Commission on the History, Philosophy and Sociology of Soil Science
International Union of Soil Sciences
and
Council on the History, Philosophy and Sociology of Soil Science
Soil Science Society of America

March 2007 Number 14

Newsletter

New Officers

New officers took over for Commission 4.5 – History, Philosophy, and Sociology of Soil Science at the 2006 World Congress of Soil Science in Philadelphia, Pennsylvania, USA. The new Chair is Ed Landa and the new Vice-Chair is Christian Feller. We expect a second Vice-Chair to be appointed soon, probably from Australia as that is the site of the next World Congress. Some background on our new officers:

Edward R. Landa holds an M.S. and Ph.D. in soil science from the University of Minnesota, and has been the U.S. Geological Survey since 1978. His research has focused on radionuclide and metal mobility in soil and aquatic environments, and has included studies of uranium mill tailings, radium processing residues, oil field brines, and indoor radon. He participated in the IAEA International Chernobyl Project, and in studies of radioactive contamination in the Arctic regions. His recent research deals with the bioavailability of metals in areas impacted by vehicular traffic and coal mining.

Ed's interest in the history of science spans from the late 1970's, with an early emphasis on the history of the radium processing industry—a spin-off of his research on present-day soil contamination at these sites. This historical research resulted in a paper in *Scientific American* (1982) and a monograph published by the Colorado School of Mines (1987). His more recent historical interest has been on the history of soil science. He has co-authored papers on the contributions of soil physicists Lyman Briggs and Edgar Buckingham, and color scientist Albert Munsell. Ed served as the Chair of the SSSA Committee on the History, Philosophy and Sociology of Soil Science in 2004.

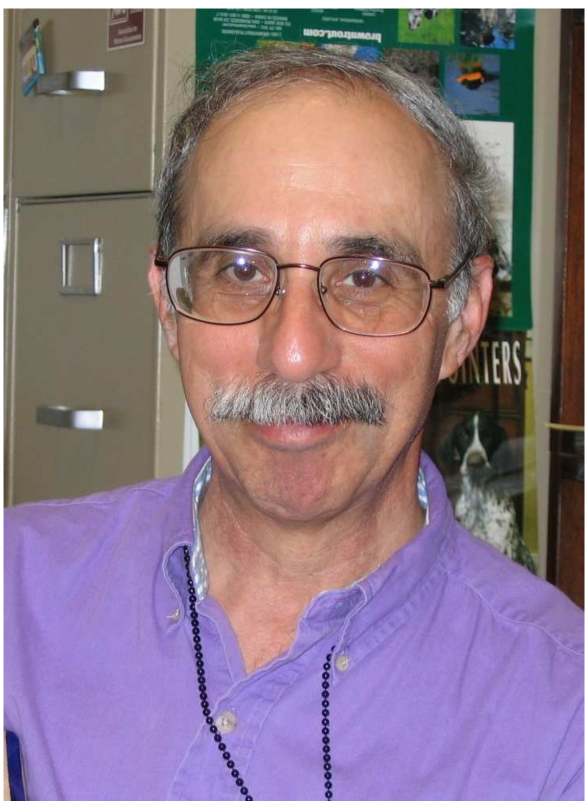
Contents

Submissions always welcomed

Christian Feller is Director of Research (Exceptional Class) and a Soil Scientist at the "Institut de Recherche pour le Développement (IRD)". He also serves as IRD Representative for Madagascar. Dr Feller earned his M.S. and (first) PhD degrees in organic chemistry from the Sorbonne University (Faculty of Sciences) in Paris and his "Thèse d'Etat" (the highest degree in France) in Soil Science from the Louis Pasteur University in Strasbourg (France).

Dr Feller's program focuses mainly on soil organic matter studies (SOM properties, dynamics and functions) applied to soil fertility and environmental services. Recently he was largely involved in impact of agroecological practices on soil-plant carbon sequestration for tropical and subtropical areas, and especially for no-till systems. He also has a strong interest in the history of soil science and has published articles and book chapters on the subject. He serves as vice-chair (2006-2010) of Commission 4.5 "History, Philosophy and Sociology in Soil Science" of the International Union of Soil Science.

Dr Feller has authored or co-authored more than 150 research publications and edited or co-edited 4 books. He served as a scientific editor for the French Soil Science Review ("Etude et Gestion des Sols") and has co-edited books and recently for the Advances in Soil Science collection. He is active in the American and French soil science societies and is a Member of the "Académie d'Agriculture de France" (French Academy of Agriculture).



Edward Landa, new Commission 4.5 Chair

Christian Feller, new Commission 4.5 Vice-Chair

As the major focus of their IUSS roles, Christian and Ed are presently finalizing a list of contributors (soil scientists, artists, historians, philosophers) for a volume (working title: "Soil & Culture") dealing with the many ways in which humans view and interact with soils.

Editorship of the newsletter has also changed hands. Eric Brevik has taken over primary editorship. Eric is an Associate Professor of Geosciences at Valdosta State University in Valdosta, Georgia, USA. Eric has research interests in carbon sequestration by soil and surficial sediments, the use of electromagnetic induction in soils research, and anthropogenic impacts on the soil resource. He served as Vice Chair of the SSSA Committee on the History, Philosophy and Sociology of Soil Science in 2005, as Chair in 2006, and has served as an editorial assistant for the IUSS / SSSA History, Philosophy and Sociology of Soil Science newsletter for the past two years. Historically, he has researched and published on the soil science contributions of George N. Coffey and Edward E. Free.

Thanks to our Departing Officers

We would like to take this opportunity to extend a hearty thanks to our departing officers. Benno Warkentin, Dan Yaalon, and Hans van Baren have served as the Chair, First Vice-Chair, and Second Vice-Chair and Editor of the Newsletter respectively over the past four years. As a group they have set a high standard for future officers to meet. Many thanks to all three of you for all that you have done to promote the history, philosophy, and sociology of soil science!

Editor's Note

This particular issue of the newsletter is focused on the World Congress of Soil Science, held in Philadelphia, USA, July 2006. It includes summaries from history, philosophy, and sociology of soil science related symposia along with lists of papers and authors and selected abstracts. The news items and articles are also WCSS related, for example, the CD of US historical publications was first offered at the WCSS and the historical articles contained here are based on talks given at the WCSS.

Because of the length of this newsletter, a second newsletter will be coming out this summer with additional articles plus coverage of the history, philosophy, and sociology of soil science happenings at the 2006 Soil Science Society of America meeting. Any and all submissions for this second newsletter of 2007 are welcomed. These may include short articles, book reviews, and news items. Please send such materials to Eric Brevik at ecbrevik@valdosta.edu.

Soil History Website

Eric Brevik is now maintaining a history of soil science website, it can be accessed at http://chiron.valdosta.edu/ecbrevik/HistoryMainPage.htm. Items of interest on the website include upcoming meetings, a link to achieved versions of this newsletter, links to associated committees and organizations, and links to research aids for those working on soil history projects. The research aid links include soil science history abstracts presented at recent meetings (2004 and after), the archive of soil science at the University of Missouri, the core historical literature of agriculture at Cornell University, a bibliography of soil science history works, and others. Comments on the website, including suggestions for additions and improvements, are always welcomed and can be sent to Eric Brevik at ecbrevik@valdosta.edu.

CDs with Historical USA Publications now Available

Submitted by William R. Effland, Ph.D., Soil Scientist, USDA/NRCS

The 2-volume CD set "A Digital Collection of Selected Historical Publications on Soil Survey and Soil Classification in the United States of America" comprises a selection of scanned maps, photographs, unpublished reports and government publications that provide some historical perspective on soil survey activities and the development of soil classification in the United States. The objectives of the project were (1) to preserve and increase access to historical soil maps and "grey literature", and (2) to encourage research, study and use of historical documents for soil science and soil survey. The scanned documents cover various topics such as tropical soils; the history of the National Cooperative Soil Survey; historical development and theory of soil classification; field excursions organized for 1st and 7th International Congresses of Soil Science; soil survey investigations; and *Soil Taxonomy*. The series of historical soil maps, 1909-1998, illustrates several conceptual changes in soil geography and soil classification at the national and regional (province-based) scales.

Project contributors were William R. Effland, Douglas Helms, Hari Eswaran, Paul Reich, Sharon Waltman and Amy Yeh. Initially, Douglas Helms suggested scanning several historical documents for distribution at the 18th World Congress of Soil Science in Philadelphia, PA, USA during July 9 to 15, 2006. Several years prior in conjunction with a university soil geography class, Sharon Waltman provided the original version of Marbut's 1931 soil map which helped catalyze scanning additional national scale soil maps. Amy Yeh meticulously scanned most of the reports including the 5-volume bibliography of soils of the tropics by A.C. Orvedal.

The project was a preliminary effort to distribute selected historical maps and documents. Some scanned documents may have minor errors in spelling, etc. due to the limitations associated with optical character recognition (OCR) technology and various page formats which were difficult to scan correctly. Interested persons with questions about the scanned files or requests for the CDs can email the project leader at william.effland@wdc.usda.gov. The "Publication Sources" lists the references for each report, map or photograph. The list is organized by "folder" name and specific references are located within each folder.

Citation

Effland, W.R., D. Helms, H. Eswaran, P. Reich, S. Waltman and A. Yeh. 2006. "A Digital Collection of Selected Historical Publications on Soil Survey and Soil Classification in the United States of America", Soil Survey Division, USDA Natural Resources Conservation Service, Washington, DC. 2 CD volumes

The CDs contain the following references:

CD 1 Contents

Bibliography of Tropical Soils folder

Orvedal, A.C. 1975. Bibliography of Soils of the Tropics. Vol. I. Tropics in General and Africa. Tech. Ser. Bull. No. 17, U.S. Agency for International Development (USAID). Tech.Assist. Bur., Office of Agriculture, Washington, DC. 255 pp.

Orvedal, A.C. 1977. Bibliography of Soils of the Tropics. Vol. II. Tropics in General

and South America. Tech. Ser. Bull. No. 17, U.S. AID, Tech. Assist. Bur., Office of Agriculture, Washington, DC. 242 pp.

Orvedal, A.C. 1978. Bibliography of Soils of the Tropics. Vol. III. Tropics in General and Middle America, West Indies. Tech. Ser. Bull. No. 17, U.S. AID, Tech. Assist. Bur., Office of Agriculture, Washington, DC. 178 pp.

Orvedal, A.C. 1980. Bibliography of Soils of the Tropics. Vol. IV. Tropics in General and Islands of Pacific and Indian Oceans. Tech. Ser. Bull. No. 17, U.S. AID, Tech. Assist. Bur., Office of Agriculture, Washington, DC. 155 pp.

Orvedal, A.C. 1983. Bibliography of Soils of the Tropics. Vol. V. Tropics in General and Tropical-Mainland Asia, Pakistan, Nepal and Bhutan. Tech. Ser. Bull. No. 17, U.S. AID, Tech. Assist. Bur., Office of Agriculture, Washington, DC. 325 pp.

Charles E Kellogg folder

Kellogg, C.E. 1940. Reading for Soil Scientists, Together with a Library. Jour. Amer. Soc. Agron. 32(11):867-876.

Kellogg, C.E. 1961. Soil Interpretation in the Soil Survey. United States Department of Agriculture, Soil Conservation Service. Issued April 1961, 27 pp.

Kellogg, C.E. 1962. Useful Items for a Long Journey of Soil Exploration. United States Department of Agriculture, Soil Conservation Service. Revised, May 1962, 4 pp.

David R Gardner folder

Gardner, D. R. 1957. The National Cooperative Soil Survey of the United States. Doctoral Thesis, Graduate School of Public Administration, Harvard University, 270 pp.

Marbut Transcontinental Excursion folder

Marbut, C.F. 1927. The Transcontinental Excursion Under the Auspices of the American Soil Survey Association (Descriptions, Discussions and Interpretations of Soils and Soil Relationships along the Route of the Excursion). Unpublished manuscript. First International Congress of Soil Science, Washington, DC.

Marlin G Cline folder

Cline, M.G. 1979. Soil classification in the United States. Agronomy Mimeo No. 79-12, Cornell University Department of Agronomy, Ithaca NY. 207 pp.

Photographs folder

Source: Unknown
Photograph of 1927 Field Excursion with the 1st International Congress of Soil Science.

Source: Transactions of the 7th International Congress of Soil Science, Madison, WI, USA, 1960
Photograph of 1960 Field Trip in Wisconsin with the 7th International Congress of Soil Science
Photograph of 1960 Field Trip in California with the 7th International Congress of Soil Science
Photograph of 1960 Field Trip in Iowa with the 7th International Congress of Soil Science
Symbol and Motto of 7th International Congress of Soil Science, 1960

Posters folder

Effland, W.R., H. Eswaran, D. Helms and P. Reich. 2005. A Chronological History of Science for Soil Survey in the United States of America: 1899 to 2006. Poster Session: Recent Developments in the National Cooperative Soil Survey. Agron. Abstr. http://www.acsmeetings.org/2005/ Verified on June 8, 2006.

Roy W Simonson folder

Simonson, R.W. 1986, 1987. Historical aspects of soil survey and soil classification.
I. 1899-1910. Soil Survey Horizons. Spring 1986. v. 27 (1): 3-11;
II. 1911-1920. Soil Survey Horizons. Summer 1986. v. 27 (2): 3-9;
III. 1921-1930. Soil Survey Horizons. Fall 1986. v. 27 (3): 3-10;
IV. 1931-1940. Soil Survey Horizons. Winter 1986. v. 27 (4): 3-10.
V. 1941-1950. Soil Survey Horizons. Spring 1987. v. 28 (1): 1-8;
VI. 1951-1960. Soil Survey Horizons. Summer 1987. v. 28 (2): 39-46.
VII. 1961-1970. Soil Survey Horizons. Fall 1987. v. 28 (3): 77-84.

Scanned Maps folder

1909 United States Soil Provinces *United States Soil Provinces* [map]. 1:7,500,000 (approximate). IN: Whitney, M. 1909. Soils of the United States. U.S. Department of Agriculture, Bureau of Soils Bulletin 55 (Plate I). Washington, D.C.

1911 Preliminary Soil Map of the U.S. (G.N. Coffey) Coffey, G.N. *Preliminary Soil Map of the U.S.* [map]. 1:5,000,000. IN: Coffey, G.N. 1912. A Study of the Soils of the United States. U.S. Department of Agriculture, Bureau of Soils Bulletin 85. Washington, D.C.

1913 US soil map (Figure 4) *United States soil map* [map]. Scale not given. IN: Marbut, C.F., H.H. Bennett, J.E. Lapham, and M.H. Lapham. 1913. Soils of the United States. U.S. Department of Agriculture, Bureau of Soils Bulletin 96 (Figure 4). Washington, D.C.

1913 Soil Provinces and Soil Regions of the United States (Plate II) *Soil Provinces and Soil Regions of the United States* [map]. 1:7,000,000. IN: Marbut, C.F., H.H. Bennett, J.E. Lapham, and M.H. Lapham. 1913. Soils of the United States. U.S. Department of Agriculture, Bureau of Soils Bulletin 96 (Plate II). Washington, D.C.

1931 Marbut soils map. *Distribution of the Great Soil Groups (Soil Provinces)* [map]. 1:8,000,000. IN: Marbut, C.F. 1931. Distribution of the Great Soil Groups (Soil Provinces). Atlas of American Agriculture (Soils, Plate 2), USDA Bureau of Chemistry and Soils, Washington, DC.

1938 Soil Associations of the United States *Soil Associations of the United States* [map]. 1:7,500,000 (approximate). IN: Baldwin, M., C.E. Kellogg, and J. Thorp. 1938. "Soil Classification," *Soils and Men: Yearbook of Agriculture 1938*, p. 979-1001, U.S. Government Printing Office, Washington, D.C.

1973 General Soil Map. *General Soil Map* [map]. Scale not given. IN: Soil Survey Staff, USDA/SCS. 1975. Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys. U.S. Dept. of Agric. Handbook 436. U.S. Govt. Print. Off. Washington, DC. 754 pp.

1987 Principal Kinds of Soils. *Principal Kinds of Soils: Orders, Suborders and Great Groups* [map]. 1987. 1:7,500,000. Original compilation in 1967 by the U.S. Department of Agriculture, Soil Conservation Service. National Cooperative Soil Survey Classification of 1967, Reviewed 1985. IN:

National Atlas of the United States of America. Department of Interior, U.S. Geological Survey, Reston VA
22092.

STATSGO folder

Soil Survey Staff. 1998. *Dominant Soil Orders and Suborders – Soil Taxonomy 1998, United States of America* [map and poster]. 1:7,500,000. Maps and photographs, USDA Natural Resources Conservation Service. National Soil Survey Center, Lincoln, NE, NSSC 5502-0898-
01

CD 2 Contents
Soil Survey Investigations Reports folder

Gile, L.H., R.J. Ahrens, and S.P. Anderson (eds). 2003. Supplement to the Desert Soil Project Monograph – Soils and Landscapes of a Desert Region Astride the Rio Grande Valley Near Las Cruces, New Mexico. Vol. III, USDA/NRCS National Soil Survey Center, Lincoln, NE. 393
pp.

Ruhe, R.V., R. Daniels and J. Cady. 1967. Landscape evolution and soil formation in southwestern Iowa. USDA/SCS Tech. Bull. 1349. 258 pp.

Soil Taxonomy folder

Soil Survey Staff. 1960. Soil classification: a comprehensive system. 7th Approximation. USDA Soil Conservation Service, Washington, DC.

Interested persons with questions about the scanned files may contact the project leader at william.effland@wdc.usda.gov.

World Congress of Soil Science Symposia

Thoughts on the Philosophy and Sociology of Soil Science from Papers Presented to WCSS-18

by Benno Warkentin

The 18th World Congress of Soil Science in Philadelphia, July 2006, was the opportunity to learn what soil scientists and others interested in soils are doing, and also to meet the people doing it. Almost half of the papers were submitted from outside the USA, so this was an international sample. While there were papers on soil history, of more interest to me was what the papers said about the philosophy of soil science, about what people think and do.

I do not intend this as a summary of the papers; the diversity was too great. Rather, I will discuss the highlights that were important to me. The tremendous diversity was a characteristic of the Congress that I believe was a strength, one that distinguished it from research meetings.

The papers were organized into some 120 different symposia. The symposia topics had been chosen by members of the 20 commissions of the International Union of Soil Sciences (IUSS); authors were requested to indicate the symposium or symposia in which their papers could best be accommodated. During the final organization, papers had to be shifted from crowded symposia to those with fewer submissions. A few papers, from four to a dozen, were chosen for presentation in oral sessions, the remainder as posters.

It was the number of these poster papers that indicated soil scientists' interests. Often the paper titles did not reflect the content expected from the symposia titles. I base this statement on titles; I did not read all of the abstracts. Titles with multiple ideas, the subtitles often based on words taken from "popular" concerns, were common. (Funding agencies must be appeased.) But I concluded that the symposium titles and ideas chosen by leaders in their fields, the commission members, were not a good fit with what scientists were doing. Some symposia attracted as few as a dozen papers, others attracted nearly 100. The papers ending up in the "less popular" symposia were not always on the topic of that symposium. The "popular" or more correctly the topics of current interest were: fertilization, phosphorus, organic matter, and soil/plant/water relationships. These papers indicate that the focus of soils research is on crop production. Recent environment based topics such as landscapes and global perspectives on soils were less represented. This may be a lag in changing research emphasis, but likely it reflects the still pressing needs for food production in many parts of the world. An international congress would be expected to reflect this.

The submissions to symposia on topics such as future needs in soil science, or on concepts such as sustainability and global priorities were few and came dominantly from groups outside of the traditional "soil science" groups. I define "traditional" as the groups carrying that name, e.g. departments at universities or at research institutions. I accept this as a positive feature, but I sense a feeling among some of my colleagues that we "own" soil science and these others will not do it as well as we can. Do we own "soil science"? In a recent article in the Journal of Soil and Water Conservation, Philippe Baveye[1] has used the example of "Martian soils," asking whether we lose an opportunity for new research by concluding that the material on the Mars surface is not a soil in our definitions.

In my younger days of reviewing research papers for soil science journals, I was sent a paper on a topic that I considered outside of soil science. I returned it to the editor without review but with the comment "this is not soil science." The reply came back from the wise editor in the next mail—"Soil science is that which soil scientists do. Review it." I have remembered this.

Commission 4.5 (History, Philosophy and Sociology of Soil Science) of the IUSS sponsored two sessions on "History of Soil Science in Developing Countries," an oral session with five papers and a poster session with 16 papers. Some papers on history and on philosophy of soil science were also scattered in symposia on other topics. I consider this encouraging—soil history should be an integral component of soils topics.

The papers on soil science in developing countries discuss background pieces of a topic that has not yet been documented in detail. The several colonizing nations had different structures for adding soils knowledge and for managing soils. How did soil science change in the transition to independence? What influence did the new social structures have on soils teaching, research and community outreach? How did this differ from countries without a colonial tradition? What lessons did this teach us? A fertile topic for research on soil history.

The richness and diversity of soil science was reflected in the papers presented on work, work that soil scientists are presently doing. An interesting example was the symposium on "Terra Preta," the Amazonian dark earths. This symposium

[1] Baveye, P. 2006. A Future for Soil Science. J. Soil and Water Conservation, 61(5):148A-151A.

was a tribute to Wim Sombroek, a friend to many soil scientists and servant to ISSS (now the IUSS). What began with investigations by Sombroek and others of a curious and unusual natural phenomenon (small areas of apparently anthrogenic, fertile, black soil in the Amazon region) rescued an old indigenous practice of using charcoal to improve soil quality.

The promise of the WCSS title "Frontiers of Soil Science – Technology and the Information Age" was not fulfilled by being a major component of the diverse papers presented at the Congress. The symposium titles had indicated that the program planners from the Commissions were leading the way to the new frontiers for soil science. Communication of soils information for different audiences was discussed in several papers. Policy makers were often identified as an audience that needed to be reached. The modeling of soil processes was a minor aspect. Attention was paid to the technology of teaching soil science, especially at the university level. This very important function appears to be more advanced in talking than in doing.

The IUSS leadership is actively pursuing the issue of communicating soils information to a range of audiences. Three examples were presented to the Congress. These examples of initiatives of the IUSS bode well for the future of soil science. They show that the soils leadership is meeting the problems we see.

The IUSS is participating actively in global initiatives such as the International Year of Planet Earth in 2008 under the leadership of the International Union of Geological Sciences. A series of 12 brochures has been produced on the scientific themes. The one on soil "Soil – Earth's Living Skin" was written by David Dent, Alfred Hartemink, and John Kimble. See www.yearofplanetearth.org for details on the program and on the brochures.

The American Geological Institute (AGI) has been active in communicating information on the earth sciences (including soil science) to the large audience of non-specialists. The brochure "Soils, Society, and the Environment," written by six soil scientists, was published by the AGI in cooperation with the Soil Science Society of America, the Natural Resources Conservation Service (USDA), and the U.S. Geological Survey.

Alfred Harteminck[2] has gathered and edited papers from 55 soil scientists on the topic "The Future of Soil Science." This small volume should have a large influence in defining our role and our future activities.

Now on to Brisbane, Australia in August 2010.

History of Soil Science in Developing Countries

A historical highlight of the WCSS was a session on the history of soil science in developing countries. This session offered a unique opportunity to address soil science history outside of the United States, Europe, or Russia, the places where most soil science history work has been done.

The session was organized by Dan Yaalon, Anthony Young, and Eric Brevik. The organizers were extremely pleased with the quality and geographical distribution of the papers that were submitted.

This newsletter will reprint the abstracts from the oral session and those from the

[2] Harteminck, A. 2006. The Future of Soil Science. IUSS, Wageningen, The Netherlands.

poster session that are directly related to the history of soil science in developing countries. Some additional history, philosophy, and sociology of soil science posters were included in the poster session, just the titles and authors of those presentations will be given.

Presentations in the History of Soil Science in Developing Countries Symposium:

38: 4.5A History of Soil Science in Developing Countries – Oral
Presiding: Eric Brevik
Convenors: Daniel Yaalon, Anthony Young

Soil Survey in Developing Countries, with Special Reference to British Overseas Territories.

Anthony Young, Univ of East Anglia, University Plain, Norwich, NR4 6SH, United Kingdom

Tropical soil science was founded on soil survey. Identification and mapping of the main soil types of a country was the first step towards evaluation of their land use potential, leading to agricultural development. With the major exceptions of India and Ceylon (Sri Lanka), most early soil survey was conducted by expatriate staff from the colonial powers. The leading players were Dutch, French, Belgian and British scientists. The Dutch in the East Indies (Indonesia) produced the first tropical soil map in 1901, for part of Sumatra. French studies in West and Central Africa were conducted by ORSTOM (founded, as ORSC, 1943), with Georges Aubert a leading figure. Belgian contributions were the founding in 1953 of the Inter-African Pedological Service of the CCTA in Yangambi, Belgian Congo (Congo), a project of which was the first Soil Map of Africa (1964) by J. L. d'Hoore. There was a US survey of Puerto Rico in 1942, and collaboration of American scientists with South America and with China. Further links were between the former USSR and developing countries of Central Asia. Soil survey in the former British colonies falls into three eras: pioneers, the age of reconnaissance surveys, and post-independence studies by local staff. The pioneers, who began surveys between 1920 and 1932, were Frederick Hardy in the West Indies, Arthur Hornby in Nyasaland (Malawi), Frederick Martin in Sierra Leone, Geoffrey Milne in East Africa, the ecologist Colin Trapnell in Northern Rhodesia (Zambia), and Cecil Charter initially in the West Indies but most notably in the Gold Coast (Ghana). These are giants on whose shoulders their successors stand. The era of reconnaissance surveys was 1950-1970. Incentives were the post-war focus on development, the UK Colonial Development and Welfare Act (1945) and Colonial Pool of Soil Surveyors (1954). Rapid survey became possible through availability of air photographs, and application of a geographical or ecological approach. Space restricts mention to only a few countries. The most complete national coverage was of Uganda, carried out largely 1958-60. Two of the three provinces of Nyasaland (Malawi) were surveyed (by the writer) 1958-62. From 1951 onwards there were surveys of large parts of the Gold Coast (Ghana) and Nigeria. Immense surveys, by grids of pits, were conducted for irrigation schemes in Sudan. The UK Land Resources Development Centre surveyed not only soils but also forest and pasture resources, extending resource surveys to land evaluation and, in a few cases, economic analysis of development options. Work in the West Indies was based on a single Regional Research Centre, which produced 26 ‘Green Book' surveys. National cross-fertilization came through New Zealand cooperation (1964-67) with Malaya (Malaysia) and Pacific island territories, and Dutch aid to the Soil Survey of Kenya from the 1970s. By 1970 most countries had sufficient information to supply national soil maps, of varying reliability, to FAO-Unesco Soil Map of the World (1970-80). Small-scale maps were a starting point for national planning, and importantly, identification of soil types for subsequent more detailed surveys. The third era follows political independence and the replacement of expatriates by local professional staff. India is an exception in that staffing has always been largely local, with S. P. Raychaudhuri a leading figure; an All-India Soil Survey Scheme, a truly ambitious project, was started in 1956. Most countries retain a soil survey unit with staff of high quality, although their activities are often constrained by a low operating budget. Efforts are focused on local surveys for specific development purposes. Among early staff of local origin were Henry Obeng and Victor Adu in Ghana, and Harry Obihara in Nigeria. For priority, however, none can compete with Mohammed el A'al, appointed in Sudan in 1929, and A. W. R. Joachim, Ceylon (Sri Lanka) 1930. Presentation will focus on the era of reconnaissance surveys. Discussion is invited particularly on the aims and achievements of this period, and whether the results are of lasting value at the present day.

The Importance of Colonial Research in the Development of French Pedology.

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At the end of the 19th century, French soil science was dominated by agricultural chemistry. The notion of soil profile was poorly developed and soils were often described as a succession of topsoil and subsoil or active and inert soil (Gasparin, 1843 to 1860). An astounding description of soils, profiles, and the symbolization of pedogenetic processes were given by the Danish forester P.E. Muller in his "Natural forms of Humus", which is an analysis of podzolization (1879, 1884). With this book, Müller can be considered as one of the most important forerunners of Pedology and can be seen as a cofounder together with Dokuchaev (Feller et al., 2005). Though this book was translated in French in 1889, its new conception of soil remained quite unnoticed in France at this period. In the years 1870-80, there were two approaches of soil science: "agricultural chemistry" for the study of soil properties and "agricultural geology" for soil survey. On this basis, the most important and systematic soil survey developed by French institutions was that of Madagascar in 1900. The French government decided to collect 500 soil samples in the "red island" to be analyzed in Paris by the famous chemist Müntz and his colleague Rousseaux (Müntz & Rousseaux, 1900). The history of this work was described in detail by Sourdat (1996). Authors applied to tropical soils an evaluation of fertility based on their own temperate references and thus predicted that some Malagasy soils, which are now considered as the most fertile ones, were very poor and quite sterile and could never be cultivated! In another French colony, the Martinique island, a farmer named Octave Hayot wrote a book in 1881 on Martinique agriculture, which has remained completely unknown until recently (Blanchart & Feller, in preparation). In this book: (i) he compared the weathering processes and products (soils) of a basalt in France and in tropical conditions (Martinique), (ii) he noted that it was impossible to apply the French reference scale (that of Gasparin) in terms of soil fertility to tropical soils. It can be considered that these two works in Madagascar and in Martinique are not only precursors of French tropical Pedology but also contributed to the emergence of French Pedology in general. The first French treatise on Pedology is based on tropical examples. In 1926, a young geologist, Henri Erhart, defended his thesis on “The influence of the geological origin and external factors on the formation and the agricultural value of lateritic soils in the East of Madagascar”. This thesis was followed by the first French treatise on Pedology (Erhart, 1935) based on tropical examples. One year later, (Agafonoff 1936b) published a book on Tunisian soils (another French colony) with a pedological map. At the end of the 2nd World War, the French government decided to create a scientific institute for the developing of the colonial empire. That was the birth (1943) of the ORSC “Office de la Recherche Scientifique Coloniale” renamed ORSTOM “Office de la Recherche Scientifique et Technique d'Outre-Mer” some years later (1960) and named IRD “Institut de Recherche pour le Développement” since 1998. During the 2nd World War, Georges Aubert (1941) had already published a book on the “ Sols d'Outre-Mer” (Overseas Soils) and was contracted to propose a very large project for the development of Pedology research in the French colonies. He built up a vast program based on an astounding 3 page paper published four years before (quoted by Boulaine, 1980-81). In that paper, he described carefully the research project (soil formation, soil distribution and soil surveys), the training project (of metropolitan and colonial scientists) and the “building” project (the necessity to develop overseas centres specialized in Pedology). ORSTOM's Pedology developed very rapidly from the years 1950 to 1970. Specific training activities for overseas locations stopped in 1981 and were integrated into French Universities, but over 30 years ORSTOM had trained more than 100 French pedologists and more than 150 foreign pedologists (35 countries), mainly from the developing countries. During half a century, ORSTOM was probably the most important institution in the world for the emergence and development of Pedology in developing countries.

Soils of the Indo-Gangetic Plains, India : Their Historical Perspective and Management.

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The Indo-Gangetic Alluvial Plains (IGP) are among the most extensive fluvial plains of the world and cover several states in the northern, central and eastern parts of India. The agriculturists of ancient India (2500 BC to 600 AD) were quite conscious of the nature of soils and its relation to the production of specific crops. However, the scientific interest of the Indian soils began when the Geological Survey of India started studying the soils in 1846 and then the soils of the IGP were recognized as one of four major soils of the country. In the past, the IGP are thought to consist of older and younger alluvia of Pleistocene age. Recent soil geomorphic studies suggest the presence of more than two soils/surfaces younger than 13,500 BP. The IGP witnessed climatic fluctuations, especially after the last glaciation. A cold, arid to semi-arid climate prevailed during the early Holocene to about 7,390 BP in the central and western parts of the IGP. Later, a warm and humid climate set in, followed by drier conditions that continued until the present. Neotectonic movements in response to the northern push of the Indian Plate also played a significant role in the evolution of geomophology and soils of the Gangetic Plains. By creating microhigh and microlow sites, it has been ultimately responsible for the formation of more and less sodic soils in the semi-arid part of the IGP. During the early Holocene to 7,390 BP and also during the latter warmer and wetter periods, weathering of minerals, illuviation of clay, decalcification and little addition of organic matter have been the major pedogenic processes. Clay illuviation in soils of the IGP has not always resulted in clay skins or, where present, in pure void argillans. Impure clay pedofeatures appear to be typical in these soils of the Plains. Clay mineral assemblages of the soils indicate the pedogenic development of smectite-kaolin mineral which can be considered as a potential indicator of paleoclimatic change during the Holocene from arid to humid climates. Development of soils in the IGP indicates that climatic fluctuations are more important and soils older than 2,500 BP are relict paleosols but they are polygenetic because they were again altered during the period of subsequent climate change. Polygenesis of soils of the IGP appears to be a common phenomenon and each pedogenic event needs more attention to record the different climates under which they took place. The soils under arid and semi-arid climates are impoverished in organic carbon and phosphorus but rich in potassium. The adverse arid climatic conditions induce the formation of pedogenic $CaCO_3$ and as a result, sodicity develops in the subsoils. At present the formation of $CaCO_3$ is proceeding at a very fast rate. Even during the early to middle part of the 19th Century, much of the land in the IGP was under cultivation with traditional mixed cropping. Over the last three to four decades the production of foodgrains, chiefly of rice and wheat, increased tremendously by introducing high input technologies. However, this has ended with the degradation of many natural resources that has implications on the sustainability of soils for rice-wheat cropping systems. Soil Organic Carbon (SOC) sequestration has been reported to be a boon whereas Soil Inorganic Carbon (SIC) sequestration a bane for farming. High SIC in semi-arid climates, however, does not pose a significant problem to soil productivity. In fact, adoption of appropriate management techniques has increased the SOC stock of the IGP soils cutting across dry and humid tracts. This has been realized after comparing soil survey data over two time periods representing relatively low and high management programmes. Recent C-modeling indicates that perhaps the IGP soils have reached a quasi-equilibrium in terms of SOC over a period of 30-40 yrs of Green Revolution. In view of the extensive area of the IGP, a new initiative in registering pedogenic thresholds during polygenesis and their interaction in a landscape are essential to manage the agricultural productivity with time.

History and Development of Soil Science in Mexico.

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Soil knowledge in the pre-Colombian era was a noticeable attribute of indigenous people in Mexico. A Mayan soil classification for the Yucatan peninsula has been used by local people. The Aztecs and Toltecs in the Central Valleys classified soils by land use and textures. Some names still persist today. In spite of this, the "modern" era of soil science in Mexico started in 1926 when the Mexican National Commission of Irrigation (NCI) brought American soil scientists to train the first agronomists on soil surveys required for the implementation of irrigation of lands. In 1929, the first Mexican scientific meeting, known as "The First Agrological College", was held in Meoqui, Chihuahua. This meeting is considered as the first formal activity in the field of soil science in Mexico. The Rockefeller Foundation played an important role in the development of soil science in Mexico. In 1943, a collaborative agreement was signed between the Mexican Department of Agriculture and the Rockefeller Foundation. As a result, the use of fertilizers for crop production was implemented and soil fertility as an area of study developed significantly in the country. One of the most significant impacts of the Rockefeller Foundation on the development of soil science in Mexico was through an academic exchange, in which Mexican technicians obtained graduate-level degrees in the USA and later returned to Mexico to conduct research programs. In 1946, the NCI was restructured and transformed into a federal-level department named the Secretary of Water Resources (SRH). As a consequence, reduction of experienced soil surveyors occurred during the period of 1947-1966. In 1968, the Commission for Studies of the National Territory (CETENAL) was created under a collaborative project with FAO, a soil map of Mexico was completed during the 70s. This information was included in the FAO soil world map. Soil maps created by CETENAL and its successor, the National Institute of Statistics, Geography and Informatics (INEGI), have used the FAO/UNESCO soil classification system. A new version of the FAO Soil Classification System was generated in 1988, which affected the soil maps generated by INEGI. However, the maps have not been and possibly will not be updated, giving a chance to the negative idea that the maps are not really useful. One of the major problems in the development of soil science in Mexico has been the lack of communication between the farmers and scientists. To alleviate this problem, some researchers have suggested that the ethnopedological knowledge should be incorporated into soil maps, since, in many cases, a map generated from ethnopedological knowledge is more precise and accurate than similar technical maps for management purposes.

Historic Interactions between the U.S. and Chinese Soil Scientists on Modern Soil Science Development in China.

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Although China has had thousands of years of experience in crop production and has accumulated a wealth of indigenous knowledge on soil management and fertilization practices for restoring and maintaining soil productivity, the development of modern soil science in China has always been international in nature. From the early twentieth century, students from China have studied soil science abroad and many soil scientists from all over the world have worked on projects in China. Perhaps some of the most noteworthy interactions have involved the U. S. and Chinese scientists. This presentation will review several such interactions and the life history and professional activities of a number of prominent soil scientists involved in these interactions and their subsequent influence on the development of soil science in China today. Mr. T. Y. Tang was likely the first Chinese soil scientist trained in the U. S., when he studied with Professor Emil Truog of the Soil Science Department at the University of Wisconsin, Madison from 1910 to 1914. Mr. N. F. Zhang also studied with Prof. Truog years later in 1931 and then returned to Nanjing to initiate the first nation-wide fertilization program in China. Perhaps the most notable collaboration between the U.S. and Chinese scientists was the national soil survey program conducted in China in the 1930s. In 1930, Dr. Charles F. Shaw, a soils professor from the University of California - Berkley, published his remarkable book entitled “The Soils of China” during his sabbatical leave at the Nanjing University in China. During 1931-1932, the national soil survey team was organized under the Geological Survey Institute of the National Commission for Natural Resources Survey in Beijing by Dr. W. H. Wong. Dr. R. L. Pendleton, a graduate of the University of California and then professor at the University of Philippines, was invited to China to supervise the national soil program. In 1933, Dr. James Thorp of the USDA Bureau of Chemistry and Soils was sent by Curtis F. Marbut to China to replace Pendleton in supervising the national soil survey program. Although Marbut died in China during his instructional visit in 1935, his soil classification approach laid the foundation for soil classification in China by Chinese soil scientists for the next two decades. The collaborative effort of Dr. Thorp and his eight assistants, including K. C. Hou, T. Y. Cschau, L. C. Li, Y. Hseung, E. F. Chen, L. T. Chu, C. K. Li, and Y. T. Ma resulted in the massive publication by Thorp entitled: “The Geography of the Soils of China” (1936). These Chinese soil scientists as well as a number of others who were educated at U.S. universities in the 1930s and 1940s were prominent in providing leadership in establishing soil science research institutions and shaping the modern development of soil science in China. Interactions with the U.S. were interrupted from 1950 to the end of the 1970's, but interactions between soil scientists on mainland China and the former Soviet Union increased. The rapid growth in soil science research and education from 1979 onward, however, has been influenced by the increasing interactions of Chinese scientists not only with scientists in the U.S., but also with those in Russia and other European countries. Today, the tradition of international collaboration in soil science between Chinese soil scientists and those from all over the world continues to flourish.

173: 4.5A History of Soil Science in Developing Countries - Poster

Presiding: Eric Brevik
Convenors: Daniel Yaalon, Anthony Young

Landmarks of History of Soil Science in Sri Lanka.

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Sri Lanka is a tropical Island in the Indian ocean at 790 39' to 810 53' E and 50 54' to 90 52' N consisting of a land area of 65,525 km2 with a population of 19 million. The country was under colonial rule from 1505 to 1948. The majority of the people in the past and present earn their living from activities based on land which indicates the important of the soil resource. The objective of this paper is to explore the landmarks of the history of Soil Science, specially the soil survey and mapping work, to highlight the achievements and failures, which is useful to enrich our present understanding of Sri Lankan soils.

The landmarks or the phases of the history can be divided to four phases, namely, the early analytical period which is prior to 1925, the genetic, soil profile and reconnaissance phase from 1930 to 1950, the Canada-Ceylon aerial resource survey phase from 1955 to 1960 and the modern era of Soil Survey and Classification since 1960. During the early period detailed analytical studies of coffee and tea soils were compiled, and these gave mainly information on up-country soils of the island and fertilizer recommendations for these two crops based on field trials. In addition rice and forest soils were also studied in less detail. During 1930 to 1950, the second period, soils of Sri Lanka were studied based on the genetic concepts of Russian workers as reflected in the soil profile. During this time many soil surveys of areas proposed for development under irrigation schemes were commenced. Based on these data and using the geological and meteorological maps, the first genetic classification of Sri Lanka soils and a provisional map showing distribution of 16 major soil series were published. During the third period of 1955-1960, valuable information on the land resource was collected by aerial resource surveys from a Canada-Ceylon Colombo plan aid project. This covered 18 major river basins and about 1/4th of the island, which resulted in producing an excellent soil map and information of the area called the Kelani Aruvi report... The modern era, since 1960 to present showed the highest period of development in Soil Science in Sri Lanka. In 1972, the updated soil map of Sri Lanka consisting of Great Soil Groups and Soil Taxonomic equivalents according to United States Department of Agriculture was published with the Handbook of Soils of Sri Lanka (Ceylon) by the Soil Science Society of Sri Lanka. Excellent work was also conducted by the Department of Agriculture and Irrigation, various research institutes such as Tea, Rubber, Coconut and Sugarcane Research Institute and the Universities. These included investigations on soil fertility, physical & chemical properties, nature of organic matter, macro and micro nutrient status, mineralogy and their distribution and classification. The Coconut Research Institute studied the coconut growing soil in detail and mapped them according to yield potential.

A major leap forward in Soil Survey, Classification and development of a soil data base was initiated in 1995 with the commencement of the "SRICANSOL" project which was a twining project between the Soil Science Societies of Sri Lanka and Canada. Phase I and II of this project is now completed with detail soil maps at a scale of 1:250,000 and 1:40,000 for the Wet and Intermediate Zones of Sri Lanka, respectively. The database consists of soil profile data and physical and chemical properties of a benchmark site for each series identified. The soils are classified according to current systems such as Soil Taxonomy and the FAO classification. The mapping and development of the database for the dry zone of Sri Lanka will be completed soon. These databases will be useful in land use planning, where environmental sustainable agriculture could be practiced in these soils.

This account of landmarks of the history of Soil Science in Sri Lanka shows the developments during the last century. The emphasis should now change in using the soil information to address the major environmental problems in the country which are soil erosion and pollution of ground water by agricultural activity. This will lead to better development of agri-environmental health in the country in the future.

The main moments in the development of soil classification in Romania.

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The beginning of soil classification in Romania goes back to the first decade of XXth century and is owed to G. M. Murgoci (1872-1925), an eminent scholar, geologist and soil scientist, the founder of modern soil science in this country. Historically three moments mark the long-way of Romanian soil classification development. - The genetico-geographical moment (1911), when the soils were classified (by Murgoci) on the basis of the genetico-geographical principle conceived by the Russian School of Dokuchaev and his disciples. This principle holds that the genetical properties of soils are strongly related on the geographical environment and the basic unit of every classification should be the genetical soil type named accordingly. The legend of the first Soil Map of Romania (1911), made using this principle, may be considered also, as the first Romanian scientific soil classification. It comprises 16 units (soil types and soil associations), mostly named according to Russian nomenclature: chestnut soil, chernozem, podzol, but also preserves most of the Romanian one, e.g. reddish brown soil, lacovishte (humic gley soil), plaur (floating organic soil). The genetico-geographical approach dominated soil classification in Romania until the 7th decade of XXth century. Meanwhile several attempts at soil classification had been made: Chirita -1955 issued a classification based on biological factors, Florea (1964) reunited the soil types in soil classes (zonal and intrazonal), Cernescu & Florea (1962) worked out a systematic soil list with the aim to be used in soil survey. - Morphogenetic moment (1969) – this approach was conceived to replace the genetico-geographical classification which proved to generate much confusion. This new system used as classification criteria the genetic (morphogenetic) soil characteristics – mainly genetic soil horizons. It was developed only at higher level categories – class, subclass, genetical soil type and genetical soil subtype. The morphogenetic system was a short-live one. The soil surveys were further carried out in the basis of systematic soil list (1962). - Morfodiagnostic (quantitative or morphometric) moment,– This classification approach has been introduced in Romania as the consequence of the strong impact of the newly emerged world-wide systems of soil classification, mainly the USDA Soil Taxonomy and the FAO-UNESCO Legend of the World Soil Map. The first attempt was the Soil Classification System (1973) that used the principle of diagnostic horizons promoted by the USDA 7th Approximation and the FAO-UNESCO Legend. The taxa were defined in terms of diagnostic soil horizons and soil horizons sequence. The second attempt (1980) was marked by publication of the "Romanian System of the Soil Classification" (RSSC), that like the previous one is based on diagnostic horizons, properties and attributes as used in the USDA Soil Taxonomy (1975) and the FAO-UNESCO Legend (1974). This system was used for more than 20 years, until 2004 when it was replaced by the "Romanian System of Soil Taxonomy" (RSST). This is the latest version of soil classification in Romania. It is alligned mostly to the World Soil Reference Base as concerns nomenclature, diagnostic horizons, properties and diagnostic materials. Like all other previous Romanian soil classifications, RSST has a pyramidal-hierarchical structure: class (12), genetical soil type (32), genetical soil subtype (270). In order to enforce its practical side, priority at lower levels has been given to soil species (texture) instead of soil family (nature of soil parent material) as in RSSC.

Discovering Soils in the Tropics: Charter's Interim System of Tropical Soil Classification.

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Early soil surveyors in the tropics encountered unique environmental conditions. Soil survey was challenging in areas of dense tropical vegetation since it was difficult to directly observe the landscape without clearing survey lines. Continuous observation of soil boundaries in thick vegetation areas is not practical using conventional soil survey techniques. Research and applications of soil morphology, genesis and classification were important for soil mapping, and land use and management in the tropics.

The soil survey of Ghana (formerly Gold Coast) originated in 1946 to investigate relationships among soils and various crop diseases such as swollen shoot associated with cocoa production. Previously located in the Eastern Region of Ghana, the Soil Research Institute (SRI) was a unit of the former West African Cocoa Research Institute. The SRI is currently located in the Ashanti Region. From 1951 to 1956, Cecil Frederick Charter (1905-1956), a British geographer, directed the SRI with assistance from Hugh Brammer and others. Charter had previously worked on tropical soil survey in Trinidad; British Honduras; Antigua and Barbuda, Leeward Islands; and Tanganyika. Ghana was subdivided into 37 soil survey regions primarily based on major river drainage basins and mapped using the detailed reconnaissance method (1:250,000). Over three hundred and sixty (360) different soil series were established and their suitability for crop and livestock production documented in a series of technical reports and memoirs accompanied by analog (i.e. hard-copy) maps. Three soil survey methods included (1) preliminary; (2) reconnaissance; and (3) detailed procedures. Local environmental conditions influenced field data collection methods among the coastal plains, forested plateau, Voltaian basin and interior savanna physiographic regions. On agricultural research fields and selected individual farms, detailed soil surveys (1:10,000) were conducted and published in more than 200 technical and miscellaneous reports. Soil associations were delineated using survey lines oriented approximately at right angles to drainage lines. Soil associations were organized into (1) consociations; (2) simple soil associations; (3) compound associations; and (4) complex associations.

The soil series concepts and soil landscape relationships developed by Charter and his staff utilized the soil genetic model proposed by Neustrev where soil is a function of climate, vegetation, relief and drainage, parent material and age. Soil series concepts were based on descriptions of multiple pedons (approximately 30) for each soil series. Influenced by Milne's work on catenas, soil-hillslope models were developed to illustrate surface and subsurface distributions of soil series, parent materials and vegetation. Various soil series were identified at sampling points using idealized hillslope diagrams, soil horizonation, Munsell color, field determined "Morgan" pH, and a combination field texture and modified Atterburg ribbon test. Other environmental factors such as landscape position, parent material, and vegetation and climatic zones were considered. Soils formed from "drift" materials over residual parent materials and associated with stonelines were frequently observed in roadcuts and other exposures.

During 1954, Dr. Charles E. Kellogg, Director, USDA/SCS Division of Soil Survey documented his observations of Charter and Brammer from his two week visit to Ghana. Kellogg's African Journals, a historical collection at the USDA National Agricultural Library, describe his field visits and personal meetings with Charter discussing tropical soils and other subjects. Kellogg undoubtedly influenced Charter's concepts of tropical soil classification through his "Preliminary suggestions for the classification and nomenclature of great soil groups in tropical and equatorial regions" presentation in the 1948 First Commonwealth Conference on Tropical and Sub-tropical soils.

At the 1954 5th ICSS in Leopoldville, Charter "staunchly defended the traditional genetical system of soil classification" against proposed "formula types of classification." Charter prepared a brief outline of his proposal for tropical soil classification in a very short amount of time and presented it at a special symposium on soil classification near the end of the Congress. Charter's interim system for tropical soil classification was a hierarchical design with 6 levels: Order, Suborder, Great Soil Group Family, Great Soil Group, Great Soil Subgroup, and Soil Series. Soil series were further subdivided into "soil sub-series" which is nearly equivalent to the various phases of soil series (depth, stoniness, gravel occurrence, etc.). Following the death of Charter in 1956, Brammer published the interim scheme in the Proceedings of the 6th ICSS in Paris. In 1962, Brammer published additional detailed soils information related to agriculture and land use in Ghana.

The comparison of national soil maps through time provides some insights with respect to the development of soil geography and soil classification concepts for a country. In Ghana, national maps with soils information were published as a Geology Map (1947); Great Soil Groups (Provisional; 1958); Great Soil Groups No. 4; C.F. Charter's Preliminary Map of Great Soil Groups (1954); Provisional Map of the Principal Soil Complexes of the Gold Coast; Great Soil Groups (1961); Soil Map of Ghana (1971); and the 1998 Digital Soil Map of Ghana. This presentation will examine the various national maps of Ghana and compare characteristics from the various maps with theoretical developments in the classification of tropical soils in West Africa.

Historical development of soil science in Malaysia.

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Malaysia consists of three regions, Peninsular Malaysia on the southern tip of the Asian mainland and Sabah and Sarawak on the island of Borneo. All three regions were part of the British Commonwealth and Peninsular Malaysia became independent in 1957 while Sabah and Sarawak in 1963 when they joined Malaya to form Malaysia. The development of soil science in Malaysia has mainly been spearheaded by soil surveys and other branches of soil science have mainly played a supporting role. Soil surveys in each of the three regions initially developed separately and to a large extent still remain separate. The development of soil surveys in Malaysia can be divided into three main periods. The pre-independence period from around 1882 to 1955 saw mainly ad hoc soil surveys by British staff of the Department of Agriculture. With the development of the rubber plantation industry, unpublished soil surveys of some rubber plantations were carried out by soil surveyors attached to these plantations. Even at this early period most of the surveyors emphasised the importance of geological parent materials on soils in Malaysia. This period ended with a proposed classification of soils of Peninsular Malaysia by Owen (1951). The second period, which lasted from around 1955 to 1990, saw systematic reconnaissance soil surveys being carried out mainly to locate areas with potential for agricultural development. This period saw soil surveys being carried out by soil scientists from the Commonwealth countries such as Britain, Canada and New Zealand under the Colombo Plan, from the United States under the Peace Corps and some Dutch soil surveyors. This period saw the completion of reconnaissance soil surveys of the whole of Malaysia using different systems of classification for the three regions. Local soil surveyors gradually took over the reconnaissance soil surveys after 1965 and subsequently carried out semi-detailed soil surveys of areas with potential for agricultural development. The third period from 1990 saw the development of a Malaysian Soil Taxonomy by modifying Soil Taxonomy to suit local conditions using Bahasa Malaysia terminology. A major difference was to create an order of Lithosols and modifying significantly the classification of Histosols by using the depth of organic soils at the Great Group level and the stage of decomposition only at the sub-group level. This period also sadly saw the Department of Agriculture declaring that soil survey maps and reports were restricted material and hence not available to other users. This period also saw the private sector increasing greatly their soil survey activity in their plantations. In spite of all these problems soil surveys have greatly contributed towards the agricultural development in Malaysia. The earlier rubber and now oil palm industry developed to what it is today because of the contributions of soil surveys.

The Soil Management Support Services: training the trainers overseas.

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The Soil Management Support Services (SMSS) was a program sponsored by the US Agency for Development (USAID) and implemented by the USDA Soil Conservation Service. It supplemented a Benchmark Soils project with five universities which USAID supported to improve the transfer of agricultural technology to small farmers in developing countries, primarily in the tropics. It was believed that appropriate soil management technology for specific soil families in Soil Taxonomy developed at one location could be transferred to other tropical locations having the same or similar soils. The knowledge gap was consistent soil data and information throughout the tropics. Thus an intensive 10-year program building a large soil data base, proposing and testing changes in Soil Taxonomy, and working with in-country soil scientists began in late 1979 and was formalized in the Soil Survey Division of the Soil Conservation Service in 1980 and later became known as the Soil Management Support Services under the leadership of Hari Eswaran.

SMSS started with soil classification workshops to gain experience and knowledge with Oxisols and Ultisols, then included Vertisols, Andisols, and wet soils in the tropics. A separate effort to build a database was the World Benchmark Soils Project (WBSP) which eventually accumulated data for more than 1000 pedons from 40+ countries. A spin off was laboratory strengthening and interlab correlations done in collaboration with ISRIC, the International Soil Museum facility. The study of soils was facilitated by International Committees (ICOMs) headed by international experts. Over the years there had been tweleve ICOMs dealing with separate soil orders, wetness criteria, soil climate parameters, soil family criteria, and even anthropogenic influences. SMSS supported newsletters, scientific exchanges, and classification and correlation workshops thereby enabling many scientists to be involved. Eventually about 50 countries used Soil Taxonomy, either directly or as a model to refine national classification schemes. The WBSP contains common interpretations for the sampled pedons and serves as a model for improving local information about soil management technology. This data is now available on-line from the USDA Natural Resource Conservation Service (formerly the Soil Conservation Service) for use by competent scientists everywhere.

As more experience was gained the workshops evolved into soil management ones illustrating how soil data was being interpreted and used in providing advice on numerous management options. Workshops in colder regions, in wet areas, and for varied and integrated ecosystems throughout many parts of the world contributed to an expanding network of scientists and interested practicioners. As sustainability concepts and concerns became more urgent, the lessons learned through the multi-faceted SMSS have been extended, in part, by the World Reference Base workshops as IUSS activities being held in additional countries. Important SMSS contributions to the training of trainers have been: standardized sampling and characterization of important soils for agriculture and forestry, uniform databases and interpretations, improved criteria and definitions used in soil classification, field guides, books, brochures, slide sets, CDs, and published papers. But perhaps the enhanced global network of soil science specialists is the legacy of greatest value.

Colonial Soil Science in the Former British West Indies.

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Regular studies in soil science in the British West Indies began with the establishment of the Imperial College of Tropical Agriculture (ICTA) at St. Augustine, Trinidad, in the early 1920's. It was to train agricultural development officers for posts in tropical areas of the British Colonial Service. University graduates in science from British Universities came for a one-year diploma in Tropical Agriculture, the DTA that bound the holders proudly together. The first lecture on opening day in 1923 was on soil science, given by F.H. Hardy, who was appointed the Professor in Soil Science. He had come to the Islands a few years before with a degree in geology, and had sorted out some of the clay minerals at a time when the differences were considered due to different mixtures of amorphous materials with kaolonite. Hardy studied physical properties of soils in coca plantations in Trinidad. He spoke of 'root room', which encompassed many physical constaints to crops. After retirement in the 1940's, he taught for several years at the Inter-American Institute at Turrialba, before returning to St Augustine for final retirement. Some ICTA staff were primarily research scientists studying crop production constraints in the different Islands, British Guiana (present Guyana), and Belize. Colonial specialists in soil conservation came out to deal with problems such as the erosion of the flysch deposits in Barbados. These highly erosive deposits are sediments from the South American land mass deposited in sea water. Coral covers the remainder of Barbados. Several Islands have a volcanic history, both older and recent. Sugar cane breeding and nutrition were organized by the private sugar industry with stations in Barbados and in Jamaica. Geological and land suitability reports were prepared for the Islands. Several Professors of soil science came from Britain to serve for periods of 2 to 4 years. This era ended with creation of The University of the West Indies in the 1950's, with campuses in Trinidad and Jamaica. Agriculture, along with engineering and smaller colleges of science and liberal arts assumed the ICTA facilities. A short-lived Federation of the West Indies was suceeded by sequential independence of the Islands, Barbados was first, and they also established a local college. Barbados, with an excellent school system based on the British public schools, was an early contributor of students to British universties and later to UWI. Strong programs in agricultural research continued at the St, Augustine campus. The first West Indian to become Professor in Soil Science, in the 1950's, was Nazeer Ahmad. He was born in British Guiana, attended the ICTA program, and obtained his Ph.D. from the University of Nottingham. He taught at UWI, and after retirement served as agricultural adviser to the government of Guyana. The careers of these two professors in soil science, Fred Hardy and Nazeer Ahmad, will be profiled as examples of the colonial, and post-colonial with the influence of the colonial era.

Soil Survey in Puerto Rico: A Brief History.

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Soil surveys of Puerto Rico have been published in three iterations, 1902, 1942 and 1965-2003. The first survey is of particular importance in the history of Puerto Rico and in plans for the tropical territories. At the conclusion of the Spanish-American War, the United States acquired Puerto Rico in the Treaty of Paris, December 10, 1898. The Foraker Act of April 2, 1900, established a civilian government. By mid-1900, Congress had funded an U. S. Department of

Agriculture investigation, which was issued in December 1900, as the Congressional document "Agricultural Resources and Capabilities of Porto Rico," by Seaman A. Knapp. Knapp recommended among other things a federally-funded agricultural experiment station. Congress had already established federally operated stations in Alaska (1899) and Hawaii (1900), and would later establish stations in Guam (1908) and the Virgin Islands (1918). Congress appropriated money for a station which was operated temporarily the first year, 1901 at Rio Piedras, and then moved permanently to Mayaguez. Frank G. Gardner, the first director, transferred to that position from the Bureau of Soils, where he had participated in the bureau's first surveys conducted in 1899. The Bureau of Soils and the federal experiment station undertook a survey, which was led by Clarence W. Dorsey, one of Gardner's colleagues at the Bureau of Soils, and published in 1902.

The soil survey covered an area in west-central Puerto Rico composed of two 8 km- (5 miles-) wide strips on each side of the military road (now highway PR 10) from Arecibo on the north coast to Ponce on the south coast. The survey area was approximately 885 km2 (330 square miles; 85,500 ha, 211,200 acres), which is about ten percent of Puerto Rico's land area. The location of the transect was an excellent choice. It represented most of the island's diverse physiographic regions and agroecological zones: Holocene and Quaternary swamps and alluvial deposits along the north coast; a karst region developed in Tertiary limestone; the dissected humid uplands of the Cordillera Central composed of Cretaceous volcanic and plutonic rocks; the southern subhumid limestone belt; and the floodplains and lagoons on the semiarid south coast.

Dorsey and his colleagues differentiated 16 "soil types" such as Arecibo sand and Ponce loam, and two land units (coral sand, riverwash). Organic matter and particle size distribution were determined for one or more pedons of each of the 16 soil types. No profile descriptions were provided, but the salient morphological features were mentioned. Reflecting the partial sponsorship of the survey, a comparatively large section of the narrative for each soil type was focused on agricultural considerations. The authors noted a pattern they had observed in the United States, namely, that the farmers, through empirical observations, had discovered the soils best suited to their crops. The authors also expressed some humility in admitting that understanding soil-plant relationship was not yet sophisticated enough to utilize soil surveys to predict the value of new agricultural enterprises. But they urged the experiment station and Bureau of Soils to collaborate further.

In 1928, the Division of Soil Survey (USDA) and the University of Puerto Rico Agricultural Experiment Station initiated a detailed and comprehensive survey of the soils of Puerto Rico. Ray C. Roberts was in charge of the survey party, which over the duration of the fieldwork consisted of 25 soil scientists, prominently including James Thorp. This survey, published in 1942, benefited from developments and refinements in soil science and soil surveying. It especially benefited from work in other tropical countries and territories, including Hugh H. Bennett's and R. V. Allison's work in Cuba.

During 1965-2003, Standard Order 2 soil surveys at a scale of 1:20,000 for all of Puerto Rico were published in the following area reports: Lajas Valley Area, Mayaguez, Humacao, San Juan, Ponce, Arecibo, and the

Caribbean National Forest. The first two of these reports, Lajas and Mayaguez, were unique in being published in both English and Spanish text. All of the surveys except the Lajas Valley Area, first published in 1965, used Soil Taxonomy. That survey is now being updated. Further updates are planned for the rest of the Island. In a departure from recent practice, the new updates will be based on Major Land Resource Areas rather than the political boundaries.

Soil science publications – History and current trends.
Alfred Hartemink

Pedophilosophy (Pedosophy) – a new field of philosophy of science.
Ioan M. Munteanu

Soil Science and Philately.
Hans-Peter Blume

What has soil science learnt from an early volcanic landscape study in south-east Australia?.
Jonathan E. Holland

Historical evolution of the scientific method and its application to soil science.
Pierfrancesco Nardi, Fabio Tittarelli, Paolo Sequi

New opportunities of chemical amelioration of sodic-saline soils in the Ararat Plain in Armenia.
H. S. Hovhannisyan, Gagik Karamyan

The Benguet State University Soil Science Research Information Compendium.
Tessie Miga Merestela

Hugh Hammond Bennett's Journey: Soil Scientist to Soil Conservationist.
Douglas Helms, Natural Resources Conservation Service

Amazonian Dark Earth Symposium and Associated Bio-Char Workshop

At the 18th World Congress of Soil Science (WCSS) in Philadelphia this July a symposium and workshop were devoted to discussions of Amazonian Dark Earths and their implications for contemporary management of bio-char. Specifically, on 13 July a symposium organized by Antoinette Winklerprins and William I. Woods entitled "Amazonian Dark Earth Soils (*Terra Preta* and *Terra Mulata*: A Tribute to Wim Sombroek" featured five speakers and over two dozen posters. The next day an all-day workshop organized by Johannes Lehmann and Danny Day entitled "Bio-char as a Soil Amendment – Research Priorities and Challenges" was held.

Both of these meetings were directly related to the work of the late Wim Sombroek (ISRIC, Wageningen, The Netherlands) who was instrumental in bringing the significance of these anthropogenic soils to the attention of the scientific world over four decades ago. Wim in his monumental 1966 *Soils of the Amazon* (Centre for Agricultural Publication and Documentation, Wageningen) not only provided the baseline for the soils of this enormously significant region, but also brought the *terra preta* (black earth) and *terra mulata* (brown earth) soils to the attention of the outside world. These soils, Amazonian Dark Earths (ADE) as they are now known, have highly elevated organic carbon and nutrient contents relative to surrounding Oxisol and Ultisols. Seemingly out of place in a region with weathering rates 100 times those of the mid-latitudes these soils were created by pre-Columbian Indians and largely abandoned after Europeans contact and consequent massive depopulation. Their significance to questions of sustainability in the Amazon and other lowland tropical regions and possible important role they might play in global climate mitigation have driven the substantially increased pace of recent research efforts.

During the last years of his life Wim's efforts were devoted toward organizing an international, multidisciplinary group of researchers to systematically examine these soils with the ultimate goal being the replication of ancient techniques of soil enhancement to form "*Terra Preta Nova*" or new black earth, this time within a time span of decades rather than centuries. The focus of this research is to develop and provide applications for environmental-friendly management of agricultural landscapes based on sound understanding of the biogeochemical processes. Sombroek, who passed away in 2003, made such fundamental contributions to the study of these distinctive anthrosols that Wim is now widely referred to as "The Godfather of *Terra Preta*."

The papers and discussion from the WCSS symposium and related workshop formed the basis for a feature article that appeared in *Nature* (Harris, Emma. 2006. Black is the New Green. *Nature* 442:624-626). More recently, Springer has agreed to publish an edited volume related to the topics entitled: *Terra Preta Nova*: A Tribute to Wim Sombroek." This volume will be edited by William I. Woods, Wenceslau Teixeira, Johannes Lehmann, Christoph Steiner, and Antoinette WinklerPrins and is the third in a series related to Amazonian Dark Earths and Bio-char.

Submitted by William Woods

Presentations at the Amazonian Dark Earth Symposium:

72: 1.6B Amazonian Dark Earth Soils (Terra Preta and Terra Preta Nova): A Tribute to Wim Sombroek – Oral

Presiding: Antoinette Winklerprins
Convenor: William I. Woods

Bio-char Black Carbon) Stability and Stabilization in Soil.
Johannes Lehmann, Saran Sohi

Compositions of the Humic Acids in Amazonian Anthropogenic Dark Earth Soils.
Etelvino H. Novotny, Michael H. Hayes, Eduardo R. De Azevedo, Beata E. Madari, Tony J. F. Cunha, Tito J. Bonagamba

The Rescue of an Old Indigenous Practice in the Tropics - Using Charcoal to Improve Soil Quality.
Wenceslau G. Teixeira, Gilvan C. Martins, Murilo R. Arruda, Christoph Steiner

Microbial Activity as Soil Quality Indicator in Annual and Perennial Plantations Treated with Charcoal, Mineral- or Organic Fertilizer in a Highly Weathered Amazonian Upland Soil.
Christoph Steiner, Wolfgang Zech, Wenceslau G. Teixeira

New Dark Earth Experiment in the Tailândia City - Pará-Brazil: the Dream of Wim Sombroek.
Dirse C. Kern, José L. Cometti, Maria de Lourdes P. Ruivo, Francisco J. Frazão, Tarcisio E. Rodrigues, Marcondes L. Costa, Jorge L. Piccinin, João B. Rocha

133: 1.6B Amazonian Dark Earth Soils (Terra Preta and Terra Preta Nova): A Tribute to Wim Sombroek – Poster

Presiding: Antoinette Winklerprins
Convenor: William I. Woods

Macromolecular Speciation of Organic Matter in Black C rich Anthrosols: Insight from 13C CP-MAS NMR and Synchrotron Based C (1s) NEXAFS and FTIR-ATR Spectroscopy.
Dawit Solomon, Johannes Lehmann, Janice Thies, Biqing Liang, James Kinyangi, Flavio Luizão, Jan Skjemstad,

Anthrosol Diversity in Brazil: Terras Pretas, Terra Mulatas and Sambaquis.
Carlos E.G.R. Schaefer, Guilherme R. Correa

Formation of Dark Earth Soils in Western Amazonia, Iquitos, Peru.
Andrew Zimmerman, Augusto Oyuela-Caycedo

Humus Composition Analysis by the NAGOYA Method for Amazonian Dark Earths of the Middle Amazon, Brazil.
Satoshi Nakamura, Mario Hiraoka, Eiji Matsumoto, Dokkyo Univ, Kenji Tamura, Teruo Higashi

Nutrient Bioavailability of Anthropogenic Dark Earth Soils and Surrounding Soils of Central Amazonian.
Newton Paulo de Souza Falcao, Ana Cristina Souza da Silva, Lillian França Borges, Nicholas B. Comerford

Terra Preta Research: The preSombroek and Sombroek Periods.
William I. Woods, William M. Denevan

Creating *Terra Preta* in Homegardens?: A Preliminary Assessment.
Antoinette Winklerprins

Changes in Soil Phosphorus Fractions and Species in Amazonian Dark Earths (Terra Preta) across a Long Chronosequence.
Shinjiro Sato, Biqing Liang, Dawit Solomon, Johannes Lehmann

Biodiversity in Amazonian Dark Earths Soils.
Maria de Lourdes P. Ruivo, Maria de L. Oliveira, Dirse Kern

Geochemistry of Dark Earth Amazonian.
Jucilene A. Costa, Dirse Kern, Marcondes L. Costa, Tarcisio E. Rodrigues, Nestor Kampf, Johannes Lehmann, Francisco J. L. Frazão

Nutrients' Quantifying and Counting (C E N) of Microbial Population (Fungi and Bacteria) from Soils Enriched by Wood and Slaughter-House Wastes in TailÂNdia County – ParÁ – Brazil.
Maria de L. Oliveira, Maria de Lourdes P. Ruivo, Ivone C. Magalhães, Eliane Ribeiro

Bio-Char Applications to a Tropical Oxisol Increase Crop Yield and Modify Water Relations.
Julie Major, Marco A. Rondon, Johannes Lehmann

Humic Acids of the Amazonian Dark Earth Soils: Terra Preta De Índio.
Tony Jarbas Ferreira Cunha Sr., Beata E. Madari, Ladislau Martin Neto Sr., Luciano P. Canellas Sr., Marcelo Simões Sr., Wilson Tadeu L. da Silva, Débora Milori, Lucedino P. Ribeiro Sr., Lúcia Helena C. Anjos Sr., Gabriel de A. Santos Sr.

Soils with Archaeological Dark Earth in Caxiuanã (Eastern Amazon): Pedologic Structuring, Mineralogy, Chemical Composition, Fertility and Influence of the Crop.
Marciléia S. Carmo, Marcondes L. Costa, Dirse C. Kern

Long-Term Oxidation of Biomass-Derived Black Carbon and Effects on Soil Fertility and Organic C Cycling.
Biqing Liang, Johannes Lehmann, James Kinyangi, Dawit Solomon, Janice Thies, Flavio Luizão

Isolating Unique Bacteria from Terra Preta Systems: Using Culturing and Molecular Techniques as Tools for Characterizing Microbial Life in Amazonian Dark Earths.
Brendan O'Neill, Julie Grossman, Siu Mui Tsai, Jose Elias Gomes, Carlos Eduardo Garcia, Dawit Solomon, Biqing Liang, Johannes Lehmann, Janice Thies

Soil Microbial Communities Associated with Anthropogenic Dark Earths (Terra Preta) and Black Carbon Particles.
Julie Grossman, Brendan O'Neill, José Elias Gomes, Siu Mui Tsai, Biqing Liang, Johannes Lehmann, Janice Thies

Addition of Vegetable Residues to the Soil: the Experience of TailÂNdia-Pa-Brazil, Subsidies for the Formation of New Black Earth 2.
Monteiro K. F. G. Sr.

Measurement of Total Soil Carbon by NIR Spectroscopy in Land Uses of the Brazilian Amazon.
Sandra M. O. Sa, Carla M. B. Nussio, Didier Brunet, Martial Bernoux, Christian Feller, Norberto C. Noronha, Carlos E.P. Cerri, Carlos C. Cerri

Mineralogy, Chemistry and Origin of Phosphor of Ceramics Found in Dark Earth Soils of the Amazon Region.
Marcondes L. Costa, Marciléia S. Carmo, Dirse C. Kern, Edivan C. Oliveira

Soil Fauna Management in Amazonia: Making use of "Ecological Services" in Agroecosystems.
Christopher Martius, Marcos V.B. Garcia, Wulf Amelung, Hubert Hoefer

Reconstructing Amazonian Dark Earths: Ancient Technology as a Tool for Sustainable Management of Tropical Soils.
Guido Hofwegen van, Thom Kuyper, Joep Broek van den, Gertjan Becx

Articles:

Ancient History of Agriculture and the Plow

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Human society traded an adventurous life of hunting and gathering for a bit of food security by inventing settled agriculture. Farming or agriculture was probably begun 10 to 13 millennia ago in the fertile crescent of the Near East. It is widely recognized among anthropologists and agricultural historians that inventors of plant farming were women, and that of livestock raising were men. It is probable that women started gathering wild fruits, seeds, and roots around their caves and shelters while men were busy hunting. Archaeologists have also suggested that in ancient China, women were the first to invent agriculture. In a hunter-gatherer society, it is usually the men who hunt and women who gather. Therefore, women had a better knowledge of plants. This conclusion is also supported by strong evidence that most ancient cultures worship goddesses such as Ceres, Demeter, Mary, Laxmi, and the Mother Earth as Dherra, Vasundherra etc.

In the Mediterranean region, native cereals that grow naturally included Einkorn, Emmer or wild wheat (*Triticum* *diococcum* and T. *monococcum*), barley (*Hordeum vulgare*) chickea (*Cicer arietinum*) and flax (*Linum usitatissimum*). Prehistoric tillage, the deliberate manipulation of soil to cover the seed and protect it from birds and rodents, may have occurred in flood plains and deltas of rivers (e. g., Nile, Tigris, Euphrates, Indus). Alluvial soils of flood plains and deltas are light enough (less cohesive and free of stones and gravels) to be scratched by a forked branch or a digging stick. Prehistoric tillage tools were probably developed on easy to work and light-textured alluvial soils.

Instead of a simple digging stick, for sowing and collecting bulbs and tubers, humans started using a curved root or a forked branch to chip the ground and open a furrow. With experience, the pre-historic agriculturists may have cut one limb short and sharpened it to scratch the soil, another long to form a beam and yet another one to be used as a handle.

A tillage implement called the “ard” was probably developed in the Middle East, around 5000 to 3000 B. C. The “ard”, a primitive plow, is essentially a “hoe” with a long handle so that it can be pulled by humans or animals. There were three principal parts of an ard: the beam, the handle, and the head. The head, the scratching tool, comprised of the foreshare and the mainshare. The triangular head was initially made of wood and later of stone before being replaced by a metal share. There were 2 main types of ards. The Døstrup ard has an oblique share and head and can penetrate deep into a soil. It is named after the Døstrup bog/marsh in Jutland. The Triptolemos ard has a pointed share that produces a narrow v-shaped furrow and pushes the soil on both sides without inversion. It is named after the Greek God and Hero “Triptolemos”.

Pre-vedic Harappan Civilization in the Indus Valley dates back about 5000 years, when row crops sown in a plowed field was a common practice. The Harappan Civilization apparently collapsed about 3500 years ago with the invasion of Aryans from the Caucuses region. Sanskrit scriptures, Vedas, provide some clues to such an invasion. Vedas have references to plowing and agriculture. The oldest, Rigveda (1000 B. C. in written form and oral version for several centuries prior to that) refers to plowing (*Krishantah*) using large wooden plows (*Langgala or Sira*) drawn by 6, 8, 12 or even 24 oxens.

The plow won religious sanctions in many ancient civilizations (e. g., Indian, Chinese, Greeks, Asyrians, and Egyptians). Similar to the Greek God, the Hindu Epic “Ramayana” (400 to 500 B. C.) is also based on the divine birth of the Goddess “Sita” when the King Janak was advised by pundits to till a field with an “ard” made of silver to break a serious drought. The ard share got stuck against an earthen pot buried in the soil, in which was discovered a baby girl named “Sita”. Faithfuls believe that torrential rain fell as soon as the King lifted the baby “Sita” in his arms. The epic Ramayana is still celebrated annually throughout South Asia and as far east as Bali in Indonesia. Ramayana also records suggestions about catchment processes which impact water quality.

The ard was later fitted with a seed funnel and used as a drill. Animal-pulled seed drills were used in Egypt about 2100 B. C., and soon thereafter in the valleys of the Indus and Yangtze Rivers. India and Japan had seed plows in pre-Christian times, but it did not appear on the European continent until the 17th century. The ard eventually evolved into a well known Roman plow, as described by Vergil around 1 AD.

The ard spread to Western Europe during the pre-Christian era. However, the moldboard plow was introduced into Western Europe during the 5th to 10th centuries AD. In England, Jethro Tull (1674-1741) described different tillage implements in the late seventeenth or early eighteenth century. He designed a seed drill that comprised of working parts set in motion when it was pulled by animals. This was the beginning of the mechanization of farm operations. He believed that an objective of plowing was to pulverize the soil grains into small particles so that they could be ingested by plant roots.

Several old plows are displayed at the U. S. National Museum of Plows. The very first moldboard wooden plow in the U. S. was developed around 1740. In the U. S. the cast iron moldboard plow was first designed by Thomas Jefferson in 1784. It was patented by Charles Newbold in 1796 and marketed by John Deere in the 1830s. It was the introduction of the moldboard plow (the Prairie Breaker) that literally conquered the western U.S. The use of steam power for traction in 1910 revolutionized agriculture, which eventually expanded the global cropland area from 250 Mha (620 million acres) in 1700 to 1500 Mha (3700 million acres) by 1980. This, along with other innovations, increased global food production at a rate faster than that of population growth and eventually ushered in the Green Revolution during the 1970s.

Sowing crops in an untilled field originated in the U. S. Corn Belt in response to the severe problem of soil erosion and non-point source pollution. No-till (NT) farming was practiced on about 100 Mha (250 million acres) of cropland worldwide in 2006. Most of the cropland area under NT farming is in the U. S., Brazil, Argentina, Canada, Australia and Paraguay. The resource-poor farmers of Africa and South Asia are still using the traditional ard or hoe developed 5 to 7 millenia ago. An emerging constraint to the spread of NT farming in the U. S. Corn Belt is the removal of corn stover as a feedstock for bioethanol production in developed countries, and as a source of cooking fuel and fodder in developing countries. This strategy amounts to "robbing Peter to pay Paul", and its longterm impact must be carefully assessed. Despite its adverse effects on soil quality, plowing increases crop yields when fertilizers, herbicides and soil amendments are not used, as is the case for small land holders of the tropics and sub-tropics.

Agricultural production increased drastically during the second half of the 21st century. Average grain yield of crops in the U. S. increased between 1900 and 2000 by a factor 6 for corn, 3 for wheat, 2.5 for soybean, 4.5 for rice, and 4.0 for peanuts. The number of people fed by one U. S. farmer increased exponentially from 12 in 1930 to about 100 in 1990. These achievements were made possible by use of the modern plow that could cultivate large areas, growing input-responsive varieties, and making plant nutrients and water available at critical stages of crop growth. While supporters of Malthusian views predicted widespread famines and starvation, especially in densely populated developing countries, soil scientists and agronomists perfected agricultural techniques which ushered in the Green Revolution and saved hundreds of millions from starvation.

Over the millenias, developments in agriculture and growth in human population have been inter-linked. The world population was 0.3 billion (B) in 1 AD, 0.31 B in 1000, 0.40 B in 1250, 1.65 B in 1900, 2.52 B in 1950, 6.06 B in 2000, and 6.5 B in 2006. In 1000 years, from 1000 to 2000, human population increased by 20 times, and doubled many times. However, it will never double again, and will stabilize at about 10 B by the end of the 21st century. It will not double again because of the food security provided by the advances in agriculture made possible through the evolution and modernization of plow and other inventions.

At the time when the world population was 940 million, Thomas Malthus (1798) warned that "population, when unchecked increases in geometric ratio. Subsistence, increases in arithmetic ratio". Malthus could have never imagined that the world population could increase to 6 B by 2000, and stabilize at 10 B by 2100. Neither could he foresee that subsistence could also increase in geometric ratio through revolutionary advances in agriculture.

While the supporters of Malthusian concepts have been proven wrong during the last two centuries, there is no cause for complacency in improving agricultural technologies. The fact remains that even greater challenges lie ahead. The future increase in world population, from 6.5 B in 2006 to 10 B in 2100, will almost entirely occur in developing countries. These are the countries where advances in agriculture have lagged behind, and natural resources are severely degraded and under great stress.

While pre-historic farming began 10 to 13 millenia ago with the invention of a primitive plow in the form of a digging stick or a forked branch to scratch the soil surface, it may reach its climax by elimination of the plow and conversion to NT farming through advances in biotechnology, soil specific management (precision farming) and provisions to supply nutrients and water directly to the roots of GM crops. The most dramatic advances in agriculture are yet to come during the 21st century.

The Transition From Colonial Soil Science in the Former British West Indies

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INTRODUCTION

The Windward and Leeward Islands in the Caribbean passed through the hands of several colonizing countries—Spain, France, Britain, and the Netherlands—often several times during the 18th century. The changes of hands were accomplished through battles at sea (sometimes termed piracy), and political negotiations to solve problems in Europe. As a Canadian, I had been offended on learning that the Island of Barbados was considered more desirable in the negotiating rounds than Canada (referred to as "several acres of snow"). On my first visit to the Caribbean, after a number of years living in "those acres of snow," I saw the point.

Sugar was the dominant crop, for which the high manual labor demand was initially filled by slaves and indentured persons brought from Africa and India. Mechanization came later and was only partially successful.

This note tells the soil science story of those islands and territories in the Caribbean that were under British Colonial administration after the mid-19th century. They were referred to as the British West Indies. In the late 20th century they gained independence as separate countries.

Schooling in the 19th and 20th centuries was based on the British curriculum, with teachers coming mostly from Britain. Before state-supported education, schools were organized by church groups. Education for the 0 to 6 and also the 6 to 12 years was highly valued by the population, including those originally brought as slaves or indentured workers.

The most successful high school graduates went to Britain for their university degrees. In the early 1940s crossing the Atlantic during the World War became more difficult and some students went to Canadian universities. They built a special relationship in agriculture between the West Indies and Canada.

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE (ICTA)

While scientists from European countries had contributed sporadically to natural history studies in the British West Indies, systematic studies related to agriculture began in the colonial period with the planning and opening of ICTA in St. Augustine, Trinidad in 1922.

This one year program leading to a diploma in tropical agriculture (DTA) was designed primarily to train officers for agricultural work in colonial African countries. Later a second program was added at ICTA, more science based, leading to an associate degree. The students, from British universities, were graduates in biology, chemistry or geology. Local students with British degrees were admitted. The instructors came from Britain. A strong camaraderie developed among the DTA holders. They were proud of the degree. Many went from positions as Colonial officers to other positions in Europe, including after PhD study to professorships.

Schools granting diplomas in agriculture had been established near St. Augustine in Trinidad and in Spanish Town, Jamaica, to train students for agricultural positions in the West Indies. These students, largely local, filled positions in aiding agricultural production.

THE REGIONAL RESEARCH CENTRE (RRC)

ICTA concentrated on teaching; research was organized under “Research Schemes.” The 1947 Soils Research Scheme was combined with the Banana and Cocoa Schemes in 1955 to form the Regional Research Centre, housed with ICTA at St. Augustine. A strong cooperative relationship developed between ICTA and RRC, also including the territorial Departments of Agriculture. This grew when the University of the West Indies later took over the ICTA facilities.

The RRC had central laboratory facilities, and carried out field research in the different territories. Soils studies played a large role. Fertilizer response information for various crops was a recognized need. Fertility trials were set out, with the attendant difficulties and costs of managing field experiments hundreds of miles apart, and separated by water (Fig. 1).

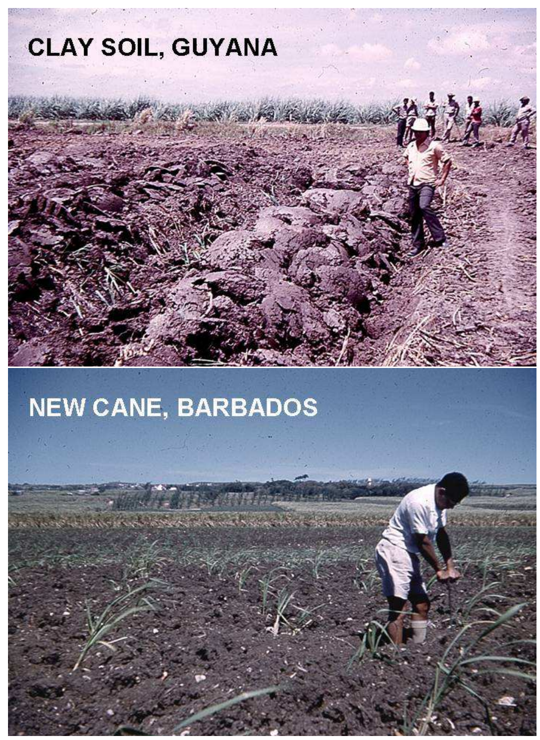

Figure 1.

Sugar was the backbone of agriculture in many territories. The sugar industry privately maintained its own research stations in Barbados and in Jamaica. The RRC did not carry out research on sugar cane. These research units in breeding and in management of cane were staffed by expatriate scientists from Britain. This work was recognized in the international scientific community. Sugar cane production in British Guiana (now Guyana) was dominated by the Booker's Sugar Company, which carried out its own sugar research. Their scientists devised management systems for dealing with acidic and poorly drained clay soils.

SOIL AND LAND USE SURVEYS

Soil surveys of the different territories, with reports published during the 1950s and '60s, concentrated as much on land capability as on soil classification. In steeply hilly areas, the information was often based on landscape analysis.

The Soils Research Scheme (May, 1947) "provides for systematic soil-surveys, together with related researches into the chemistry and physics of the main soil-types, including the investigation of the possible role of trace-elements in West Indies agriculture." The interpretation of the results in terms of land-use and land-capability was added.

Soils information from field soil surveys was published for: Antigua, Barbuda, Barbados, Dominica, Jamaica (in several reports), Grenada, Guiana, Monserrat, St. Kitts and Nevis, St. Lucia, St. Vincent, Trinidad and Tobago. The issue, as in so many places, was getting agriculture to benefit from this information. "The soil map needs to be used."

SOIL EROSION, DEGRADATION, LAND USE

Steep slopes, erosive soils, a climate with heavy rain storms, and pressing land needs of an increasing small-farmer population combined to make erosion and land use planning major issues. Beginning in the 1930s soil conservation officers, often ICTA graduates, were assigned to different territories to provide erosion control information. Showers (2006) describes the situation and the response in her studies of erosion control programs in Africa. The officers in the British Caribbean were "environmental pioneers" working in an often "misunderstood environment" with a populace that did not appreciate the control measures.

Barbados is an example of a local difficult situation. Most of the surface geology is a coral cap, but in the northwest part the coral has been eroded away, exposing the flysch deposits underneath (Figure 2). Water control to prevent erosion of these deposits, with stratified sediments of different grain size, becomes very difficult. Slumping is a problem for housing.

Figure 2.

THE UNIVERSITY OF THE WEST INDIES (UWI)

Colonial influence decreased after the 1960s. The University (UWI) began with two campuses, one in St. Augustine, concentrating on agriculture and engineering programs, and another campus in Mona, Jamaica, with medicine, law and other university studies. This was part of the planning for a West Indies federation, which did not mature. The Federation of the West Indies was short-lived. Barbados opened a local college, other territories followed. With Barbados first, the British West Indies colonial components became independent nations.

Teaching at UWI Trinidad began in 1963. UWI in Trinidad took over the ICTA facilities; research was expanded as the University undertook major agricultural research programs in the different territories. Students in agriculture now took the BSc degrees at UWI. Advanced studies were initially followed overseas, until graduate programs were established at UWI.

The colonial administration left both a system and highly trained soils people in the West Indies countries.

TEACHING, from ICTA to UWI

Fred H. Hardy, with a degree in geology, came from Britain to Antigua in the West Indies in 1921 to study soils. He concluded that the differences he saw in soils were due not to different mixtures of other minerals with kaolinite, but that the swelling soils contained a specific clay mineral. This was before X-rays were used to identify powdered materials.

When ICTA was formed Prof. Hardy moved to Trinidad and gave the first lecture, on soil science, at 8:00 a.m. on opening day in 1922. He continued to study soils, developed soil testing methods, and published a number of papers about soils on different islands. He stressed the importance of physical properties for crop growth, using the concept "root room" in his lectures.

On retirement in 1956 he moved to Costa Rica and taught soils at the Inter-American College of Agriculture in Turriabla. On his second retirement he moved back to St. Augustine, Trinidad. Fred Hardy was a quiet, unassuming man, a dedicated scientist with interest in applying soil knowledge. He had a large role as the first Professor of Soil Science at ICTA.

The position of Professor was then filled by a succession of expatriate soil scientists, often on two or three year appointments, until Dr. Nazeer Ahmad was appointed in 1969. He was born in British Guiana (now Guyana), obtained the associate degree from ICTA and a doctorate in soil science from the University of Nottingham. He then returned to ICTA to teach soils. He had a wide knowledge, both of distribution of soils in the different territories and of their chemistry. His teaching and research, as well as his open manner, was an influence for many students at UWI.

ACKNOWLEDGMENTS

Personal contacts with soil scientists at ICTA, UWI and RRC over a number of years provided me with the background of the organizations and taught me about the soils of the West Indies. I am especially indebted to Professor Emeritus Nazeer Ahmad for arranging much of my learning over many years, beginning with the time of transition from ICTA to UWI.

The UWI students who completed MSc degrees in soil and water studies under my direction at McGill University shared

information on West Indies cultures and on their home Islands.

This short and incomplete summary was presented as a poster to the World Congress of Soil Science, Philadelphia, July 2006.

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Book Review

The Natural History of the Bible
- An Environmental Exploration of the Hebrew Scriptures, by Daniel Hillel:

Traversing river valleys, steppes, deserts, rain-fed forests and farmlands, and seacoasts, the early Israelites experienced all the contrasting ecological domains of the ancient Near East. As they grew from a nomadic clan to become a nation-state in Canaan, they interacted with indigenous societies of the region, absorbed selective elements of their cultures, and intergrated them into a radically new culture of their own. Daniel Hillel reveals the interplay between the culture of the Israelites and the environments within which it evolved. More than just affecting their material existence, the region's ecology influenced their views of creation and the creator, their conception of humanity's role on Earth, their own distinctive identity and destiny, and their ethics.

In The Natural History of the Bible, Hillel shows how the eclectic experiences of the Israelites shaped their perception of the overarching unity governing nature's varied manifestations. Where other societies idolized disparate and capricious forces of nature, the Israelites discerned essential harmony and higher moral purpose.

Inspired by visionary prophets, they looked to a singular, omnipresent, omnipotent force of nature mandating justice and compassion in human affairs. Monotheism was promoted as state policy and centralized in the Temple of Jerusalem. After it was destroyed and the people were exiled, a collection of scrolls distilling the nation's memories and spiritual quest served as the focus of faith in its stead.

A prominent environmental scientist who surveyed Israel's land and water resources and has worked on agricultural development projects throughout the region, Daniel Hillel is a uniquely qualified expert on the natural history of the lands of the Bible. Combining his scientific work with a passionate, life-long study of the Bible, Hillel's writing offers new perspectives on biblical views of the environment and the origin of ethical monotheism as an outgrowth of the Israelites' internalized experiences.

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