International Union of Soil Sciences

**Personal history of Donald R. Nielsen relating to Soil Science and discussed with Ole Wendroth**

Family background and heritage

My Father's father came unescorted to the US as an 8-year old orphan from Denmark to join his two older brothers in the outskirts of Denver, Colorado. After finishing 8th grade and growing up on their local farm that supplied fresh vegetables sold to the community of Denver, my Father served a 4-year enlistment in the U.S. Marine Corps soon after World War I. After his military service, he moved to Phoenix where he worked during the remainder of his life receiving a mediocre salary as a farmer. He made all management decisions to grow three sequential vegetable crops throughout each year on about 1000 total hectares using only 30 inches of irrigation water. Each crop was harvested, ice-packed in crates, and shipped within railroad cars to the eastern states of the US.

My Mother, having parents from England and being born in eastern Colorado, met my Father in Denver while she was working as a telephone operator. After their marriage, they moved to Phoenix where I was born as their only child in 1931.

Early life

During the Great Depression, I spent my early youth living in my parent's 2-bedroom wooden home in the developing town of Phoenix, Arizona located in the arid, dusty region of Maricopa County, across which the dry bed of the Salt River has existed for centuries. I never thought about working for money because my whims for occasional extra enjoyment were always readily available with a few cents from my parents. Without spending a penny, I frequently enjoyed walking through desert regions observing plants and animals living together. As I was picking up archeological artifacts from prehistoric Hohokam Indians, I often saw javelina, burros, coyotes, wolves, turkeys, buzzards as well as smaller creatures such as turtles, lizards, rattlesnakes, horned toads, scorpions, tarantulas and millipedes. I saved arrowheads made of flint, stones shaped and used as tomahawks, various grinding stones and bone awls, pieces of turquoise jewelry, ceramic and adobe figurines, and fragments of decorated pottery.

My first formative experience as a teenager was attending and graduating from Phoenix Union High School – an absolutely unique high school that required every teacher to have an MS or MA degree, and many of them had a PhD. Those having only a BS or BA degree were not allowed to teach any subject. It was enlightening for me or any teenager living anywhere in the entire state to be able to obtain a highly beneficial education at PUHS by choosing any one of 22 entirely different curricula. Students during their freshman year at school were required every day to attend a 1-hour quiet study hall to work on their homework. During each of the next three years, if their grade average for the previous term remained a B or better, no study hall was required. Those not maintaining a B or better had to continue to attend compulsory study halls. Every student registered, selected courses, designed a class schedule, purchased required textbooks in the bookstore, etc. – a process similar to that while attending college.

Having considered all of the 22 options, I selected the Scientific Curriculum containing year-long courses in biology, chemistry and physics - each having five 1-hour lectures and a 3-hour laboratory every week. It also required a 4-year sequence of mathematical courses during each and every term. Hence, even before going to college, I became familiar with calculus, differential equations, imaginary and complex numbers, statistics, determinants, permutations, probability, maxima and minima, infinite series, and even more. To satisfy a second language requirement, I chose Spanish because it was familiar to me living in Phoenix. I chose three electives: 1. General Shop, because I wanted to learn the practicalities of metal work, radio construction, welding, electricity and magnetism, refrigeration systems and automobile mechanics. 2. Mechanical and Architectural Drawing that much later helped me to produce graphs throughout my entire career. And 3. US Junior Reserve Officer Training Corps (JROTC) rather than various physical education courses.

As I proceeded through high school, I had the desire to enjoy more activities without taking money from my parents. My first job involved dusty conditions – digging and sampling soils across farmers' fields to ascertain deficient levels of plant nutrients as well as identifying pests that reduce crop yields. Having tolerated such dusty conditions, I told my Father that I had tentatively decided to use my high school education to study agriculture in college. He gasped and immediately responded, "Do you really wish to follow my footsteps working every day from sunrise to long after it's dark without ever having time or making enough money to relax during weekends or enjoy a vacation? I suggest that you study accounting, economics or some topic to make a more fruitful living helping others. Don't study agriculture and become a farmer like me."

Education

While still in high school, I decided to attend Arizona State College at Tempe to keep my parent's financial support for my education to a minimum. Arizona State was previously known as Tempe Normal School that emphasized curricula for those wishing to become teachers and other programs associated primarily with business-oriented careers related to economics, politics and sociology. But what would I study there? - I was puzzled. For the first time in my life, I sought professional advice. I took a weeklong series of aptitude, IQ, personality and other kinds of tests followed by individual discussions with several counselors at Phoenix Junior College (now known as Phoenix College). They informed me that I could study whatever I decided, but advised me to become an accountant, a finance manager, an auditor, etc. because of my so-called ability with numbers, mathematics and people. Following what they suggested, I entered Arizona State with the idea that being an accountant might make a good career. I took courses that included Accounting, Economics and Business Mathematics. Although my grades in each course were excellent, I "hated every minute" of that first semester, and concluded that I would never again seek professional counseling! Fortunately, my second semester was a stimulating experience because I switched to chemical, biological and physical science courses. They were wonderful! Hence, I was on a desirable path, and at the beginning of the next school year, I transferred to the University of Arizona in Tucson that had more options including a diversity of many other science courses.

Before entering UofA, I worked again during the summer sampling dusty fields to identify insects that needed to be eradicated. Each day I frequently thought about my childhood when I saw various animals in the desert without any obvious source of water. I curiously pondered, "Where did the animals find drinking water in a region that received less rainfall than a cm each month? Drinking water was rarely available because the creek beds remained dry throughout most of the year" Not knowing the answer accelerated my thinking about what I might study in Tucson.

When I arrived at UofA, I talked with Professor Theophil F. Buehrer – the initiator and Head of the major Agricultural Chemistry and Soils in the College of Agriculture. Rather than emphasizing agricultural production as it was and remains today in most majors of Soil and Crop Science and Agronomy within US colleges of agriculture that cater to the constant vigilance of state and national agricultural commodity groups, the entire campus endorsed and supported the Agricultural Chemistry and

Soils major. It led to many different kinds of careers applicable to the different ecological regions of Arizona that are characterized by huge extremes of chemical, physical and biological diversity.

While earning my BS degree under the advice of Dr. Buehrer and working part time in the laboratory of W. T. McGeorge, the only State Chemist of Arizona, I became acquainted with Professor Wallace H. Fuller who had earned a PhD in soil microbiology at Iowa State College and was hired by McGeorge in 1948. Through my conversations with Fuller, I became aware of radioisotopes used as tracers in chemical, physical and biological processes. Before that time whenever I took courses in microbiology I spent a lot of effort looking through a microscope to identify, count and sketch different kinds of microbes in various media. Or, I isolated a culture of only one species from a mixture of other species. Or, I tried to measure the rate at which $CO_2$ evolved from their metabolic processes. But to use isotopes as chemical tracers to better understand the various processes occurring within local microbiological soil environments intrigued me. Having received the Paul Steere Burgess Fellowship during the school year of 1953-54, I earned my MS in soil microbiology under the supervision of Dr. Fuller. I studied soil C/P ratios critical to soil microbial decomposition of plant material using P32 as a tracer to quantify P uptake by different kinds of crops from soils having various amounts of P. The tracer could easily and accurately identify the source of P. Typical microbiologists were not sufficiently versed in mathematics and physics to apply their knowledge to the solution of soil problems in cultivated, irrigated farms. Hence, thanks to Dr. Fuller seeking opportunities for me to further advance my education, I was able to study mathematics, physics and soil physics with Dr. Don Kirkham – the internationally renowned soil physicist at Iowa State University – who provided my financial support for four years until I received my PhD in 1958. During those years, I focused my research on soil hydrology.

## Selecting a career in soil science

Even after receiving three degrees during my formal education at three different universities, I was not able to fully understand what my father knew and did as a farmer to grow irrigated lettuce and carrots on different soils while I was growing up in Phoenix. Nevertheless, upon graduating at Iowa State University and not yet submitting any applications for an academic position, I was offered six different university positions within the US. I responded to the Irrigation Department of the University of California, Davis to teach and conduct research on the irrigation of vegetables grown in California. During my entire 40-year career at UC Davis, I never conducted an irrigation experiment in California on a field of vegetables! Instead, I started studying the intricacies of water and solute movement in soils, conducted many experiments in both the lab and in the field under a variety of local conditions and eventually had countless opportunities to witness first hand the management of water and land resources for crop production in many different regions of the world.

## Major career influences

A completely unexpected event occurred when I met Joanne Joyce Locke shortly before she graduated from West Phoenix High School in 1950. After the next three years, she became a Registered Nurse, I completed my Agricultural Chemistry and Soils degree, and we married each other. During the past 64 years of being married, she – more than any other person - provided the perfect opportunity and incentive for me to achieve a unique career teaching and helping others around the world.

John F. Stone who designed and made the first hand-made neutron meter that successfully measured the water content within a soil profile influenced my choice of a PhD research topic. Using his newly created neutron meter, I repetitively measured the distribution and redistribution of water within five different field soils before, during and after irrigation. It was my first opportunity to study the logic related to the success of my Father raising irrigated vegetables in Arizona and indeed, it was the key that opened the door for my employment into the Irrigation Department of UC Davis.

James W. Biggar was truly a unique scientist. We co-authored more than 100 publications. Although I could write a book about our interactions, the following is a perfect example of his daily influences on me:

> I had been reading, studying and concentrating on a research topic that I was eager to investigate and achieve a specific goal that he and I might publish if everything worked out okay. Sitting down with a few cups of coffee, I proceeded to tell him using pencil and paper all the details about my thoughts. At the end of my presentation, I asked him, "What do you think about it?"
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> Jim replied, "It's a good project, but we're not going to tackle it - it would be a waste of our time."
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> Being surprised, I quickly responded, "But Jim, I think what I have been telling you is logical and that we should start as soon as we can and submit our results for publication."
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> "Yes indeed, Don, your thoughts are logical - so completely logical that several others are probably right now already working on your proposed project and about to finish it. What you and I are going to do is skip that project and answer its succeeding, unresolved issues."

Through Jim's influence, I invariably sought the logic of unexplained observations or measurements.

Goro Uehara and I received our PhD degrees during the same year at different universities. I met him the next year and we continued to meet annually at the US Western Regional Soil Physics Technical Committee W-68. During that first meeting, I presented my research that completely neglected all aspects of electrical charge associated with soil particles. With his influence, after learning that electrical streaming potentials and soil-water flux densities were linked together, I always considered a soil property as the result of an inseparable combination of physical, chemical and microbiological processes. During the 1970's, I witnessed his global scale leadership of agriculture when he initiated Benchmark Soils Projects that were interdisciplinary programs of agrotechnology transfer between many countries involving farmers and their national political leaders. Being motivated by their global achievements, as President of ASA I chose the theme of the 1991 annual meetings of the ASA to be "Global Agronomic Opportunities".

Klaus Reichardt - my first Brazilian graduate student - explored spatial and temporal scaling of water infiltrating into soil columns in the laboratory using gamma radiation to measure soil water content and completed his PhD in 1971. He inspired me to study dimensional and similitude analyses. As a result of his influence, during the following two decades I sought to understand spatial and temporal variations of water movement occurring within field soils.

And with the creative influence of Ole Wendroth from Germany who spent a 2-year postdoc with me (1990-92), we advanced the usefulness of several such analyses with peer-reviewed publications during 1990-2000 and published a textbook on spatial and temporal statistics in 2003. Today, the interaction between Ole, Klaus and myself enthusiastically continues.

Miroslav Kutílek, a Czech soil physicist and an Honorary Member of the International Union of Soil Sciences, stimulated my interest in studying paleopedology and historic global oscillations of weather and climate. With his leadership since my retirement in 1994, our recent books explain and suggest meaningful human activities for the benefit of all life on Earth.

Chakrapani Misra was the most unique student influencing my interactions with others. I met him in Bhubaneswar during the beginning of my career. Later when he was in Davis for 4 years, I was the supervisor for his PhD. Upon his return to India, he advanced to Professor of Soil Physics and served as Dean of Research in Orissa University of Agriculture and Technology. Retiring from the university after being employed for 33 years, he and his wife Arunabala were initiated into the Sanyasasharam - the traditional Indian Ascertics Order and were given names of Shri Chetanananda Saraswati and Maa Amrutamayee Saraswati. They entered into their 3rd quarter of life for personal spiritual development and to render socio-spiritual service to men and women irrespective of caste and creed. By inspiring me to enhance the education of those whom I met regardless of their ethnicities and religious opinions, Chuck influenced my professional interactions more than anyone else. His influence can be partially verified by noting that 25 students from 17 countries earned MS and/or PhD degrees with me and that 74

postgraduates and professors from 36 countries spent three months to a year with me in Davis. Owing primarily to his influence, I took frequent trips to more than 30 individual countries at my own expense to encourage students and scientists to expand and accelerate their achievements and destinies.

Career progress

While spending my entire professional career at UC Davis, I was promoted from Assistant to Full Professor in 10 years, and served as Director of Kearney Foundation of Soil Science 1970-75, Director of Food Protection and Toxicology Center 1974-75, Associate Dean of the College of Agricultural and Environmental Science 1970-86, Chairman of Department of Land, Air and Water Resources 1975-77, Executive Associate Dean of the College of Agricultural and Environmental Science 1986-89, Chairman of Department of Agronomy and Range Science 1989-91 and Director of Hydrologic Science 1991-93.

Career highlights

Member of Sigma Xi, Phi Kappa Phi, Gamma Sigma Delta, Phi Lambda Upsilon and Alpha Zeta
Senior Post-Doctoral Fellow, NSF, Iowa State University 1965-66
Fellow of American Society of Agronomy, 1969
Science Citation Classic for Hilgardia paper published in 1973
Fellow of Soil Science Society of America 1975
Fellow of American Geophysical Union 1984
Adjunct Professor, Faculty of Agron. and Vet. Institute, Rabat, Morocco, 1984
Honorary Member, Indian Soil Science Society, 1986
Honorary Doctorate, Ghent State University, Belgium, 1986
Soil Science Research Award, Soil Science Society of America, 1986
M. King Hubbert Award, U.S. National Ground Water Association, 1994
Guest Professor, China Agricultural University, Beijing, 1995
Guest Professor, University of Agriculture, Vienna, Austria, Mar.-June, 1996
Soil Science Distinguished Service Award, Soil Sci. Soc. Am, 1997
Honorary Doctorate, University of Agriculture, Austria, 1997
Honorary Member, European Geophysical Society, 1997
Robert E. Horton Medal, American Geophysical Union, 2001
Honorary Member, Romanian Academy of Agric. & Forestry Sci., 2001
Honorary Member, Rural Development Administration, Rep. of Korea, 2004-07
Honorary Member, International Union of Soil Science, 2006
Don and Betty Kirkham International Soil Physics Gold Medal, 2008

Contributing positions held in IUSS

Chair, Symposium session, Int'l Conference on Arid Lands in a Changing World, University of Arizona, June, 1969
Consultant - International Atomic Energy Agency, Vienna, 1974-75
Vice President, Commission I, Soil Physics, 1975-78
Chair, Session 9, International Soil Science Society Congress, Edmonton, 1978
Member, Executive Council, 1978-82
President, Commission I, Soil Physics, 1978-82
Chair, Work Group, Spatial Variability of Soils, 1982-1986
Member, Budget and Finance Committee, 1982-86
Chair and Organizer, Symposium entitled, Solute transport mechanisms and solute matrix interactions, Hamburg, 1986
Member, Board of Directors, College on Soil Physics, International Center for Theoretical Physics,

Trieste 1985-2010
Participant, Conference of Working Group MV, Cornell University, Ithaca, July, 1992
Alternate member, IUSS Council, Bangkok, Thailand, 2002
Consultant for the U.S. Army, NASA, California Department of Water Resources, California Department of Education, USEPA, FAO, USAID and USDA.
Reviewer of several university departments of Land Grant Colleges as well as Cooperative Research and Agricultural Research Service units of the USDA.

Contributing positions held in SSSA

Chair, Division of Soil Physics, 1970
Member, Board of Directors, 1970
Member, Organization, Policy and Bylaws Committee, 1973
Member, Nominations of Soil Physics Division, 1973
Member, Board of Directors, 1976
Member, U.S. Panel coordinated through the Soil Science Society of America that visited USSR as part of the US-USSR Science Exchange, 1976
Member, Organization, Policy and Bylaws Committee, 1982
President-Elect of SSSA, 1983
Chair - Program Planning Committee, 1983
Member - SSSA Executive Committee, 1983
Member - SSSA Board of Directors, 1983
Member - Honorary Member of SSSA Committee, 1983
President of SSSA, 1984
Member - Intersociety Coordinating Committee, 1984
Member - SSSA Board of Directors, 1984
Member - SSSA Executive Committee, 1984
Member - Long Range Planning Committee, 1984
Member - Soil Science Distinguished Service Award Committee, 1984
Chair - Nominations for President-Elect Committee, 1985
Member - SSSA Executive Committee, 1985
Past President of SSSA, 1985
Member - SSSA Board of Directors, 1985
Chair - Fellows Committee, 1985
Chair - General Awards Committee, 1985
Chair - Honorary Member of SSSA Committee, 1985
Chair - Soil Science Distinguished Service Award Committee, 1985
Chair - Special Awards Committee, 1985
Chair - Organization, Policy, & Bylaws Committee, 1985
Member - Long Range Planning Committee, 1986
Member - Organization, Policy, & Bylaws Committee, 1987
Member - Special Awards Committee, 1987
Member - Ad Hoc Committee on Identity for Soil Science, 1992
Chair - Study Committee on Number/Quality of Nominations, 1992
Chair - Feasibility of Book on Regionalized Variable Theory, 1995
Member - Organization, Policy, & Bylaws Committee, 1997
Member - Agronomic Science Foundation Board of Trustees, 1998
Chair - Budget & Finance Committee, 1999
Member - Budget & Finance Committee, 2000
Member - Kirkham Conferences Committee, 2000
Member - Agronomic Science Foundation Board of Trustees, 1996-2001

Member - US National Committee for Soil Science (2001-2002) and Chair (2002-6)
Co-Chair - Kirkham Conferences Committee, 2004
Member – Special Awards Committee, 2006
Member – Don and Betty Kirkham Soil Physics Award Committee, 2006
Chair - L.R. Ahuja Ag Systems Modeling Award Committee, 2009

Contributing positions held in US National Academy of Science

Member - Space Applications Board, Remote Sensing for Soil and Water Resources
Member - Geophysics Board, Water Resources Review Committee of the Food and Agriculture Board
Member - Committee on Scholarly Communication with the People's Republic of China of NRC
Chair - Agriculture Delegation to China, August 28- September 13, 1991
Member - National Technical Advisory Committee, Board of Trustees of the U.S. National Institute for Global Environmental Change

Ten from more than 300 peer-reviewed documents inspiring similar future research from others

Nielsen, D. R. and J. W. Biggar. 1961. Miscible displacement in soils: I. Experimental information. Soil Science Society of America Proceedings 25(1):1-5.

Cassel, D. K., D. R. Nielsen and J. W. Biggar. 1969. Soil water movement in response to imposed temperature gradients. Soil Science Society of America Proceedings 33(4):493-500.

Biggar, J. W. and D. R. Nielsen. 1976. Spatial variability of the leaching characteristics of a field soil. Water Resources Research 12(1):78-84.

Bazza, M., R. H. Shumway, and D. R. Nielsen. 1988. Two-dimensional spectral analysis of soil surface temperature. Hilgardia 56:1-28.

Nielsen, D. R. and Mohammad H. Alemi. 1989. Statistical opportunities for analyzing spatial and temporal heterogeneity of field soils. Plant and Soil 115:285-296.

Ünlü, K., D. R. Nielsen, and J. W. Biggar. 1990. Stochastic analysis of unsaturated flow: One dimensional Monte Carlo simulations and comparisons with spectral perturbation analysis and field observations. Water Resources Research 26(9):2207-2218.

Wendroth, O., A. M. Al-Omran, C. Kirda, K. Reichardt, and D. R. Nielsen. 1992. State-space approach to spatial variability of crop yield. Soil Sci. Soc. Am. J. 56:801-807.

Kutílek, Miroslav, and D.R. Nielsen. 1994. Soil Hydrology. Catena-Verlag, Cremlingen-Destedt, Germany, pp. 370.

Nielsen, D.R., and O. Wendroth. 2003. Spatial and Temporal Statistics–Sampling Field Soils and Their Vegetation. Catena Verlag, Cremlingen-Destedt. pp. 398.

Kutílek, Miroslav and D.R. Nielsen. 2010. Facts about global warming. Rational or emotional issue? Catena-Verlag, Cremlingen-Destedt, Germany, pp. 227.

Personal views on future tactics for learning, appreciating and managing soils

My first view, published 30 years ago in Geoderma 40:267-273.1987, still lingers in my mind and is updated in the following three paragraphs:

> Even though improvements are generally needed in undergraduate programs leading to a baccalaureate degree in soil science, much greater emphasis on soil science is needed in primary and secondary education. Children learn about "reading, 'riting and 'rithmetic" in grade school but rarely does a teacher tell them about soils and the importance of their long-term management in relation to the needs of our daily lives. Indeed, there are no educational courses about soils required in grade or high schools in the US. After attending primary and secondary schools, students in most countries are provided opportunities to learn history, language, mathematics, biology, nutrition, health, humanities, social science, etc. But unfortunately, they are generally not taught about soils and their essential, unique roles in the development, management and conservation of different landscapes.
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> The other end of the educational spectrum leading to post-graduate degrees also needs improvement because nowadays countless professors manifest the propensity to make improved "carbon copies" of themselves through their postgraduate students. They urge them to learn, yet they continue to give gentle, convincing guidance to their graduate students to follow the same academic rut that they are following. Why do professors adhere to such behavior? Because the origin of financial resources for them and their graduate students to conduct research drastically changed during the past two decades. Before then, sufficient funding necessary for research to verify independent, creative ideas of a professor and those of his/her graduate student was adequately available within each university. Hence, students explored their own original ideas, completed their research and published their creativity. Having never told my students what to work on, I was always proud of their unique ideas and revealing achievements. Nowadays, what are professors doing for the future of soil science in addition to teaching classes and conducting research to be reported at professional meetings and published in peer-reviewed journals? They are spending a major portion of their time and energy writing countless external grant applications submitted to local, national and international organizations to investigate politically derived objectives rather than exploring new, seminal avenues of soil science. Graduate students included in such projects have to work on accomplishing the project deliverables rather than conducting research that focuses on their own ideas.
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> Obtaining knowledge of soil science is an exciting challenge because it is an intricate blend of pedology, biology, chemistry, physics, mathematics, and various other disciplines. Agricultural science curricula and their underpinning research usually emphasize biology and chemistry at the expense of an inadequate understanding of both mathematics and physics. Although the personal computer will partially rectify the mathematics deficiency, physics remains a neglected puzzle for most soil scientists. For the global population to learn how to successfully manage the earth's soil resources, we have to accelerate our efforts to extend and transfer a comprehensive knowledge of soil science to the populace and its future generations.

My second view exists owing to the fact that undergraduate and postgraduate degrees as well as individual courses in soil science do not even exist in the majority of US colleges and universities. Such institutions, numbering more than 1000, are members of the National Association of Independent Colleges and Universities (NAICU). Those providing present-day knowledge about soil science, agriculture and landscape ecology number much less - only about 200, and are members of the Association of Public and Land-Grant Universities (APLU).

While I served as Chair of the US National Committee of Soil Science, I never achieved my primary goal to have soil science taught in high schools and institutions belonging to the National Association of Independent Colleges and Universities (NAICU). Unknown to the committee members during my 4-year tenure as Chair, I made visits at my own expense to junior colleges, state colleges, and private and public

colleges and universities in all four regions of the US as well as state and federal high school teacher associations. Many were receptive, but no visit led to the next step.

Hopes for the future

Although I am fully aware that today's immediate goal is the avoidance of regional and global conflicts, a universal need for humanity is the protection and maintenance of global soils. Assuming that my personal views on future tactics described above are eventually accomplished, humanity could achieve what V. Gordon Childe (1892-1957) might have listed as the twentieth discovery and application of science - that is, the development of a technology and desire by society to manage the globe's natural resources without soil exhaustion. With the help of our professional peers throughout the world, I am hopeful when the next page of history is recorded, that twentieth discovery and application of science shall have been accomplished as well as the avoidance of regional and global conflicts.