UNIVERSITY of FLORIDA IFAS

A SOIL AND WATER SCIENCE DEPARTMENT PUBLICATION

# Myakka

VOLUME 13
NUMBER 2

SUMMER 2013

## contents



http://soils.ifas.ufl.edu

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# Environmental Pedology: Science and Applications

## *From the Chair...*

Pedology is the study of soils as they occur on the landscape. A central goal of pedological research is improve holistic understanding of soils as real systems within agronomic, ecological and environmental contexts. Attaining such understanding requires integrating all aspects of soil science. Soil genesis, classification, and survey are traditional pedological topics. These topics require astute field assessment of soil morphology and composition. However, remote sensing technology, digitally-linked geographic data, and powerful computer-driven geographic information systems (GIS) have been exploited in recent years to extend pedological applications beyond traditional field-based reconnaissance. These tools have led to landscape modeling and development of digital soil mapping techniques.

Florida State soil is "Myakka" fine sand, a flatwood soil, classified as Spodosols. Myakka is pronounced 'My-yak-ah' - a Native American word for Big Waters. Reflecting our department's mission, we named our newsletter as "Myakka". For details about Myakka fine sand see: http://soils.ifas.ufl.edu/docs/pdf/Myakka-Fl-State-Soil.pdf

This newsletter highlights Florida pedological activities of the Soil and Water Science Department (SWSD) and USDA Natural Resources Conservation Service (NRCS). The following overview draws heavily upon data generated during the Florida Cooperative Soil Survey Program, a joint effort of the NRCS and the UF-SWSD (http://soils.ifas.ufl.edu/flsoils/). Included in this newsletter are a few examples of science and application of pedology in addressing some of the critical issues related to sustainable plant productivity and conservation and protection of natural resources.

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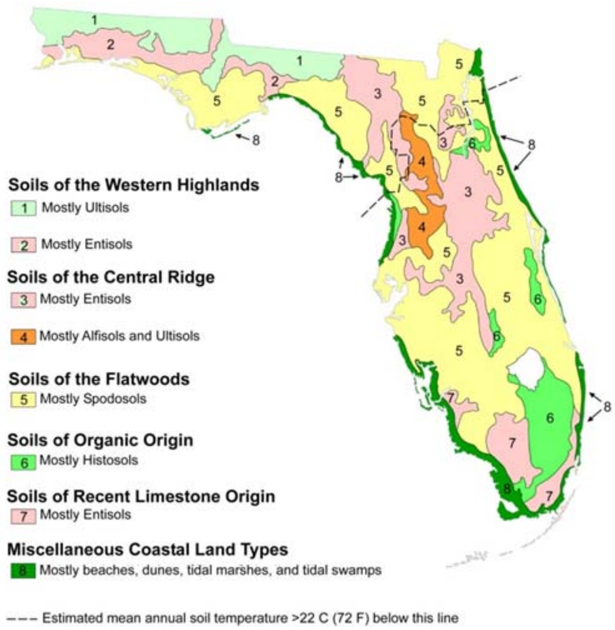
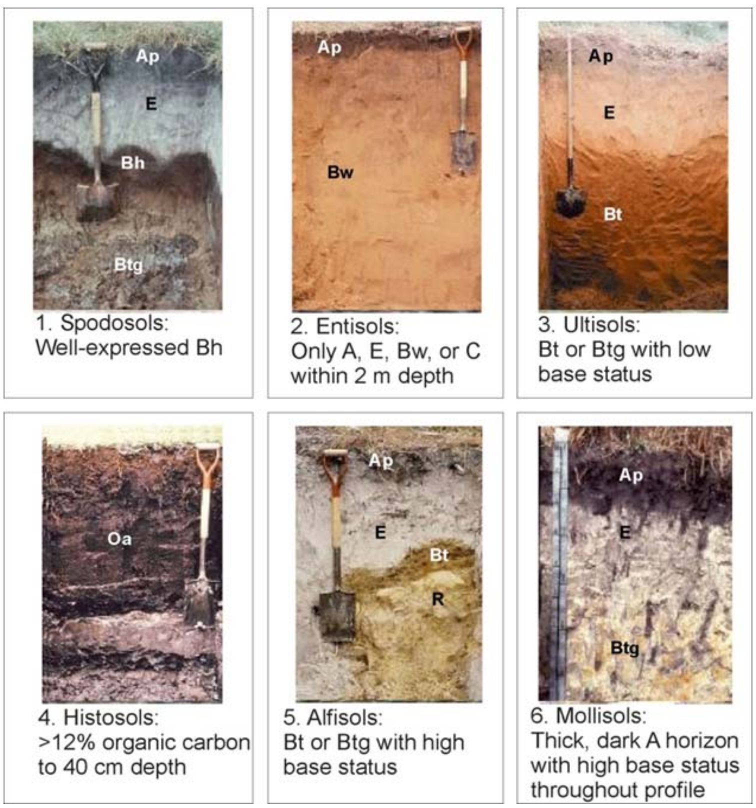
## Pedological Overview of Florida Soils

Florida is entirely within the US southeastern coastal plain. Thus its soils have formed primarily in marine deposits. Nonetheless, it has an extremely diverse array of soils– forming in sands, mucks, marls, and rock-plowed limestone – ALL of which are used in agriculture. Soil distribution in Florida shows a general correspondence with physiographic features and parent materials of the panhandle and peninsula.

Florida soils north of Lake Okeechobee formed mainly in sandy to loamy marine and fluvio-marine parent materials, under a variety of drainage conditions. Flatwoods soils are prevalent in this part of the state. “Flatwoods” is a term applied to nearly-level, poorly -drained uplands with seasonally-fluctuating water tables and native plant community dominated by pines and relatively dense understory. Flatwoods soils are often drained artificially for agriculture. The dominant flatwoods soil order is Spodosols, which are sandy and characterized by carbon-enriched Bh subsurface horizons. Other prevalent sandy soils of Florida include the orders Entisols and Ultisols, which can range from excessively- to poorly drained and occur on a variety of landscapes. The driest of these soils are associated with “sandhills” ecosystems that are common along the central ridge (generally corresponding to “Entisols”), characterized by an open canopy of pines and oaks with sparse understory.




**General soils map of Florida by Dr. Victor Carlisle in Water Resources Atlas of Florida (1998). Legend of the general soils map was abridged for the purposes of this newsletter.**




**Soil profile images with horizon designations and brief criteria for six of the seven soil orders in Florida (excluding Inceptisols), in order of areal extent. These profiles are only examples; there is a large range in morphological properties for each order. Orders are distinguished on the basis of soil properties, including diagnostic horizons. Soil photos shared by Dr. Victor Carlisle, Frank Sodek, and various other scientists (USDA-NRCS & UF-SWSD)**

Soils south of Lake Okeechobee (The Everglades) formed predominately under very poorly drained conditions in sawgrass residue or in calcium carbonate associated with or derived from shallow or exposed limestone. Consequently, the area is dominated by organic soils (Histosols) and soils rich in carbonate. Organic soils thin southward, and very shallow soils over limestone rock are common near the tip of the peninsula and in the Keys. There are fairly extensive areas of soils forming in “marl”, a form of calcium carbonate that precipitates in shallow water as promoted by photosynthetic carbon dioxide uptake by algae. Areas of exposed limestone have been rock plowed and used for crop production, exploiting the warm winter climate.

The USDA soil taxonomic hierarchy consists of 6 categories: order, suborder, great group, subgroup, family, and series. Seven of the 12 soil orders defined in the USDA system are found in Florida. The morphology and composition of these soil orders affect their suitability for various uses. In Florida, Spodosols are associated with fluctuating water table, and most Histosols are very poorly drained. The other soil orders can range from excessively-well- to very-poorly drained.

For additional information, contact Willie Harris at: apatite@ufl.edu

## Pedological Research and Environmental Applications

Pedology is inherently "environmental" since it involves holistic spatial and temporal assessments of soils in the environment. Factors that affect the natural flux of components also are pertinent to matters of environmental concern. Soils are a compositionally and spatially complex medium. However, that complexity is not random but is based on the orderly arrangement of horizons that formed from pedological processes. The depth and direction of water flow in conjunction with soil morphology and composition (horizon distributions) are determinants of contaminant fate in the environment. Below are selected pedological highlights of Florida soils and an introduction to the critical zone concept that integrates the domains of plant canopy, soil, bedrock, and water.

## Histosols – Organic Soils of Florida

**Soil below the stairway was lost as a result of subsidence.**

The organic soils (Histosols) in south Florida formed over several thousand years when organic matter production exceeded decomposition in the seasonally-flooded sawgrass wetlands that flourished in the area south of Lake Okeechobee now referred to as the Everglades Agricultural Area (EAA). Since the onset of drainage for crop production and settlement, soil organic matter decomposition rates have exceeded accretion rates, resulting in a loss of soil and a lowering of the surface elevation, which is a process referred to as subsidence. These Histosols formed when the land was flooded for much of the year, resulting in insufficient oxygen in the soil to maintain active populations of aerobic microorganisms that decompose organic matter. Thus, under flooded conditions, organic matter accretion often exceeds decomposition. However, upon drainage, aerobic microorganisms decompose soil organic matter at a much higher rate compared to the anaerobic microorganisms that dominate in flooded soil. As such, microbial activity as affected by drainage is considered the main factor influencing soil subsidence. However, other factors also contribute to soil subsidence, including a loss of buoyancy following drainage, shrinkage and compaction caused by vehicular traffic, and soil loss by wind erosion and burning.


**Subsidence post located at Everglades REC near Belle Glade, FL that was driven to bedrock in 1924. The top of the post was at the soil surface in 1924, and approximately 6 feet and 3 inches of soil has been lost up to 2013.**

The rate of soil subsidence historically averaged 1.1 inches/year, but now the rate is estimated at 0.55 inches/year. There are several potential mechanisms that can explain this decline through time, including increased mineral content of soil, humification, water management (maintenance of higher water tables), and adoption of best management practices (BMPs). One argument for the decrease in subsidence rates is that mineral matter within the soil profile has increased through time as soil volume was lost. As the organic matter is decomposed, the minerals, such as calcium carbonate, sand, and clay, is not lost and in fact its proportion to the total soil volume increases as subsidence occurs. In addition, as Histosols decompose, the easily degradable components are lost first while the more resistant components persist, leading to decreases in the subsidence rate. Another major factor influencing the decline in the subsidence rate through time is improved water management. The subsidence rate is closely aligned with water table depth, as demonstrated by organic matter decomposition rates being impaired by flooding. Implementation of BMPs has also led to more water storage in EAA fields, which helps to retard organic matter decomposition and decrease the subsidence rate. Adoption of minimal tillage regimes has also helped to minimize disturbance and loss of soil organic matter. Changing land management practices under BMP implementation, and the chemical nature of the soil itself, are slowing down the soil subsidence rate allowing for continued use of these soils for agricultural production.

For additional information, contact Alan Wright at: alwr@ufl.edu

## Spodosols - Dominant Soil Order of Florida

*What they are:* Roughly speaking, Florida Spodosols are sandy soils with well-expressed Bh (alias "spodic") horizons that occur within 2 m. These horizons, though dominated by sand (>90%), are enriched with carbon and aluminum derived mainly from the overlying horizons. That translocation process, called "podzolization", results in nearly white E horizons of stripped sand overlying black Bh horizons. Boundaries between E and Bh typically are clear or abrupt in thickness but can range from smooth to irregular in topography.

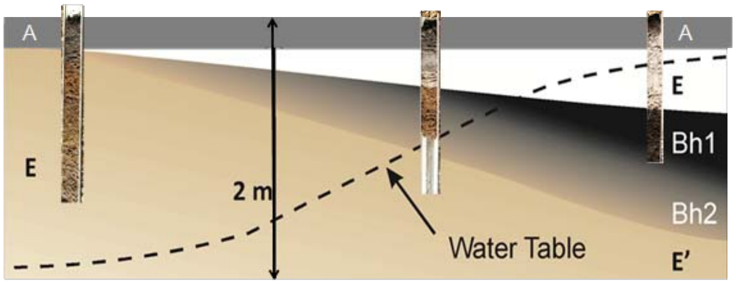
**Two Florida Spodosol profiles showing abrupt-smooth (left) and abrupt-irregular (right) E-Bh boundaries.**

*Importance in global carbon budget and dynamics:* It was calculated from Florida soil survey data and maps that the Bh horizon amounts to approximately 431 million metric tons of carbon, about 0.05% of the global soil carbon pool. However, given that Bh horizons commonly extend well below 2 m, this figure amounts to a "tip of the iceberg" assessment. Mechanisms of Bh formation as well as their stability under different climatic/hydrologic conditions, are pertinent to global carbon dynamics.

**Deep exposure (several meters) of a Spodosol at a heavy mineral mine showing thin Bh in 2-meter soil zone and thick Bh with upper boundary beginning at about 2 meters depth.**

*Water table linkage:*
Northern Spodosols are commonly well drained but Florida Spodosols are mainly restricted to zones of seasonal water table fluctuations. Research has shed some light on the role of water tables in Florida Spodosol genesis though questions remain. Artificial "Spodosols" can be created within a few weeks in the laboratory under fluctuating water table conditions using coated sands collected from imperfectly-drained sites but not from excessively-drained sites such as sandhills. Thus the water table has both a predisposing role and a direct triggering effect on the process. Sufficient frequency and duration of near-surface saturation appear to bring about threshold biogeochemical conditions (e.g., iron depletion, increased organic acid concentrations, reduced aluminum crystallinity) that enable podzolization for the weathered soil components of Florida. This water table linkage makes Florida Spodosols particularly relevant to carbon dynamics under changing climate.

*Interactions with nutrients and contaminants:* The stark contrast (white to black) between the E and Bh horizon of Spodosols is more than just visual. There is a major contrast in soil components and their potential to interact with nutrients and contaminants. The E horizon has negligible retention capacity for phosphate and arsenate, while the Bh horizon has a relatively high affinity for these anions. The Bh horizon has a much higher phosphorus sorption capacity than A horizons due to its relative enrichment with aluminum. However, the organically-associated aluminum in Bh horizons does not bind phosphate as tightly as common inorganic forms of aluminum oxides in Florida sand-grain coatings. Hydrology is a major seasonal determinant of nutrient transport since the extent of nutrients interactions with the Bh varies seasonally with water table depth.




**Schematic representation of the common morphological transition between better-drained soils (left) and Spodosols (right), showing relative seasonal high water table depth. Frequency and duration of near-surface water saturation would increase from left to right.**

*Spodosol myths debunked by pedology:* The term "hardpan" is commonly used in reference to the Bh horizon but in most cases it is neither "hard" nor a "pan." Abundant pedological observations and data collected during the soil survey of Florida indicate that the Bh is not generally restrictive of root penetration nor does it commonly have low permeability. The Bh forms <u>because</u> of the hydrology; it is <u>not the cause</u> of the hydrology.
For additional information, contact Willie Harris at: apatite@ufl.edu

## Hydric Soils

The concept of hydric soils is relatively new to soil science, the term "hydric soil" having been coined in the late 1970's to designate soils that formed in wetlands; however, during the past three decades, in response to increased concern of the status of wetlands, these seasonally wet soils received enough attention to merit a special designation of their own. Hydric soils are soils that currently support or are capable of supporting wetland ecosystems. Soil modifications are not needed to maintain or restore a wetland. In the case of drained hydric soils, only removals of hydrologic modifications are needed to restore wetlands. Conversely, nonhydic soils currently are not supporting nor are they capable of supporting wetland ecosystems. Soil modifications are needed to create a wetland on nonhydric soils.

Hydric soils are defined as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Nearly all hydric soils exhibit characteristic morphologies that result from repeated periods of near surface saturation and/or inundation for more than a few days. Saturation or inundation when combined with microbial activity in the soil causes a depletion of oxygen. This anaerobiosis promotes biochemical processes such as the accumulation of organic matter and the reduction, translocation, and/or accumulation of iron and other reducible elements. These processes result in characteristic morphologies that persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils. Hydric soil indicators are formed predominantly by the accumulation or loss of iron, manganese, sulfur, or carbon compounds. Marl is an additional morphology not related to oxidation- reduction reactions. Soil morphologies that identify hydric soils in-situ are known as Hydric Soil Indicators. Since 1900 more than one dozen publications have identified field indicators of hydric soils.

Of the forty-five known hydric soil indicators in the United States, twenty-five occur in Florida. Each of the hydric soil indicator is identified by a unique alpha-numeric identifier as well as a name. The two hydric soil indicators most used to delineate hydric soils in Florida are S6 (Stripped Matrix) and S9 (Polyvalue Below Surface). The requirements of S6 are as follows: A layer starting within 6 inches of the soil surface in which iron/manganese oxides and/or organic matter have been stripped from the matrix exposing the primary base color of soil materials. The stripped areas and translocated oxides and/or organic matter form a faintly contrasting pattern of two or more colors with diffuse boundaries. The stripped zones are 10% or more of the volume and are rounded. For additional information contact Wade Hurt at: whurt@ufl.edu

**This soil (left) has the indicator S6 (Stripped Matrix) starting at a depth of about 4 inches. The requirements of S9 are: A layer with value 3 or less and chroma 1 or less starting within 6inches of the soil surface. Using a 10X or 15X hand lens at least 70% of the visible soil particles must be masked with organic material. Observation without a hand lens appears to be close to 100% masked. Immediately below this layer, 5% or more of the soil volume has value 3 or less and chroma 1 or less and the remainder of the soil volume has value 4 or more and chroma 1 or less to a depth of 12inches or to the spodic horizon, whichever is less. This soil (right) has the indicator S9 (Polyvalue Below Surface). All of the requirements of the indicator are met starting at a depth of about 4 inches.**

## Welcome Incoming Students Summer & Fall 2013 !

### PhD

Laibin Huang (Ogram)
Liguang Li (He)
Yan Liao (Gerber)
Mary Litrico (Clark)
Elise Morrison (Ogram & Turner)
Joshua Papacek (P. Inglett)
Anne Sexton (Daroub)
Jianru Shi (O'Connor)
Harmanpreet Singh Sidhu (O'Connor & Teplitski)
Reginald Toussaint (Wilkie)

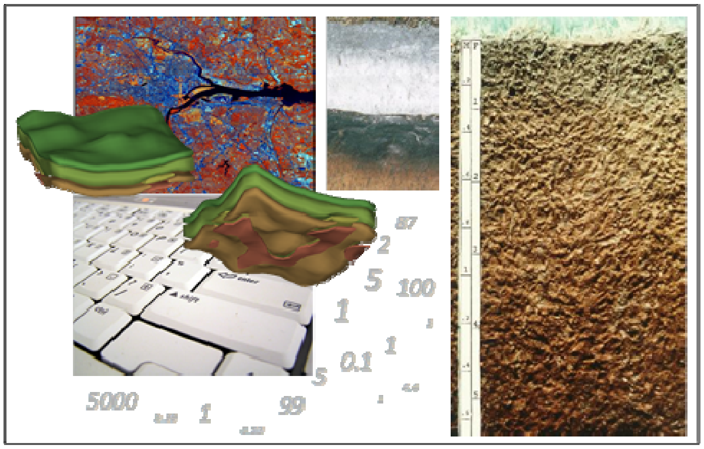
### MS

Ann Marie Couch (Hochmuth & Rowland)
Hamza Keskin (Kramer)
Carl Koch (Kramer)
Tiantian Li (Li)
Chad Livingston (Teplitski)
Kathryn McCurley (Jawitz)
Nickolas Sexson (Ma)
Keri Smith (Wright)
Brandon Snook (Kramer)

### BS

Christelle Beauboeuf (Curry)
Jessica Boevers (Curry)
Dan Carroll (Curry)
Samantha Flodin (Curry)
Lacey Hancotte (Bonczek)
Raul Horruitiner (Curry)
Joshua Keen (Curry)
Andrew Land (Curry)
Daniel Meeden (Curry)
Michael Ross (Curry)
Alexander Tran (Bonczek)

## Pedometrics – Quantitative Environmental Soil Sciences



Perhaps you are one of them? In a global sustainability survey 56% of respondents indicated that they are concerned about the depletion of natural resources, more than about climate change (49%) [GlobeScan, 2013]. Soils are at the heart of natural resources. And you know best about their value to support agriculture, timber and food production, biodiversity, ecosystem services, and the many beautiful natural spots in Florida including wetlands, dry prairies, and sandhill communities supported by a mosaic of different soils. A lot is at stake and our research addresses concerns and needs situated in the sustainability realm.

Globescan. 2013. http://sustainablefutures.info/2013/03/02/environmental-concerns-study

In a nutshell, our research group is interested in to know the *What*, *Who*, and *How* of soil ecosystems. *What* are the spatially-explicit properties of a soil to manage, protect, and sustain it? *Who* is using soil resources for *what* purpose (land use)? *What* are the threats and benefits to use soils as common goods to be shared among all of us? *How* have soils developed over time and how can we sustain them for future generations to use? These questions are important to be answered in support of food and soil security and long-term sustainability of natural resources.

Metrics and models of soils that quantify its properties, processes, and how soils are used geographically are profoundly important. Pedometrics ("pedo" ~ soils) and digital soil mapping can do all this. Our research group has quantified soil carbon storage and change across the State of Florida and analyzed how soil carbon relates to land use and global climate change. We assess relationships between soil carbon and water and nutrients (i.e., ecosystem service assessment), the risk to lose carbon from soils (e.g., prescribed fires and wildfires), how we can adapt to climate change (e.g., droughts), and provide inputs for conservation management (e.g., Florida Forever Program, Florida Department of Environmental Protection). Many other soil properties and processes in diverse ecosystems are studied by our group. We also apply quantitative soil research to other regions in ongoing projects including the conterminous United States, Andes (Peru), and southern India. We use advanced soil spectral and remote sensing methods combined with quantitative modeling and geospatial methods to map and model soil ecosystems around the world. Our research is embedded within the Global Soil Map initiative (North American Node) and Global Soil Partnership (FAO). For additional information, contact Sabine Grunwald at: sabgru@ufl.edu.

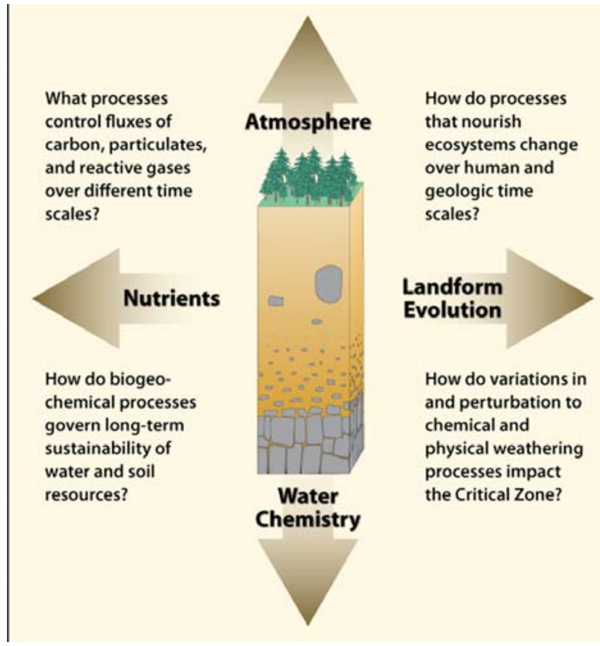
*Join us at…*

## The 14th Annual Soil and Water Science Research Forum

The 14th Annual Soil and Water Science Research Forum is scheduled to be held on September 06 2013, in Gainesville, Florida. The forum is designed to bring together representatives from state and federal agencies as well as private industry, faculty, graduate students, and prospective students interested in soil and water science. The forum will provide an opportunity for all those interested in soil and water science to interact with our students, faculty, and administrators on campus. This year's theme for the forum is on "Sustainability of Land and Water Resources". **Dr. Linda Lee**, Professor and Associate Director, Discovery Park Center for the Environment, Department of Agronomy, Purdue University, is the featured keynote speaker at this year's forum. We look forward to your participation in the forum. If you are planning to attend, please register at http://soils.ifas.ufl.edu/forum/. For additional information, contact James Jawitz at: Jawitz@ufl.edu.

## Soils in the Earth's Critical Zone

Soils encompass the Earth, forming a fragile layer between the lithosphere, the atmosphere and the biosphere. This thin mantle, historically termed the pedosphere (or the sixth sphere of the Earth), controls much of the gaseous and liquid exchange between the surface of the Earth and the atmosphere. In addition, it provides an exchange system for essential nutrients and a water supply for global food production, nourishing crops and providing a substrate for root growth and plant establishment.




**Questions being addressed through the National Science Foundation's Critical Zone Exploratory Network**

In recent decades, our appreciation for just how essential soils are to the functioning of the planet has increased considerably. We know that soils retain more than three times the amount of carbon found in the atmosphere. How will this vast pool of soil carbon respond to climate change? Scientists are rapidly seeking to better understand this large carbon pool and its stability and persistence. Land use and human activity have altered soils at the global scale. As one recent research article states, we have now entered the era of the 'The Anthropocene', which integrally connects the state of soils to human activity. How these human-driven changes impact the cycling of nutrients, water and exchange of other elements on Earth is a new area of research. Just this year, the National Science Foundation supported eight critical zone research sites nationally, with a focus on land use change and human impacts in the critical zone. Soils continue to be a major focus of these critical zone sites as they serve as a 'hub' for exchange of nutrients, the weathering of rocks and the delivery of water to streams and subsurface aquifers. We still have much to learn. As we grapple with an ever-expanding human footprint on the planet, including a changing climate, land use change and invasive species, the need for soils to continue to provide food and a secure clean water supply to society could not be greater. Soils in the Earth's critical zone have a vital role to play in the world's future. For additional information, contact Marc Kramer at: mgkramer@ufl.edu

## Subaqueous Soils and Coastal Ecosystems

Subaqueous soils form or occur in lakes, rivers, estuaries, and near-shore marine habitats. In late 2000s, the UF SWSD began to focus on these areas. Seagrass growth, suitability for shellfish aquaculture, and shoreline restoration have been the major research areas. Stakeholders such as the FDOT, FDACS, NOAA, and NRCS have each provided funding to support the SWSD efforts. Proof-of-concept subaqueous soil surveys have been created in several coastal areas of Florida. These surveys can be combined with soil interpretations such as suitability for clam aquaculture, seagrass habitat & transplant. This knowledge is extended to the local stakeholders via EDIS and have already been well received at local stakeholder meetings.

**Boats, scuba diving, soil cores, and swimming with dolphins are all part of the fun when investigating subaqueous soils.**

For additional information, contact Rex Ellis at: rexellis@ufl.edu or Todd Osborne at: osbornet@ufl.edu

**Shoreline restoration and wetland mitigation site in Ft. Pierce, FL. Red Mangrove (*Rhizophora mangle*) is planted on a 1 m grid spacing. Soil elevation, frequency of flooding, particle size, and carbon content affect mangrove growth and therefore restoration success.**

## Faculty, Staff, and Students

### Marc Kramer joins SWSD faculty

**Marc Kramer** was hired as an Associate Professor of Environmental Pedology and Biogeochemistry. Marc completed his graduate degree at Oregon State University in Corvallis, Oregon and was a post-doctoral fellow with the American Academy of Sciences through NASA Ames in Mountain View, California. He joins us from the Earth and Planetary Sciences Department at the University of California, Santa Cruz where he was an Associate Research Scientist. Marc plans to develop an interdisciplinary research program focusing on innovative applications of pedological principles to agricultural, environmental, and ecological issues as related to climate change and soils with a focus on mechanisms of soil carbon stabilization in temperate and tropical ecosystems. He has on-going field-based research projects in Georgia, Hawaii, the Pacific Northwest, California, and now in Florida. He has plans to work on a clay confinement gradient in the nearby Santa Fe Watershed as part of a new NSF initiative to study the Earth's Critical Zone. Marc will be teaching classes on Global Change and Pedogenic Thresholds (Fall) and Soil Processes in the Earth's Critical Zone (Spring). He is now settled in Gainesville with his wife Marie. For additional information about Marc's research activities, contact Marc at: mgkramer@ufl.edu.

*Congratulations to our faculty, staff, and students for their outstanding accomplishments.*

**Patrick Inglett** – Tenured and Promoted to Associate Professor

**John Thomas** – Promoted to Research Associate Professor

**Chris Wilson** – Promoted to Full Professor

Every year, the American Society of Agronomy (ASA) and the Soil Science Society of America (SSSA) selects few scientists and educators as Fellows. This is the highest honor bestowed by our professional societies. For the year 2013, the following SWS faculty are awarded this recognition.

**Zhenli He**
Professor of Soil and Water Chemistry, 2013 ASA Fellow

**Vimala Nair**
Research Professor of Environmental Soil Chemistry, 2013 ASA Fellow

**Teri Balser**
Dean and Professor of Soil Microbiology, 2013 SSSA Fellow

**James Bonczek** received **NACTA Teacher Fellow Award.** The award was presented at 59th annual NACTA (North American Colleges & Teachers of Agriculture) conference in Blacksburg, VA.

## Congratulations! Summer 2013 Graduates

**PhD**

Xiaoling Dong (Ma & Li)
Xiong Xiong (Grunwald and Harris)

**MS**

Susanna Gomez (Daroub)
Swati Goswami (Sharma Inglett)
Travis M. Knight (Hanlon)
Harmanpreet Singh Sidhu (O'Connor & Wilson)

**BS**

Jason Bloom - SLS -WS (Bonczek)
Tia Boyce - SLS -WS (Bonczek)
Shawn Desantis - IS-EMANR (Curry)
Joseph Kibiwott - SLS -SS (Bonczek)
Leah Hope Laplaca - SLS -WS (Bonczek)
Cristina Roca Rivera - SLS -WS (Bonczek)
Stephanie Schwarz - SLS -WS (Bonczek)
Evelyn Suarez - SLS -WS (Bonczek)