

# Hydropedology News

The Newsletter of *The Hydropedology Working Group of  
The Soil Science Society of America and  
The International Union of Soil Sciences*



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Dear Colleagues,

It is time again of colorful golden season of the year. The year 2005 is a special one in many ways: *The World Year of Physics 2005* marks the 100th anniversary of Albert Einstein’s miraculous year; The UN International Decade for Action “*Water for Life 2005-2015*” began with World Water Day on March 22, 2005; and an *International Year of Planet Earth* started in 2005. A brochure “*Soil – Earth’s Living Skin*” describes one of its main scientific themes (downloadable at <http://www.iuss.org/>). It is my pleasure to have this opportunity to highlight hydropedology-related activities again in this issue:

- Hydropedology Working Group (ACS 837) will hold its 4<sup>th</sup> general meeting on **Wed., Nov. 9<sup>th</sup>, 6:15-6:45 pm**, at **Convention Center, Room 150D, Lower Level**, during the ASA-CSSA-SSSA International Annual Meetings in Salt Lake City, UT. The meeting agenda will include the report of this year’s activities and the discussion of next year’s plan, including the activities for the newly approved international working group of hydropedology. Anyone interested is welcome to participate.
- The International Union of Soil Sciences (IUSS) has approved a **new Working Group of Hydropedology (WG-HP)**. This newsletter is now also an official newsletter for this new working group. A slate of activities is being planned for this new working group. Suggestions to and involvements in this WG-HP are warmly welcome. Please see more information on p. 2.
- The AGU Fall 2005 meeting will have a special session on “**Synergistic Integration of Soil Science and Hydrology and Its Role in Multiscale Environmental Observatory Networks.**” Invited speakers include Keith Beven, Susan Brantley, David Hammer, Bill Hargrove, and Richard Hooper. Robert Horton will also give a frontier lecture in hydrology at this special session. More details on p. 3.
- In the spirit of *The World Year of Physics 2005* and many emerging scientific communities’ activities, a forum on “**Einstein’s Big Idea, Darcy’s Elegant Experiment, and Dokuchaev’s Holistic Theory: Which Way to Go?**” shares some food for thoughts. Please read p. 9-10.

As always, your contributions and suggestions to this newsletter are welcome at any time.

Sincerely,  
Henry Lin, *Editor*

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## For more information ...

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## ***IUSS Approves a New Working Group of Hydropedology (WG-HP)***

### ***GOALS OF THE IUSS WG-HP:***

- To reach international soil science communities to promote hydropedology as a promising intertwined branch of soil science and hydrology that embraces interdisciplinary and multiscale studies of interactive pedologic and hydrologic processes and their properties in the earth's critical zone; and
- To advance fundamental scientific research, education and public outreach, and diverse practical applications of hydropedology across international scientific communities.

### ***PLAN OF ACTIONS (DRAFT):***

- *Officers:* Officers of the WG-HP will be appointed according to the IUSS statutes. Some interim arrangements would have to be made at the beginning in order to make the WG-HP operational and to ensure appropriate constitution of the WG-HP be developed. Each officer serves a 4-year term and can be re-elected (but not encouraged). Ideally, each term of the WG-HP officers is to be rotated around countries/continents according to the place where the World Congress of Soil Science is to be held.
- *Advisory Committee:* While the WG-HP officers will form the executive committee responsible for the operation of the WG-HP, inputs and advice from an advisory committee are suggested to guide the WG-HP activities. Each advisory committee member serves a 4-year term and can be re-appointed. It is suggested that the advisory committee consists of experts from diverse disciplines and countries.
- *Key Scientific Activity:* An International Conference of Hydropedology is proposed once every 4 years. During each conference, a slate of best quality and innovative papers are to be recognized and awarded through anonymous voting by conference participants. During each international conference, next term of the WG-HP officers is to be elected. The new officers will assume their duties at the World Congress of Soil Science that follows. The new officers will be responsible for planning the next International Conference of Hydropedology, which is to be held in the country where the WG-HP chair resides. In between the international conferences of hydropedology, the WG-HP will also use each World Congress of Soil Science as a platform to hold a symposium.
- *Other Scientific Activities:* As interest arises and resources permit, specialized workshops may be proposed to enhance hydropedology capacity building throughout the world. These workshops may be co-sponsored with other IUSS divisions and/or working groups and other scientific societies or organizations. In addition, as interest arises and resources permit, focused WG-HP wide projects may be proposed. These projects must be highly specialized (e.g., focusing on a cutting-edge issue related to hydropedology) and must have sufficient member participants.
- *Newsletter:* A semi-annual newsletter of the WG-HP will be published in conjunction with the Hydropedology Working Group of the Soil Science Society of America.
- *Funding:* 1) IUSS and Divisions 1 & 2 may give some support for the working group activities; 2) Fund raising and WG-HP proposal writing as appropriate; and 3) Gifts and donations are always welcome.

### ***IUSS New Working Group on Digital Soil Mapping (WG-DSM)***

Another new IUSS working group on Digital Soil Mapping has been approved at the last IUSS executive committee meeting. Digital soil mapping is defined as the creation and population of spatial soil information systems by the use of field and laboratory observational methods coupled with spatial and non-spatial soil inference systems. This WG-DSM is based on the successful Pedometrics Working Group model. It is led by Alex McBratney of University of Sydney, Australia. To read more about Digital Soil Mapping, visit: <http://www.digitalsoilmapping.org/>.

**Conveners: H Lin, Pennsylvania State Univ.; J McDonnell, Oregon State Univ.; Y Rubin, Univ. of California, Berkeley; R Horton, Iowa State Univ.; J Hopmans, Univ. of California, Davis**

Frontier Lecture in Hydrological Science: Advancing Hydrological Investigations by Addressing Some Challenges Posed by Dynamic Surface Soil Properties  
\*R Horton

Development of a Domain Map for Nodes of the National Ecological Observatory Network (NEON)  
\*W W Hargrove, F M Hoffman, B P Hayden, D L Urban, J A MacMahon, J F Franklin

Hydropedology From the Pedon to the Landscape: Challenges and Accomplishments in the National Cooperative Soil Survey  
\*D Hammer, J Richardson, J Hempel, P Market

The Critical Zone Exploration Network: A Tool For Understanding Earth's Weathering Engine  
\*S Brantley, A White, L Derry, O Chadwick, S Anderson, D Richter, M Firestone, J Kirchner, J Chorover, R April, T White

Uniqueness, closure and uncertainty in multi-scale hydrological networks  
\*K J Beven

Observatories as a Community Platform for Integrative Science  
\*R P Hooper, J M Duncan

A Prototype Hydrologic Observatory for the Neuse River Basin Using Remote Sensing Data as a Part of the CUAHSI-HIS Effort \*R Kanwar, U Narayan, V Lakshmi

Soils and the CUAHSI Vision and Beyond  
\*H Lin, R Bales, D Gochis, B Hornbuckle, B Johnson, W Krajewski, J McCray, J McDonnell, K Murray, B Newman, P Reed, B Simpkins, G Thyne, E Wohl, U Lall

Integrated snow, soil and water-balance measurement strategy for multi-scale environmental observations in mountain areas \*R C Bales, N P Molotch, D G Marks, E E Small

Application of Electromagnetic Induction Sensors for Mapping the Subsurface in Small Watersheds.  
\*D A Robinson, M S Seyfried, V Urdanoz, H Abdu, S B Jones, D Chandler, R Knight

Modelling the Spatio-temporal Process Variability of Soil Water Balance in a Forest  
\*G Jost, M Weiler

Temporal Stability of Soil Moisture Spatial Distribution in a Forested Catchment \*X Zhou, H Lin

Impact of Soil Depths on the Catchment-Scale Geomorphic Hydrologic Response  
\*A Uccelli, F Catani, M Marani, A Rinaldo

Soil-type based prediction of contributing areas for diffuse losses of agrochemicals  
\*C Stamm, P Lazzarotto, V Prasuhn, H Fluehler

The Effect of Anthropogenic Disturbance in the Ecohydrology of Pinyon Juniper Woodlands with Soil Biocrust  
\*I Lebron, D G Chandler, D A Robinson, J Belnap, M Madsen

Contrasting Particle Clogging in Soils and Granular Media Filters \*D C Mays

Investigating the Influence of Clay Mineralogy on Stream Bank Erodibility  
\*R K Ambers, M B Stine

Phosphorus Transport at a Wastewater Infiltration Site; Mines Park, CO  
\*S E Doyle, J E McCray, G D Thyne, K S Lowe

Air Entrapment, Soil Water Retention and Distributed Hydrologic Response in a Semi Arid Catchment  
\*D G Cahndler, J P McNamara, M M Gribb

## Profiles of Colleagues Interested in Hydropedology

### Patrick Drohan

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Patrick joined the Univ. of Nevada, Las Vegas Dept. of Geoscience in 2004 as an Assistant Professor of Soil Science. He receives his BS from Rutgers Univ. in 1992. Following graduation, he worked for the USDOJ Bureau of Land Management in Kremmling, CO and the USDA Forest Service in Fairplay, CO. His M.S. research at Penn State Univ. (1996) focused on water chemistry changes in spring baseflow related to land use and insect defoliation. He earned his Ph.D from Penn State Univ. in Soil Science. His dissertation was an examination of soils, geomorphology, climate, and biotic factors associated with an episode of sugar maple decline in northern Pennsylvania between 1979-1989. Besides teaching courses in GIS, biogeochemistry and soil mapping, Patrick conducts research in the areas of pedology and biogeochemistry. Patrick is currently a Co-Chair for the Smithsonian/SSSA Soil Exhibit Steering Committee and Chair of the SSSA Exhibit Design Committee.

### Anthony Toby O'Geen

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Toby is a soil resource specialist in cooperative extension in the Department of Land, Air and Water Resources, University of California, Davis. Toby's latest research focuses on relationships and feedback mechanisms between hydrologic flowpaths in soils and biological diversity of oak woodland landscapes. Toby is also investigating the nature and properties of seasonally submerged soils in constructed wetlands and their ability to remove water quality contaminants in agricultural tailwater. Outreach efforts include promoting new applications and visualization techniques for soil survey data.

### Craig Rasmussen

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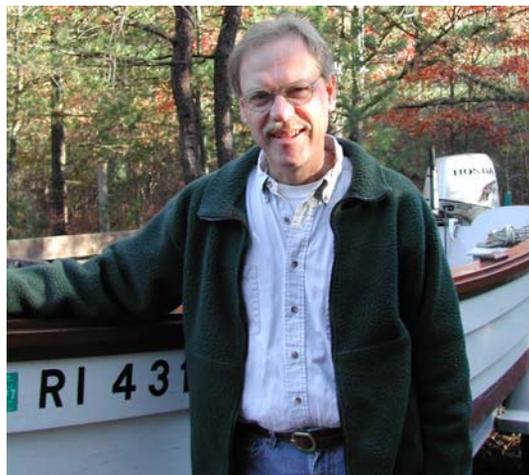
Craig joined the Univ. of Arizona as an Assistant Professor in Environmental Pedology in January 2005. He received his BS from Univ. of California, Davis. He then worked for a small consulting firm combining soil mapping techniques with a local network of weather stations and vineyard monitoring to aid growers in improving wine grape quality and production. He returned to UC Davis to complete his PhD in 2000, with a research focused on the role of soil minerals as controlling factors in the turnover and stabilization of soil organic matter in temperate conifer forests of California. In addition, he developed a model for quantifying energy input from precipitation and biologic production into soil systems. His responsibilities at Arizona include teaching undergraduate and graduate Pedology courses and conducting research into soil forming processes, particularly the link between limited precipitation, soil properties, and ecosystem function.

### **Mark H. Stolt**

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Mark is an Associate Professor of Pedology and Soil-Environmental Science at the University of Rhode Island. He teaches courses in Soils and Land Use, Soil Morphology and Mapping, and Soil Classification and Genesis. His primary research interests are in the application of soil science to various environmental issues and problems. Examples include: the effects of land use change on the terrestrial and subtidal environments; relationships between tidal and riparian soils and water quality, restoration, and land management; the role of soils in the treatment of domestic wastewater; and the processes operating in hydric soils, subaqueous soils, and soils with aquic conditions. His research has focused micro and macro-morphology of carbon forms in riparian soils, variability in carbon storage among soil types varying by drainage classes, fate and transport of N and P in shallow-narrow drainfields, distribution of subaqueous soils in estuaries, and soil morphology-aquic condition relationships.

### **Michael H. Young**

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Michael joined DRI in 2000 as an Assistant Research Professor. He received his BA in Geological Sciences from Hartwick College, an MS in Geological Sciences from Ohio University, and his Ph.D. in soil physics and hydrology from the University of Arizona in 1995, where he studied vadose zone monitoring systems, lysimeters, and soil water recharge. After completing a post-doc at Arizona, he spent 2.5 years at the Georgia Institute of Technology in Civil and Environmental Engineering as a Senior Scientist, evaluating the movement of pathogens and surfactants in soil systems. At DRI, Dr. Young's current research projects include the impacts of near-surface water movement on soil development in arid climates, water flux through alternative waste disposal covers, and the numerical prediction and statistical uncertainty of deep water flux in arid and semi-arid climates. He is now an Associate Research Professor and Deputy Director of the Division of Hydrologic Sciences.

*Michael H. Young, Desert Research Institute*

During the past 3-5 years, a diverse group of researchers at the Desert Research Institute (DRI) has been conducting research projects that seek to better understand the role of hydrogeology in regulating near-surface soil water balance, surface runoff potential, and soil-water-plant relationships in highly water-limited ecosystems. Vadose zone hydrology, my research area, plays an important part in the research, as do the areas of geophysics, geomorphology, quaternary geology, and plant physiology. The overall goals of these projects are to better understand how environmental processes that affect water and energy movement in soil are linked, and how those linkages can be used to predict ecosystem responses to land disturbance, land restoration, and global environmental change.

For example, Young et al. (2004) examined soil hydraulic properties along a soil chronosequence at the Mojave National Preserve, CA. The surface covered by mixed plutonic parent material ranged in age from 50 to 100,000 years. We showed, for the first time, how hydraulic properties covary with time in arid desert pavement environments. Specifically, we noted that the saturated hydraulic conductivity declined in value by 100 fold as the desert pavements formed, and that the surface age could be used to predict the saturated hydraulic conductivity ( $r^2 = 0.9254$ ). Further, the results suggested that Av horizon development (vesicular A horizon) represented a key process controlling water cycling, potentially influencing ecosystem function in arid lands. As part of another study, we examined a second Mojave Desert chronosequence; but this time we compared soil hydraulic properties in highly-bioturbated soils, found underneath desert shrubs with those of adjacent desert pavements where the structure remained intact. We sought to determine the extent to which soil structure might affect the hydraulic properties, and hence the ability of water to infiltrate the soil adjacent to and directly beneath perennial shrubs. The results (Shafer et al., 2004) indicated that age did not affect the hydraulic conductivity of bioturbated soils underneath canopies. Hence, water could infiltrate deeper into the soil in these localized areas around shrubs, potentially allowing for deeper root penetration and enhanced drought tolerance.

These results raised interesting questions about the mechanisms of water entry into these older, highly structured soil surfaces. Using a grant from the Nevada Water Resources Research Institute, Darren Meadows, a doctoral student at the University of Nevada, Reno, developed a method to determine the hydraulic properties of individual peds in these desert pavement soils. He used a combination of the tension infiltrometer method and a transient evaporation technique, and then examined the spatial variability of hydraulic properties at the cm scale. Meadows and colleagues showed (Meadows et al., 2005) significant variability in the hydraulic properties of peds across distances of only about 10 cm, as well as clustering of peds into high and low conductivity zones. According to our analysis, more than 90% of water flux through intact pavements could be occurring through less than 0.01% of the soil volume. The interped regions are suggested as major conduits for water infiltration, thereby bypassing low conductivity soil peds and supplying water to deeper soil horizons.

A number of other on-going studies are looking at hydrogeologic processes at different scales (from 10s of microns to 100s of meters). Ultimately, we will use the results of these pedology- and hydrology-related studies to better predict how soils restore themselves following disturbance, and how water balances (and hence ecosystems) react to changes in global climate. These projects

are supported by a number of researchers at DRI, including Eric McDonald, Todd Caldwell, David Shafer, and Stephen Zitzer. A variety of funding sources are supporting this research, including the Army Research Office's Terrestrial Sciences Program, the Department of Energy's Nevada Operations Office, and the Desert Research Institute's vice-President for Research.

### **References:**

- Meadows, D.G., M.H. Young, E.V. McDonald. 2005. A laboratory method for determining the unsaturated hydraulic functions of individual soil peds. *Soil Sci. Soc. Am. J.* 69 807-815.
- Shafer, D.S., M.H. Young, S. Zitzer, E.V. McDonald, T.G. Caldwell. 2004. Coupled environmental processes: Implications for landscape development in the northern Mojave Desert. DRI Publication No. 45203.
- Young, M.H. E.V. McDonald, T.C. Caldwell, S.G. Benner, D.G. Meadows. 2004. Hydraulic properties of a desert soil chronosequence in the Mojave Desert, USA. *Vadose Zone J.* 3:956-963.

### **Publications of Interest ...**

- ***The Natural History of the Bible – An Environmental Exploration of the Hebrew Scriptures:*** Daniel Hillel. 2006. 376 pages. Columbia University Press. Combining his distinguished scientific work with a life-long passionate study of the Bible, Hillel offers new perspectives on biblical views of the environment and the origin of ethical monotheism as an outgrowth of the Israelites' internalized experience in five natural domains (riverine, pastoral, desert, rainfed, and maritime) and two artificial domains (urban and exile). Hillel revealed the interplay between the culture of the Israelites and the environments within which it evolved.
- ***Under Ground – How Creatures of Mud and Dirt Shape Our World:*** Yvonne Baskin. 2005. 237 pages. ISLAND Press. Dirt – the final frontier? NASA's robotic rovers made headlines as they scraped their way across the Martian surface, searching for signs of water and life. But while we explore alien landscapes, a vital and fascinating underworld teems beneath our feet. The soils of earth, weather on land or compressed under tons of ocean water, nurture a frenzy of life and human activities. While space exploration continues to dwarf underground investigations, world scientists are making unprecedented efforts to reveal earth's own underground world – a truly alien realm that is critical to life on earth. Baskin leads an intriguing tour of this virtually uncharted territory in this fascinating book.
- ***Ecohydrology of Water-Controlled Ecosystems – Soil Moisture and Plant Dynamics:*** Ignacio Rodriguez-Iturbe and Amilcare Porporato. 2004. 442 pages. Cambridge University Press. This book represents an important body of work stemming from many years of productive effort by the authors. As revealed in this book, what is clearly needed to advance our understanding of ecohydrological dynamics in water-limited ecosystems is a solid quantitative framework for modeling the stochastic nature of plant-available soil water and its influence on vegetation structure and function.
- ***Regolith Landscape Evolution Across Australia – A compilation of regolith-landscape case studies and landscape evolution models:*** Edited and compiled by R. R. Anand and P. de Broekertof. Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME). The volume has 51 Australian regolith-landscape evolution case studies, includes regolith-landscape models and weathering histories of deeply weathered terrains, and contains a synthesis of geochronology of the Australian regolith and a guide to regolith mapping.

- **Global Priorities in Soil Science Research:** A workshop sponsored by the U.S. National Science Foundation will be held at the 18<sup>th</sup> World Congress of Soil Science, with a report to be issued that could serve as a blueprint for future research trusts and funding needs in soil science. This workshop will caption two major workshops on research frontiers in soil science and the critical zone that are planned in the USA in 2005. The workshop on **Frontiers in Exploration of the Critical Zone** has been held at the Univ. of Delaware, October 24-26, 2005 (<http://ag.udel.edu/plsc/Conference/>). This workshop attracted 155 people from many disciplines, with a good mix of soil scientists and geoscientists. This workshop facilitates a unified voice from the scientific community to funding agencies concerning soils research and the critical zone investigations. This meeting was an outgrowth of an ongoing conversation among several critical zone scientists and several funding agencies about the need for a concerted initiative to study weathering, water-rock interactions, biogeochemical cycles, soil formation and evolution, and interdisciplinary critical zone science. During the workshop, a total of 24 site proposals were discussed with a goal to establish a critical zone exploration network (CZEN) as a network of people, ideas, sites, databases, and tools. For more information about CZEN, visit the web site: <http://www.wssc.psu.edu>. In **December 12-14, 2005**, the National Academies will convene an international workshop on **Frontiers in Soil Science Research** to identify emerging research opportunities and expected advances in soil science, particularly in the integration of biological, geological, chemical, and information technology sciences. The workshop will: 1) identify particular research priorities and potential breakthroughs within soil science; 2) identify the interdisciplinary and cross-disciplinary research areas in which soil science is involved, particularly in the field of biogeoscience; and 3) identify technological and computational needs to advance soil science. For more info about this upcoming meeting, visit the web site: <http://www7.nationalacademies.org/soilfrontiers/>.
- **Smithsonian Soils Exhibit:** The Smithsonian's Exhibit Developer, Barbara Stauffer, and the head of the design firm (Beth Miles of mfm design in DC) will unveil the recently completed concept design materials at the ASA-CSSA-SSSA Annual Meetings in Salt Lake City. This special event will be held on **Monday, November 7, 3-4 p.m. at the Marriott Downtown**, and will be followed by a reception from 4-5 p.m. The Smithsonian Soils Exhibit is an amazing opportunity to show the world how critical and exciting soil is. Please help by donating now. For more info: <http://www.soils.org/smithsonian/>.
- **National Cooperative Soil Survey Conference:** This national meeting was held in Corpus Christi, TX, May 21 - 26, 2005. Three standing committees (Research Agenda, NCSS Standards, New Technology) and four in-conference committees (WEB Soil Survey—Promoting Partnerships, Ecological Principles in Soil Survey, Recruitment and Retention of Soil Scientists in Soil Survey, and Water Movement and Water Table Monitoring in Soil Survey) had active discussions and made recommendations. The *Committee on Water Movement and Water Table Monitoring in Soil Survey* developed a report and made six recommendations for implementation in the NCSS. For more information, visit the web site: <http://soils.usda.gov/partnerships/ncss/conferences/index.html>.
- **Water Information Center:** The National Academies has created a new Web site (<http://water.nationalacademies.org/>) that provides free access to more than 100 Academies reports on water-related issues. This Center aims to assist the work of water scientists, engineers, managers, policy-makers and students in the developing world.
- **Shaping the Future – America's Environment Today:** On the eve of the Earth Day 2005, Christine Todd Whitman, former Governor of New Jersey and EPA Administrator, gave a keynote speech at the Penn State's 2<sup>nd</sup> annual Colloquium on Environmental. Among the key messages she delivered were: economic growth and environmental stewardship must go hand in hand; environment is not in the top 10 list of American people; smart growth in America is needed for sustainable development. She also stressed that water makes people go to work!

## ***Einstein's Big Idea, Darcy's Elegant Experiment, and Dokuchaiev's Holistic Theory: Which Way to Go?***

Henry Lin, Penn State University

When Albert Einstein was named the “Person of the Century” in 1999, *TIME* Magazine described him as “*the pre-eminent scientist in a century dominated by science. The touchstones of the era--the Bomb, the Big Bang, quantum physics and electronics--all bear his imprint.*” Einstein’s big idea was  $E = mc^2$  (a simplified version of a more elaborate equation that Einstein devised:  $E^2 = m^2c^4 + p^2c^2$ ). Perhaps the most far-reaching legacy of this 1905 equation is that it provides the key to understanding the most basic natural processes of the universe, from microscopic radioactivity to the big bang itself. Another legacy of this equation is that it captures the imagination of everyone. For many, the world’s most famous equation and Einstein’s other leaps of imagination revealed how scientists can be just as visionary as artists, writers, and other “creative” types. Until Einstein's time, scientists typically would observe things, record them, then find a piece of mathematics that explained the results. Einstein exactly reversed that process. He started off with a beautiful piece of mathematics that was based on some very deep insights into the way the universe works and then, from that, makes predictions about what ought to happen in the world. It's a stunning reversal to the usual ordering in which science is done. It is a legacy of the power of human creativity in science. To hear Einstein himself explained the famous equation, visit: <http://www.aip.org/history/einstein/voicel.htm>.

In contrast, the Darcy’s law, discovered in 1856 by the French hydraulic engineer Henri Darcy, was derived from extensive experimental work on the flow of water through sand filter beds. Darcy was concerned with the public water supply of Dijon, France, in particular the acquisition of data that would improve the design of filter sands for water purification. In search of this, Darcy set out a series of experiments “to determine the laws of flow of water through sand.” The experimental apparatus employed by Darcy was fairly simple by today’s standard. But the elegant equation he formulated ( $Q = K_s A \Delta h/L$ ) has had far-reaching impacts, serving as a foundation from which many sophisticated theoretical and practical derivations have been devised. It is a legacy for the hydrologic sciences. Interestingly, the Darcy’s law emerged as an entirely empirical equation, resulting from what would now be considered as a “black box” approach. Darcy showed that a single parameter, now called the saturated hydraulic conductivity, is sufficient to describe water flow through saturated sand. This global parameter represents the system as a whole, regardless of pore-scale phenomena or variation. Thus, the Darcy’s principle has been applied to characterize the permeability of large geological formation or water flow through a small soil core. This law governing the laminar flow of fluids in homogeneous and saturated porous media, however, faces challenges in heterogeneous and structured vadose zone.

Vasily Vasilievich Dokuchaiev, a Russian geographer, was credited with formulating the theory of soil formation in 1883, which gave birth to modern soil science. He arrived at his theory after extensive field observations on Russian soils. For his contribution, a crater on Mars is named in his honor. Subsequently, Hans Jenny’s 1941 “*Factors of Soil Formation*” presents the fundamental equation of soil-forming factors:  $s = f(c, l, o, r, p, t, \dots)$ . While an excellent holistic conceptual framework that has had profound impacts on soil and earth sciences, “*the fundamental equation of soil formation is of little value unless it is solved,*” Jenny himself claimed. Both Dokuchaiev and Jenny expressed prophetic insight into the challenge of the quantitative solution of the soil-forming-factor equation. There is much to be done and many opportunities along the way in order to quantify the factorial model of soil formation, with the consideration of the vastly heterogeneous, structured, and heavily-human-impacted world of soils. Perhaps another Einstein is needed (this time, a practical one?) who has another big idea to bridge over spatial, temporal, and conceptual gaps of soil formation/evolution and change.

Modern sciences are ever-increasing sophistications, intensities, and costs. It is, therefore, interesting to contrast the essentially “simple, elegant, and cheap” approaches that led to the discoveries of Einstein’s relativity, Darcy’s law, and Dokuchaiev’s theory. The following paragraphs highlight the modern version of particle physics, hydrology, and extraterrestrial soil and geology research.

The future of world particle physics is dominated by the Large Hadron Collider (LHC), currently under construction at CERN (the European Organization for Nuclear Research) near Geneva. The cost of building the LHC is estimated to be over **\$2,200 million**. Experiments at this machine are believed to contribute to the solution of major unsolved questions in particle physics (such as the origin of mass, the existence of three generations of elementary particles, the matter-antimatter asymmetry in the universe, and the nature of the 'dark matter' in the universe). This supercollider, scheduled to start operation in 2007, uses a circular tunnel 27 km in circumference and is buried 50-150 m underground (visit <http://lhc.web.cern.ch/lhc/LHCnews/Counciljune2005.pdf> to view this extraordinary engineering effort). *"Particle physics is the unbelievable in pursuit of the unimaginable. To pinpoint the smallest fragments of the universe you have to build the biggest machine in the world. To recreate the first millionths of a second of Creation you have to focus energy on an awesome scale,"* *The Guardian* newspaper described. Theoretical particle physics has undergone a revolution over the last twenty years, with the emergence of lattice gauge theory and string theory that are now dominating world theoretical physics.

Emerging community-based environmental sciences seem to demand the establishment of large-scale environmental observing networks (such as the CUAHSI’s Hydrologic Observatories, the WSSC’s Critical Zone Exploration Network, National Ecological Observatory Network, and many others). Observatories are becoming as a community platform for integrative sciences. Take hydrology community as an example: the Cooperative Large-Scale Environmental Observatories (CLEOs), grew out of a joint CUAHSI-CLENAER effort, has a projected price tag of **several hundred million dollars**. The costly observatory network is expected to transform water science and engineering through promoting “river basin science” and integrating critical components of observation, information system, research, and synthesis. Ultimately, we strive to make fewer measurements to test critical hypotheses and to synthesize the knowledge for effective management.

The remarkable success of the Mars Exploration Rover (MER) mission has received worldwide attention and was the top scientific breakthrough in 2004 according to the *Science* magazine. The price tag for this mission? About **\$800 million**. Every mission to Mars is claimed to be scientifically exciting, but each one is extremely pricy. The MER looks for signs of liquid water via investigations of landforms, rocks, and soils on the red planet. So, the twin rovers essentially function as two field geologists plus soil scientists. There are a slate of missions to Mars that have been planned every two years, with a dream of retuning Martian samples back to earth and sending humans to Mars. NASA’s Mars Reconnaissance Orbiter (MRO), for example, roared into the space on August 12 this year. Its price tag? **\$720 million**. Hopefully, by exploring Mars, we learn better how to protect our home planet!

The history of scientific discovery is fascinating. Lessons learned from the past offer insights into the future of ever-increasingly sophisticated, intensive, and costly modern sciences. Soil and hydrologic sciences, for example, are at a critical threshold of advancing frontiers and exploring breakthroughs. With one foot on the Darcy’s legacy and another one on the Jenny’s treatise, hydrogeology searches for synergistic integration that might well lie in nature, waiting for us to discover. Using the words of Jenny, *“the distinction between soil and environment is arbitrary; it exists only in our minds, not in nature.”* The world is integrated, indeed, regardless how we view it. Thus, limited is gained by trying to establish tight compartments between pedology and hydrology, or between soil science and geosciences in general.





## *USDA National Needs Graduate Fellowship in Integrated Soil and Water Sciences*

### **Two (2) Ph.D. Fellowships and Four (4) Ph.D. Assistantships Available**

#### **The Pennsylvania State University**

Six Ph.D. positions (2 fellowships and 4 assistantships) are available starting Fall 2006, with competitive stipends, tuition waiver and health insurance included. We are seeking motivated individuals to pursue integrated soil and water sciences, with emphasizes on integrated, multi-disciplinary, and technology-enhanced approaches. The educational experience will blend together real-world field experience, laboratory studies, and computer-based analysis and modeling. The program will foster synergy between six participating departments across Penn State (Crop and Soil Sciences, Agricultural Economics, Agricultural Engineering, Civil and Environmental Engineering, Forest Resources, and Geosciences), and scientists from the USDA-ARS Pasture Systems and Watershed Management Unit. Students will gain proficiency in areas of national and international scientific importance and practical need, including landscape hydrology, hydrologic modeling, soil moisture prediction, precision agriculture, watershed nutrient management, land-use dynamics and planning, water-quality trading, and stormwater management.

Consideration of candidates will start in January 2006. Applications will be accepted until qualified candidates are appointed. Applicants for the USDA fellowships must be US citizens. Applicants for the assistantships are open to non-US citizens. Members of underrepresented minority groups are strongly encouraged to apply. Applicants should have a background in soil science, hydrology, geosciences, environmental sciences, land use planning, ecology, forest hydrology, engineering, or other related fields. We encourage applicants to contact associated faculty directly to learn more about their programs (see <http://cropsoil.psu.edu/usdabriefinginfo.cfm>). On-campus interviews will be scheduled in spring 2006 after initial screening. To express interest in this program, please send: 1) a letter indicating specific areas of interest, 2) a resume, 3) a copy of academic transcripts, and 4) Graduate Record Examination (GRE) scores, to: Ms. Kathy Barr, Department of Crop and Soil Sciences, 116 ASI Building, The Pennsylvania State University, University Park, PA 16802, email: [ksb1@psu.edu](mailto:ksb1@psu.edu), phone: 814-865-2025, fax: 814-863-7043. Qualified candidates will be asked to complete a formal application with the appropriate department at Penn State.

For additional information contact Dr. Henry Lin at [henrylin@psu.edu](mailto:henrylin@psu.edu), phone 814-865-6726.



*The Blue Marble: Next Generation* is a series of images that show the color of the Earth's surface for each month of 2004 at very high resolution (500 meters/pixel) at a global scale. See its animation at: [http://www.nasa.gov/vision/earth/features/blue\\_marble.html](http://www.nasa.gov/vision/earth/features/blue_marble.html).

In celebration of the **Earth Observing System**, NASA recently released the newest in its series of stunning Earth images, affectionately named the "Blue Marble." This new Earth imagery enhances the Blue Marble legacy by providing a detailed look at an entire year in the life of our planet, viewed from the unique perspective of space. (Source: NASA)

## **BLUE REVOLUTION**

Blue is joining green as an environmental buzzword. The blue revolution is the water equivalent of the green revolution and primarily refers to the need to get water for drinking and crop irrigation to the many millions of people worldwide who do not have it. The phrase has been used for some years, but it came to notice particularly in press reports of the Third World Water Forum in Tokyo. Many environmentalists believe that the need is not simply to provide water, but to do so in ways that are ecologically sound and sustainable. Solutions are desperately needed, since the UN estimates that 2.7 billion people face a critical shortage of drinkable water by 2025. It is hoped that the "green revolution" in crop productivity will soon be matched by the "blue revolution" in water resources management and sustainable development.

(Source: World Wide Words at <http://www.worldwidewords.org/turnsofphrase/tp-blu2.htm>)

## **Fun ...**

### **On Soil Taxonomy**

During a soils field trip, a student, puzzled by the "strange" soil taxonomic names, ask the professor: "Who made this thing up?" The professor, surprised by the student's question, responded: "The learnt people like me." (HSL)

### **What Is Underneath Your Feet**

A group of students gathered on a beach to answer a homework assignment: "what is underneath your feet?" One student laughed: "It is dirt. What is the big deal?!" Another student responded, "No, it is clean sand. Without it, we wouldn't have a good time here." The third student, after pondering for a few minutes, suggested, "I think it is actually solid oil. Without it, the world would be lifeless – Much like without liquid oil, cars will all be dead." (HSL)

### **Scientists vs. Engineers**

Scientists and engineers belong to two different tribes, according to Steve Squyres, the PI of the Mars Exploration Rover mission. So, on every space project, there is a tension: the idealistic, impractical scientists against stubborn, practical engineers. On a good project, it's a creative tension that draws out the strength of both sides. On a bad one, it's an acid that eats away at the collaboration until it's rotten. Why? Scientists are seekers of truth. They're people who look at the world and wonder how it works. To a scientist, there's enormous appeal in an open-ended research project, where there's no telling where it might lead. Engineers, on the other hand, are creators. They are tinkerers and inventors. To an engineer, the goal is to build something that works. And even better is to build something that gets the job done on time and within budget, often go by "good enough." The problem when engineers and scientists have to work together is that "good enough" is anathema to a scientist. There is no such thing as "good enough" when what you're after is the truth. (Source: Steve Squyres. 2005. *Roving Mars*. Hyperion, New York)