.ford@csiro.au

Carlota Garcia Paz
Departamento de Edafologia y Quimica Agricola
Facultad de Biologia
Universidade de Santiago de Compostela
Campus Universitario Sur s/n
15782 Santiago de Compostela, Spain
email: edcmgp@usc.es

Walter H. Gardner
1160 Telegraph Road #10
Washington, UT 84780, USA

Robert G. Gast
(no address)

James J. Germida
Department of Soil Science, University Saskatchewan
51 Campus Drive
Saskatoon, SK S7N 5A8, Canada
email: germida@sask.usask.ca

Carlo Gessa
Dipartimento di Scienze e Technologie Agroambientali
Universita di Bologna
Via Fanin, 40
40100 Bologna, Italy
email: carloemanuele.gessa@unibo.it

Jan Gliński
Institute of Agrophysics, Polish Academy of Sciences
Doświadczalna 4
20290 Lublin 27, Poland
email: jglinski@demeter.ipan.lublin.pl

Pieter H. Groenevelt
Department of Land Resource Science
University of Guelph
Guelph, ON N1G 2W1, Canada
email: pgroenev@uoguelph.ca

Paul R. Grossl
Department of Plants, Soils, and Biometeorology
Utah State University
4820 Old Main Hill, AGS 348
Logan, UT 84322-4820, USA
email: grossl@cc.usu.edu

Raj K. Gupta
ICARDA – CAC Regional Office
P.O. Box 4564, Tashkent
Uzbekistan

Amos Hadas
Institute of Soils, Water and Environmental Sciences
The Volcani Center, A.R.O.
P.O. Box 6
Bet Dagan 50250, Israel
email: ahadas@volcani.agri.gov.il

R. David Hammer
National Leader, Soil Survey Investigations
USDA-NRCS-NSSC
Federal Building, Room 152
100 Centennial Mall North
Lincoln, NE 68508-3866, USA
phone: 402-437-5321
email: david.hammer@lin.usda.gov

R. J. Hanks
1305 E. 2050 N.
Logan, UT 84341, USA
email: jhanks@cc.usu.edu

Roger Hartmann
Agr Sci, Coupre Links 65
State University of Ghent
Ghent 9000, Belgium
email: roger.hartmann@ugent.be

Richard J. Heck
Department of Land Resource Science
University of Guelph
Guelph, ON N1G 2W1, Canada
email: rheck@uoguelph.ca

Michael Herlihy
(no address)

Stuart B. Hill
School of Education, University of Western Sydney
Locked Bag 1797
Penrith South DC
NSW 1797, Australia
email: s.hill@uws.edu.au

William R. Horwath
3226 Plant and Environmental Science Building
University of California
One Shields Avenue
Davis, CA 95616-8627, USA
email: wrhorwath@ucdavis.edu

L. R. Hossner
Department of Soils & Crop Sciences, Texas A&M University
370 Olsen Blvd
College Station, TX 7784-2474, USA
email: lhossner@ag.tamu.edu

P. M. Huang
Department of Soil Science, University Saskatchewan
51 Campus Drive
Saskatoon, SK S7N 5A8, Canada
email: Pan.Huang@usask.ca

William F. Jaynes
Plant and Soil Science, MS 2122
Texas Tech University
Lubbock, TX 79409, USA
email: william.jaynes@ttu.edu

M. B. Kirkham
Department of Agronomy
Kansas State University
2004 Throckmorton Hall
Manhattan, KS 66506, USA
email: mbk@ksu.edu

Krystyna Konstankiewicz
Institute of Agrophysics
Polish Academy of Science
ul. Doświadczalna 4
20-290 Lublin 27, Poland
email: konst@demeter.ipan.lublin.pl

Nikola Kostic
Faculty of Agriculture, University of Belgrade
Nemanjina 6
11080 Belgrade, Yugoslavia
email: nkostic@agrifaculty.bg.ac.yu

J. Lag
(deceased)

David M. Lavigne
International Fund for Animal Welfare
40 Norwich Street East
Guelph, ON N1H 2G6, Canada
email: dlavigne@ifaw.org

David T. Lewis
2520 Penny Lane
Rogers, AR 72758, USA

Jerzy Lipiec
Institute of Agrophysics, Polish Academy of Sciences
ul. Doświadczalna 4
20-290 Lublin 27, Poland
email: lipiec@demeter.ipan.lublin.pl

Richard H. Loeppert
Department of Soil and Crop Sciences, Texas A&M University
370 Olsen Bldv
College Station, TX 77843-2474, USA
email: r-loeppert@tamu.edu

Felipe Macías Vázquez
Departamento de Edafologia y Quimica Agricola
Facultad de Biologia, Universidade de Santiago de Compostela
Campus Universitario Sur s/n
15782 Santiago de Compostela, Spain
email: edfmac@usc.es

Antonio Martínez Cortizas
Departamento de Edafologia y Quimica Agricola
Facultad de Biologia, Universidade de Santiago de Compostela
Campus Universiatario Sur s/n
15782 Santiago de Compostela, Spain
email: edantxon@usc.es

Burl D. Meek
(no address)

Konrad Mengel
Institut für Pflanzenernährung, IFZ, Justus Liebig Universität
Heinrich-Buff-Ring 26-32
35392 Gießen, Germany
email: konrad.mengel@ernaehrung.uni-giessen.de

Erika Micheli
Soil Science and Agrochemistry Department
Szent Istvan University
Páter Károly u. 1
2100 Godollo, Hungary
email: Micheli.Erika@mkk.szie.hu

Lloyd N. Mielke
P.O. Box 98
Gallatin Gateway, MT 59730, USA
email: ajjones@littleappletech.com

Fred P. Miller
(deceased)

Myron J. Mitchell
Environmental Sciences and Forest Biology
SUNY, 210 Illick Hall
1 Forestry Drive
Syracuse, NY 13210-2788, USA
email: mitchell@syr.edu

Carmela Monterroso Martinez
Departamento de Edafologia y Quimica Agricola
Facultad de Biologia, Universidad de Santiago de Compostela
Campus Sur, 15782 Santiago de Compostela, Spain
email: edcarmel@lugo.usc.es

H. J. Morel-Seytoux
57 Selby Lane
Atherton, CA 94027-3926, USA
email: hydroprose@batnet.com

Y. Mualem
Hebrew University of Jerusalem
Department of Soil and Water Sciences
P.O. Box 12
Rehovot 76100, Israel

J. C. Nóvoa Muñoz
Departamento Bioloxía Vexetal e Ciencias do Solo
Facultade de Ciencias, Universidade de Vigo
As Lagoas s/n
32004 Ourense, Spain
email: edjuanca@uvigo.es

Jnakwa O. A. Odeh
Faculty of Agriculture
A05-JRA McMillan, The University of Sydney
NSW 2006, Australia
email: i.odeh@usyd.edu.au

J. J. Oertli
Schaienweg 25
4107 Ettingen, Switzerland
email: jakob_oertli@yahoo.de

D. S. Orlov
(no address)

Xose L. Otero
Departamento de Edafologia y Quimica Agricola
Facultad de Biologia, Campus Sur s/n
15782 Santiago de Compostela, Spain
email: edajax@usc.es

Marcello Pagliai
Istituto Sperimentale per lo Studio e la Difesa del Suolo
CRA-ISSDS
Piazza D'Azeglio, 30
50121 Firenze, Italy
email: marcello.pagliai@entecra.it

Quirino Paris
Department of Agricultural and Resource Economics
3105 Social Science and Humanities Bldg.
University of California
One Shields Avenue
Davis, CA 95616, USA
email: paris@primal.ucdavis.edu

Gary W. Parkin
Department of Land Resource Science, University of Guelph
Guelph, ON N1G 2W1, Canada
email: gparkin@uoguelph.ca

J.-Y. Parlange
Department of Biological and Environmental Engineering
Cornell University
Ithaca, NY 14853-5701, USA
email: jp58@cornell.edu

Keith Paustian
Natural Resources Ecology Lab
Colorado State University
Ft. Collins, CO 80523, USA
email: keithp@nrel.colostate.edu

Augusto Perez-Alberti
Departamento de Geografia
Universidad de Santiago
Plaza de la Universidad
15703 Santiago de Compostela, Spain
email: xepalber@usc.es

X. Pontevedra Pombal
Departamento Edafologia y Quimica Agricola
Facultad de Biologia, Universidade de Santiago de Compostela
Campus Universitario Sur s/n
15782 Santiago de Compostela, Spain
email: edpombal@usc.es

Jarosław Pytka
Institute of Agrophysics PAS
ul. Doświadczalna 4, P.O. Box 201
20-290 Lublin 27, Poland
email: j.pytka@demeter.ipan.lublin.pl

Hervé Quiquampoix
UMR Rhizosphère et Symbiose, INRA-ENSAM
2 Place Pierre Viala
34060 Montpellier Cedex 1, France
email: quiquamp@ensam.inra.fr

William O. Rasmussen
Department of Agricultural and Biosystems Engineering
The University of Arizona
Tucson, AZ 85721, USA
email: rasmussw@email.arizona.edu

Ernest Rawitz
(deceased)

Paul F. Reich
Soil Survey Division
USDA-Natural Resources Conservation Service
Room 4250 South Building, 14th & Independence Ave, SW
Washington, DC 20250, USA
email: paul.reich@wdc.usda.gov

Wayne P. Robarge
Department of Soil Science, North Carolina State University
P.O. Box 7619
Raleigh, NC 27695-7619, USA
email: wayne_robarge@ncsu.edu

Pedro A. Sanchez
(no address)

Randall J. Schaetzl
Department of Geography, Michigan State University
128 Geography Building
East Lansing, MI 48824-1117, USA
email: soils@msu.edu

G. O. Schwab
(deceased)

Udo Schwertmann
Institut für Bodenkunde, TU München
Am Hochanger 2
85354 Freising-Weihenstephan, Germany
email: uschwert@wzw.tum.de

H. Magdi Selim
Department of Agronomy and Environmental Management
Louisiana State University
Sturgis Hall
Baton Rouge, LA 70803, USA
email: mselim@agcenter.lsu.edu

Johnson Semoka
Sokoine University of Agriculture, Department of Soil Science
P.O. Box 3008
Morogoro, Tanzania
email: jsemoka@suanet.ac.tz

C. Shang
Department of Crop and Soil Environmental Sciences
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0404, USA
email: chshang@vt.edu

Arieh Singer
Seagram Centre for Soil and Water Sciences
Hebrew University of Jerusalem
P.O. Box 12
Rehovot 76100, Israel
email: singer@agri.huji.ac.il

Peter Smart
Department of Civil Engineering, University of Glasgow
Glascow, G12 8LT, UK
email: geofun@gla.ac.uk

Yoong K. Soon
Beaverlodge Research Farm
P.O. Box 29
Beaverlodge, AB T0H 0C0, Canada
email: Soony@agr.gc.ca

Otto Spaargaren
World Data Centre for Soils
P.O. Box 353
6700 AJ Wageningen, The Netherlands
email: otto.spaargaren@wur.nl

Donald L. Sparks
Plant and Soil Sciences, University of Delaware
152 Townsend Hall
Newark, DE 19716, USA
email: dlsparks@udel.edu

Garrison Sposito
Department of Environmental Science, Policy and Management
College of Natural Resources, University of California
Berkeley, CA 94720-3114, USA
email: gsposito@nature.berkeley.edu

F. Stagnitti
School of Life and Environmental Sciences and Centre for Applied Dynamical Systems & Environmental Modelling
Deakin University
P.O. Box 423
Warrnambool 3280, Australia
email: frank.stagnitti@deakin.edu.au

Siobhán Staunton
UMR Rhizosphère & Symbiose
INRA, place Viala
34060 Montpellier Cedex, France
email: staunton@ensam.inra.fr

T. S. Steenhuis
Department of Biological and Environmental Engineering
Cornell University
Ithaca, NY 14853-5701, USA
email: tss1@cornell.edu

Gary G. Steinhardt
Department of Agronomy
Lilly Hall of Life Sciences
Purdue University
915 W. State Street
West Lafayette, IN 47907-2054, USA
email: gsteinhardt@purdue.edu

Witold Stępniewski
Wydział Inżynierii Środowiska Politechniki Lubelskiej
ul. Nadbystrzycka 40B
20-618 Lublin, Poland
email: W.Stepniewski@fenix.pol.lublin.pl

Georges Stoops
Laboratorium voor Mineralogie, Petrologie en Micropedologie
Universiteit Gent
Krijgslaan 281, S8
Gent 9000, Belgium
email: Georges.stoops@UGent.be

Peter van Straaten
Department of Land Resource Science
University of Guelph
Guelph, ON N1G 2W1, Canada
email: pvanstra@uoguelph.ca

Teresa Taboada Rodríguez
Departamento Edafologia y Quimica Agricola
Facultad de Biologia
Universidade de Santiago de Compostela
Campus Universitario Sur s/n
15782 Santiago de Compostela, Spain
email: edteresa@usc.es

B. K. G. Theng
Landcare Research
Private Bag 11052
Manawatu Mail Centre
Palmerston North 4442, New Zealand
email: thengb@landcareresearch.co.nz

Paul W. Unger
3603 Thurman St.
Amarillo, TX 79109, USA
email: pwunger@suddenlink.net

Pablo Vidal-Torrado
Depto de Ciencia do Solo, ESALQ/USP
University of São Paulo
Avenida Pádua Dias, 11
13418-900 Piracicaba, Brazil
email: pablo@esalq.usp.br

Jon S. Warland
Department of Land Resource Science
University of Guelph
Guelph, ON N1G 2W1, Canada
email: jwarland@uoguelph.ca

Charles E. Weaver
Earth and Atmospheric Sciences
Georgia Institute of Technology
311 Ferst Drive
Atlanta, GA 30332-0340, USA
email: cw5@mail.gatech.edu

W. O. Williamson
College of Earth and Mineral Sciences
University of Pennsylvania
0216 Steidle Building
University Park, PA 16802, USA

Hans F. Winterkorn
(no address)

C. Wesley Wood
Department of Agronomy and Soils
234 Funchess Hall, Auburn University
Auburn, AL 36849-5412, USA
email: woodcha@auburn.edu

Eiju Yatsu
91 Iwase
Matsudo-shi 271-0076, Japan

Iain M. Young
Scottish Informatics, Mathematics, Biology, and Statistics
(SIMBIOS) Centre, University of Abertay
Bell Street
Dundee, DD1 1HG, UK
email: I.Young@abertay.ac.uk

R. J. Zasoski
Soils and Biochemistry Program
University of California
One Shields Avenue
Davis, CA 95616-8627, USA
email: rjzasoski@ucdavis.edu

Lucian W. Zelazny
Department of Crop and Soil Environmental Sciences
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0404, USA
email: zelazny@vt.edu

Preface

"It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us."

Charles Darwin[1]

Darwin's tangled bank is the biosphere in poetic microcosm, and the "damp earth" he refers to is soil. Soil is arguably the most complex of all geological materials, a combination of mineral and organic constituents in solid, aqueous and gaseous forms, organized into a loose, porous, horizonated, plant-bearing material, that is constantly changing. It forms as a result of a complex series of interactions and feedbacks between lithosphere, hydrosphere, atmosphere and, biosphere. As the natural geological cover of most of the land surface of the earth, it is the focus of this encyclopedia.

Alfred North Whitehead[2] once wrote that the European philosophical tradition "consists of a series of footnotes to Plato". It might similarly be said that human history is little more than a footnote to the exploitation of soil that started with the Agricultural, or Neolithic, Revolution, 10 000 years ago. All the magnificent cultural artifacts of civilization, from cathedrals to efficient plumbing systems, are the direct heritage of this exploitation, and the big question today concerns what humanity must do to sustain the heritage. At the most fundamental level this is equivalent to asking what we must do to sustain our food-production system.

By way of answer, consider Felipe Fernández-Armesto's[3] definition of civilization: "a relationship to the natural environment, recrafted by the civilizing impulse, to meet human demands". To sustain the food-production system, we need to avoid making our demands so great, and our recrafting so extreme, that the biosphere in which we are embedded breaks down as a life-support system. Unfortunately, agriculture, the very technology we depend upon to maintain our complex societies, is strategically situated to threaten the biosphere at a vulnerable bottleneck, the soil. Soil occupies a kind of choke point through which virtually all of the fluxes of energy and matter that keep the terrestrial biosphere functioning, are squeezed between different compartments of the landscape, and for about ten millennia we have been commandeering an ever growing area of the soil for human use.

Our ecological footprint has expanded to modify, more or less completely, about a third of the earth's soils, while threatening a second third. Most of the expansion has happened since the steam locomotive opened up the grassland biomes of the western hemisphere to the markets and bellies of the Old World. Cheap energy from fossil fuel made the expansion possible, driving the human population, the ultimate crop of the soil from the point of view of *Homo sapiens*, to an exuberant burst of exponential growth. The pressure of our numbers requires that the soil provide us with ever more food, fibre and energy, as well as living space. As a consequence we have become a potent geological force, unique to the Holocene, and our activities in manipulating the soil, constitute a massive intervention into the external geological cycle. All the natural tendencies for soil to erode, to acidify, to salinize, or to become hydromorphic, depending on factors such as climate, texture and drainage, have been magnified and exaggerated at certain times and in certain places, into pathological states. Now we are a threat not only to terrestrial biomes, but also to the ecology of freshwater biomes, and even the sea as sediment loaded with agrichemicals contributes to hypoxia along coastal regions.

The fact that we have not yet invented an agricultural system that is truly sustainable means that we cannot say with any certainty that our civilization is sustainable. Disasters such as the dustbowl in the Midwestern USA, and extensive salinization in the region of the Aral Sea, have seen systems fail within two or three generations, and even where agriculture has persisted for five thousand years or more, Egypt and Northern China being the prime examples, it has been because of fortunate geological circumstances rather than human ingenuity. Hence the

[1]Darwin, Charles. 1859. On the Origin of Species by means of Natural Selection, or the Preservation of favoured races in the struggle for life. London: John Murray. 502 p.

[2]Whitehead, A. N. 1929. Process and reality, an essay in cosmology. Gifford lectures delivered in the University of Edinburgh during the session 1927–1928. Cambridge University Press, 1929. 509 p.

[3]Fernández-Armesto, Felipe. 2001. Civilizations: culture, ambition, and the transformation of nature. New York: Free Press. 545 p.

pessimism of Angus Martin[4], who, writing as an ecologist, asks: "How many millennia of deforestation, dust storms and soil erosion has it taken for us to realize that our agricultural methodology has had serious flaws in it from the start?"

Yet, history shows that we have the intelligence, imagination and courage to tackle large issues such as the problem of sustainability, and compilations such as this encyclopedia are proof that our knowledge of soils, incomplete and provisional as all science is, has grown comprehensive enough to solve the technical problems involved. If we could figure out how to solve the socio-political ones, humanity might yet achieve a sustainable civilization. Without doubt it will demand a monumental effort of cooperation on a global scale. Bill Rees[5], inventor of the concept of the ecological footprint, puts it this way: "Sustainability is the greatest collective exercise the human race will ever have to undertake".

The objective of this second edition of the Encyclopedia of Soil Science is, in a single volume, to provide an entry point into the study of that part of the solid earth that is absolutely necessary, not only to the sustainability of civilization, but more fundamentally to the sustainability of a flourishing biosphere. The basic facts, concepts and uses of the soil are presented alphabetically in the volume, which combines features of both encyclopedia and glossary. The longer articles characteristic of the former are combined with shorter, dictionary-style definitions of frequently used terms, commonly found in the latter. The intended readership is the scientist, engineer, technologist, environmentalist and planner, with an interest in soils and a concern for planet Earth. The Soil Science volume, In combination with other volumes in Springer's Encyclopedia of Earth Sciences[6], this volume on Soil Science, contributes to a comprehensive and rigorous view of the environment in which we live.

The original Encyclopedia of Soil Science was compiled by Rhodes W. Fairbridge and Charles W. Finkl, Jnr., and first published as long ago as 1979. This second edition builds on their work, and I was fortunate enough to be able to call upon those two very experienced editors for advice.

I am sorry that Rhodes did not live to see this volume in print.

Ward Chesworth

[4]Martin, Angus. 1975. The Last Generation: the End of Survival. Glasgow: Fontana. 188 p.

[5]Rees, William E. 2007. Human eco-footprints: straying off the sustainability trail. The Kenneth R. Farrell Distinguished Public Policy Lectureship, delivered at the University of Guelph, May 16, 2007.

[6]In particular the volumes covering Environmental Science, Geomorphology, Geochemistry, Sedimentology, Field Geology, Applied Geology, Hydrology and Water Resources, Remote Sensing, World Climatology, and Coastal Science.