USDA United States Department of Agriculture

NRCS’ 2019 Soil Science Collaborative Research Projects

15 Projects Representing a $1.9 Million Investment

2019 Projects Selected

Alcorn State University

Title: Serving to Serve: Training the Next Generation of USDA-NRCS UAV Pilots in Soil Conservation Applications

Unmanned aerial vehicles (UAVs) are transforming soil science. They complement the need for real-time information to enhance decision making on the improvement of soil conservation practices for underserved communities. While these communities are feeling the impacts of natural disasters, such as the current extensive Mississippi River Valley flooding, UAV real-time data would be crucial in developing aftermath soil conservation planning. The increasing use of UAV analysis for solving soil conservation problems has created a growing need for agricultural professionals with Federal Aviation Administration (FAA) UAV pilot licenses and training in soil conservation applications. Another factor impacting this growing need is a reduction in student academic retention and transition into soil and plant science careers (Collins, 2008). Students engaged in academic career mentoring programs are more likely to transition into their intended career paths (Cobane, 2010). Therefore, Alcorn State University would like to address these UAV expertise needs by preparing students to become FAA UAV licensed pilots with training in soil conservation applications. The USDA-NRCS Soil and Plant Science Division priorities addressed by this project are improving procedures for soil and ecological site inventory and increasing efficiency of technical soil services. The area of research priority addresses are training development and new investigations.

Brooklyn College of the City University of New York

Title: Development of soil survey methods for urban areas

This was based on a priority research topic for the Northeast Region of the National Cooperative Soil Survey.

Soil is a fundamental component of long-term urban sustainability and resiliency. In cities, soil-based approaches answer many ecological and environmental challenges such as flooding, water quality, solid

Leveraging Efforts

On August 15, 2019 USDA Natural Resource Conservation Service’s (NRCS) today announced $1.9 million in funding for 15 Soil Science Collaborative Research Proposals for projects focused on soil science and soil survey research.

The information gained from the collaborative research will advance NRCS’s ability to provide scientifically based soil and ecosystem information to help address important natural resources issues our nation is facing.

Currently in its 12th year, the Soil Science Collaborative Research Proposals awarded grants were selected from among 32 applications. Projects were selected on nationally identified needs in communities and landscapes.

waste disposal, noise, public health, heat island effects, and food deserts (Cheng et al., 2018). Urban soils are at the foundation of the urban ecosystem and its functions (Stroganova et al., 1997; Pickett et al., 2011).

Despite recognition of their importance, urban soils are still very poorly understood, characterized, and mapped. Analysis of urban soils is complicated by frequent contamination, extreme heterogeneity and highly variable mixtures of human-transported and human-altered (HAHT) materials. The understanding of urban soil characteristics, functions, development, and management strategies is still in an early stage (Pouyat et al., 2010), in part because of logistic and accessibility issues that prevent mapping and cataloging of urban soils.

More efficient ways to conduct soil surveys in urban areas are urgently needed to characterize dynamic soil properties, assess soil quality, identify the appropriate land use, and restore the ecosystem functions of this vital resource that serves an ever-growing percentage of the US and world-wide population. In particular, soil survey activities would benefit from the use of non-invasive techniques to map the subsurface and pre-determine the degree of heterogeneity of a site as a way of guiding the selection of representative sites and subsequent description and sampling. Soils in urban areas vary significantly over short distances with little or no indication that conditions have changed, and excavation can be prohibited or made difficult with compaction or buried artifacts. Non-intrusive technologies such as ground-penetrating radar (GPR) and electromagnetic induction (EMI) can generate large data sets covering sizeable areas in a relatively short time without the need for borings or excavations. GPR can identify subsurface interfaces from contrasting materials and restrictive or compacted horizons (Adamchuk et al., 2017), whereas EMI can detect changes in the apparent electrical conductivity, and can assess spatial variability in salinity, texture, Cation Exchange Capacity (CEC), moisture content, CaCO3 content, SOC, bulk density, pH, and structure (Doolittle and Brevik, 2014). Further interpretation of the data provided by these currently under-utilized techniques could shed light on the hydrology and related properties at urban sites.

In addition to improved approaches to mapping and site characterization, there is a need to link mappable characteristics to functional attributes of urban soils related to fertility, contamination, and water dynamics. Research is needed to develop screening protocols for organic matter properties related to the ability of soils to sequester carbon, to provide nutrients such as nitrogen and phosphorus for plant growth, to sequester inorganic contaminants such as metals, and to support biological degradation of organic contaminants. An especially important frontier is to use new molecular tools to characterize the microbial communities that are responsible for the processes underlying nutrient and contaminant dynamics. There is also a great need for screening protocols that reflect the abilities of urban soils to infiltrate, store and transmit water. For example, recent progress has been made on the use of 3-D laser scanning technologies, such as multi-stripe laser triangulation (MLT), to characterize soil structure and macropore networks that serve as primary pathways for the infiltration and flux of soil water (Hirmas et al., 2016). However, to date, these methods have not been applied to soils of urban settings.

One of the unique and challenging aspects of urban soils is the nature and properties of carbon compounds. These compounds have strong effects on biological and chemical properties that regulate fertility and contaminant dynamics and on physical properties that affect water movement through the soil profile (Pouyat et al. 2010). Urban soils have unique carbon compounds for two reasons. First, there are many anthropogenic materials in urban soils – for example, coals ash and municipal waste that can have a very high carbon content with properties that differ markedly from carbon derived from decomposition of plant detritus. Second, urban atmospheric conditions affect the nature of plant detritus and the decomposition process, creating uniquely urban carbon residues in the soil (Pouyat et al. 1995). Soil surveys provide opportunities to identify and map urban soils with distinct carbon compounds especially when combined with the latest advances in imaging technologies, such as hyperspectral imaging (HSI), that allow for the identification and mapping at sub-millimeter resolution the composition of the soil solid phase (e.g., particulate organic matter, black carbon, and Fe- and Mn-oxides). If we can characterize relationships between data obtained from geophysical tools and functional characteristics related to profile morphology, fertility, and water movement, it would be a major advance in urban soil mapping and characterization.

There is a strong need for information about urban soils, and improvements in their mapping and functional characterization would have important implications for multiple stakeholder groups. In particular, more and better information on the properties and spatial distribution of urban soil types would be invaluable to urban agriculture enterprises, community gardening programs, stormwater management, land reclamation and restoration, and general ecosystem service delivery in cities. There is great interest in the use of urban areas for supporting community outreach programs that the NRCS currently provides with financial and technical assistance. Such practices as high tunnels, urban agriculture, community gardens, agroforestry, and green infrastructure should all be accompanied or preceded by a soil investigation that encompasses both quantitative and qualitative methods. Such an investigation should also serve as a data point for urban soil survey.

Expected project deliverables that will contribute to achieving the Soil Survey mission:

- This project will develop several soil survey methods that have not been typically used by the NRCS in the past. Thanks to technological advances, we are now able to collect both quantitative and qualitative data on the unique properties of urban soils in less time and at a much lower cost. Through this project we will evaluate the data collected by these new methods with data collected using conventional methods and propose appropriate protocols to be considered for adoption by the NRCS, along with a set of recommendations for each method.
- We will provide assessment on the predictive capabilities and sensitivities of these methods on urban soil dynamic soil properties.
- The dynamic soil properties data from NYC can be added to the existing NRCS soil database.
- The hydraulic data collected in this study on the core samples will be invaluable for future modeling of specific land uses, such as improving the estimation of saturated hydraulic conductivity and better defining hydrologic soil groups.
- A database of biological, chemical, and physical properties for the selected soils of New York City will be generated as part of this project and will likely serve as a model to be replicated in other urban centers of the U.S. and the world.
- At least one graduate student and three undergraduate students from three colleges will be directly involved in this collaborative research project. Additional training and research opportunities for other undergraduate and high school students will be made available. These will motivate them to consider a soil-related career.
- Through this project we will sample 4 intact soil thick sections and a full profile-length monolith, representing 14 major soil series in New York City. The four smaller soil thick sections will be digitized using MLT and HSI and made publicly available online for both research and educational use. The larger monolith of the whole profile will be made available for educational use.

Colorado State University

Title: Harnessing the power of the National Cooperative Soil Survey to inform science-based management decisions for increased soil carbon sequestration and soil health

We propose to couple the National Cooperative Soil Survey (NCSS) Soil Characterization Database and the National Soil Survey Center (NSSC) Kellogg Soil Survey Laboratory (KSSL) soil archive with soil organic matter physical fractionations and Diffuse Reflectance Infrared Fourier Transform (DRIFT) spectroscopy to determine drivers of both topsoil and subsoil carbon (C) sequestration potential, based on the distribution of MAOM and POM, their C-chemistry and nirogen (N) requirement.

We will use machine-learning techniques to predict C storage on the basis of soil physicochemical properties described in the NCSS Soil Characterization database, and linked to soil taxa, ecological edaphic site properties, land management, and climate. This work will maximize the use of the NCSS products and provide direct ties between the soil capacity to sequester C and conservation practices. The project primarily addresses the Soil Science Division priority area: Supporting the National Cooperative Soil Survey. It also contributes to Maintaining the relevancy of soil information, providing new understanding and valuable data. It is in the new investigation area of research priority.

This project will deliver:

- Pedotransfer functions to predict soil C sequestration potential across the NCSS Soil Characterization Database sites and as it relates to soil taxa and management.
- A dataset to integrate into the current NCSS Soil Characterization Database of measured soil C and N stocks for POM and MAOM soil components for 1,000 points representative of the full database sites, and a random forest regression model to estimate them for the remaining sites.
- A dataset to integrate into the current NCSS Soil Characterization Database of the measured DRIFT spectra of bulk soils and POM and MAOM fractions for 1,000 sites representative of the full database, and a partial least square regression model to predict POM and MAOM fractions distribution from bulk soil DRIFT spectra.
- SURGO-based scalable mapping outputs for the distribution of soil C and N across different organic matter fractions and through depth, overlaid with soil taxa, ecological edaphic site properties, land management, and climate.

Kansas State University

Title: Disaggregating SSURGO soil maps across large areas using existing qualitative knowledge and modern databases

This was based on a priority research topic for the North Central Region of the National Cooperative Soil Survey.

SSURGO level 2 soil maps and descriptions are incredibly useful to a wide variety of users and have played a crucial role in the increase of crop yields over the last half century. However, more detailed soil maps are required to support the opportunities offered by precision agriculture, and to further finetune conservation efforts. It is impractical to produce such detailed maps over large areas by traditional survey methods, which explains the fascination with Digital Soil Mapping (DSM) techniques. These statistical techniques are in theory flexible enough to operate at a range of scales, and in a wide range of environments. However, their widespread use is currently hampered by the fact that appropriate parametrization of purely statistical models used in DSM requires more and differently sampled formal soil descriptions than currently available.

Our core idea is that the wealth of soil-landscape knowledge gathered during decades of traditional surveying can be leveraged in a coherent quantitative framework to make large improvements in map resolution with only modest additional expenditure. The resulting maps would be more useful to a wide variety of users, and additionally provide a better jumping off point for existing and future DSM projects.

To test this idea, we will employ a hybrid method where block diagrams and other soil-landscape information as well as Digital Elevation Models (DEMs) are used to subdivide existing polygons in soil maps across the North Central Region. This method, the maps produced in our pilot studies, and the evaluation of map quality will be the key results from this project.

New Mexico State University

Title: Seamless, regionally-specific raster soil property maps to support interpretations

Supports Soil and Plant Science Division priorities for improving procedures for soil and ecological site inventory.

An important application of soil survey is to provide land owners, land managers, and policy makers with ratings on the suitability or limitations of soil for a particular application. These ratings are delivered as interpretations and have been solely delivered by polygon-based soil data to date. Digital soil mapping (DSM) presents intriguing possibilities for the display and development of soil interpretations (Dobos et al., 2017). There are currently two shortcomings that limit the precision and accuracy of interpretations: 1) the current system requires only data from the SSURGO database, which may not be entirely reasonable for climate or geomorphology data and more authoritative data sources may be more applicable, 2) the interpretive output can only be displayed as aggregated values from the original mapping (Dobos et al., 2017). Interpretations are generally scale-independent so using higher resolution input data with quantified uncertainty is likely to allow greater confidence (or identify areas where confidence is too low to be useful) in the spatial location of the results (Dobos et al., 2017). It is likely that DSM can contribute to these two limitations by providing higher resolution climate, geomorphology, and soil property data with quantified uncertainty.

Current DSM approaches for predicting soil property data for input into generating soil interpretations generally predict soil properties at global, continental, or national extents. These top-down approaches use a single ‘global’ model, meaning that only one model is applied to predict a soil property across the entire spatial extent. For example, Viscarra-Rossel et al., (2015); Ballabio et al., (2016); Mulder et al., (2016); and Ramcharan et al., (2018) used single models for predicting soil properties across Australia, France, continental Europe, and the conterminous USA, while Hengl et al., (2017) predicted soil properties across the globe using a single model. We hypothesize that a bottom-up approach using regionally-specific models, rather than a single ‘global’ model, may provide more accurate national-scale predictions than a single ‘global’ model. Our initial tests have generally supported this hypothesis (Figure 1). However, making seamless spatial predictions from regional models has proven highly computationally demanding (initial predictions of soil depth classes from nine MLRA-specific models for the entire Upper Colorado River Basin took 19 days using a 32 Core 32 GB RAM 2.8 GHz computer) and may introduce seam artifacts along model spatial boundaries.

Thus we propose to develop a prototype interpretations engine that produces soil interpretations using digital soil maps of key soil properties and a methodology that minimizes the computational cost and border artifacts of regional modeling. It is intended that these approaches will be applicable to help address Soils2026 goals, support the NRCS–DSM team, be applicable in other soil survey regions, and facilitate application of gridded DSM products by soil survey users, including land owners and federal land management agency partners.

North Carolina State University

Title: Quantification of Blue Carbon Stocks along Salinity Gradients from Tidal Freshwater to Coastal Marine Wetlands in the Southeastern United States

This was based on a priority research topic for the South Region of the National Cooperative Soil Survey.

Sea level rise has resulted in increasing salinity within tidal estuaries of the southeastern United States. Saltwater intrusion drives shifts in wetland vegetation from healthy tidal forested swamps to degraded oligohaline marshes, and ultimately stable salt marsh communities. To date, few studies have attempted to quantify the effects of salinization on coastal soil properties, including soil carbon storage and sequestration. There is currently a great need to know how much blue carbon (C) is stored in coastal environments and how these pools are changing over time. This project will synthesize existing information and collect new soil blue C data along salinity gradients to quantify the impacts of saltwater intrusion on wetland soil properties, accretion rates, and soil carbon stocks. Additional remote sensed information will be used to quantify the spatial area impacted by salinization in North Carolina and make predictions of how far shifts towards marsh systems will occur in the future. A soil survey approach to understand dynamic changes in ecosystems, as well as associated soil properties related to soil organic carbon (SOC) sequestration and storage, would be extremely beneficial for future interdisciplinary studies. Establishment of a baseline for soil blue C accounting will allow for more collaborative research efforts across disciplines that are necessary to improve our overall understanding of global change, sea level rise, and coastal soil system changes.

Purdue University

Title: Leveraging Soil Explorer for Soils and Ecological Training

The Integrating Spatial Educational Experiences (ISEE) project has developed apps for iPad and Android devices as well as the SoilExplorer.net website. Soil Explorer pairs transparent maps of soil properties with a highly optimized hillshade basemap that provides a 3D representation of the topography. These maps are not just pretty pictures, but powerful teaching and learning tools that allow one to see relationships between soils and geomorphology and to understand why it matters. These relationships are site-specific and must be worked out by individuals familiar with a given area. How this works is best illustrated by an example.

Every landscape has a story. By using the maps in Soil Explorer, a skilled instructor can tell these stories in new and engaging ways, and engaging exercises can be devised to lead students to discover these stories on their own. At this time, however, only three maps cover the entire nation.

Leveraging Soil Explorer Purdue University available maps of soil properties in order to make Soil Explorer a more useful training tool for use anywhere in the U.S.

University of Arizona

Title: Deadly Dust on the Highway - Developing a Dust Risk Index in the Desert Southwest Grounded in Ecological Site Descriptions

This was based on a priority research topic for the West Region of the National Cooperative Soil Survey.

There is an urgent need to improve understanding and prediction of high-risk landscapes for soil dust production along major highways in the southwestern U.S. because of fatal automobile accidents, but also other human health effects such as asthma, allergies, and Valley Fever. Arizona presents a particular need and opportunity for dust research. First, due to continued drought in Arizona and the Colorado River Drought Contingency Plan, many areas in central and southern Arizona are facing water shortages. Water shortages will lead to more fallow and abandoned croplands, thus creating even more potential dust sources in the future. Second, despite some of the highest rates of dust-related fatalities (Table 1), soil dust production in the Sonoran Desert is understudied compared to other North American deserts. Third, Arizona has an established, active State Dust Group with diverse, including a collaboration between the Arizona Department of Transportation and National Weather Service building a $13 million dust detection and early warning system along the Interstate 10 corridor between Phoenix and Tucson. This effort will benefit greatly from information about soil dust production, including identification of threshold wind speeds and the most vulnerable soils to target investments for visibility, particulate, and meteorological monitoring. Finally, Arizona is already investing in dust mitigation research, including a project along I-10 near Picacho Peak where the University of Arizona is collaborating with the Arizona Department of Environmental Quality and Arizona State Land Department to compare mulching and chemical stabilizers at a large scale in 1-acre plots. There is a growing need to identify dust hotspots for the wisest investments in future mitigation actions.

Despite all of these critical needs to improve understanding and prediction of soil dust production in Arizona, stakeholders still need a dust risk index. The currently available Wind Erodibility Index (WEI) is not based on actual measurements of soil dust production and may be missing key mechanistic drivers that determine which soils and Ecological Site Descriptions (ESDs) are most vulnerable to future dust production.

University of California – Davis

Title: Machine-based algorithms to automate Soil Taxonomy

Soil taxonomy was first established to serve two functions: (1) provide an organizational system for soil properties in a way that works to explain how soils and their formative factors are connected, and (2) present a common language to be used among soil scientists (Soil Survey Staff, 2014). Taxonomic classification is currently determined by applying measured and observed properties according to the rules outlined in "Keys to Soil Taxonomy" and keying out the appropriate classification. This process has historically been performed by reading through a written copy of the Keys and manually selecting taxonomic units. No program currently exists to conduct this process automatically or semi-automatically. The development of such a program could streamline the process of accurately classifying soils, limit errors, and enhance communication of soil taxonomic language in a way that is easily accessible to those outside of the soil science discipline.

The "Keys to Soil Taxonomy" provides the framework to fully classify a soil to the family level (Soil Survey Staff, 2014). The USDA Soil Taxonomy system, as codified in the Keys, is structured in such a way that most all possible combinations of observed morphologies may be represented in a set of logical decisions. The information in the Keys is ordered as a series of logic to reach the desired classification level. The Keys provides criteria for establishing diagnostic features, diagnostic horizons, soil moisture regimes, and soil temperature regimes (Soil Survey Staff, 2014). Using these, one may then proceed with the classification process using the key. If the conditions for a taxa are not met, the next taxa is assessed until an end point is reached (Soil Survey Staff, 2014).

Since the inception of a unified taxonomic system, the soil classification process has been performed manually from available data using field descriptions and laboratory analysis. The "Keys to Soil Taxonomy", while regarded as the primary means of determining a class, is challenging to navigate without familiarity of many concepts in pedology and takes a great deal of time even for experts. To an outsider, the Keys may as well be written in an entirely different language. The development of a simpler, automated process would greatly simplify the task of soil classification. It could also be used to visualize differentiating criteria in a way that would make Soil Taxonomy more transparent to the non-expert. As the classification system is updated, older soil data must be reanalyzed to ensure consistency with taxonomic standards. Thus an automated system would streamline soil survey updates.

University of Massachusetts – Amherst

Title: Development and application of PXRF protocols to potentially hazardous metals in soils of urban forests and gardens

This was based on the priority research area as identified by the Northeast Region of the National Cooperative Soil Survey.

With 80.7 percent of the U.S. population living in urban areas and the increasing utilization of urban agriculture, the development of characterization and survey protocols of urban soils is becoming a priority to address environmental issues and better understand urban soils development, characteristics, and impacts. While urban soils are important due to their capacity to sequester trace metal pollution from entering surface and ground waters, or be taken up by trees or crops, they also commonly have elevated concentrations of potentially hazardous metals, such as As, Cd, Cu, Pb, Mn, Hg, Zn, due to past and current anthropogenic activities (e.g. fuel combustion emissions, vehicle dust, industrial activities, combustion of non-fuel materials, smelting, weathering of human materials), and act as contaminant sources through ingestion, inhalation, or biosorption.

Complete digestions and extractions protocols used to assess trace metal concentrations and their mobility are slow and expensive due to urban soil heterogeneity, intensive sample preparation, analytical chemical methods, and expensive instrumentation involved in their compositional analysis (Radu and Diamond, 2009; Horta et al 2015). Portable X-Ray Fluorescence (pXRF) offers an opportunity to rapidly assess trace metal concentrations of soil. Currently, there are several known drawbacks to its utilization such as varying field water content, organic matter concentration, and particle size class (Horta et al 2015). In addition, bioavailability and mobility assessments are obscured by the inclusion of metals within silicate minerals (Caporale et al., 2018). However, in-situ pXRF measurements may be calibrated through development of a standard protocol to overcome these issues and make predictions about trace metal bioavailability and make pedologic interpretations (Horta et al., 2015; Caporale et al., 2018). This is of critical importance for estimating urban forest ecosystem services and potential bioavailability of trace metals for urban agriculture and water resource protection.

The geographic location of our project (NY, MA, CT, and VT), development of pXRF technology, and focus on metal pollution in urban soils all address the Northeast Region, National Cooperative Soil Survey Research Priority Area. Here we aim to develop a protocol for measuring soil compositions by in-situ pXRF and apply our new protocol to important urban soil challenges (listed below) for the northeast region.

Challenges to be addressed:

- How do soil moisture, organic matter, and rock fragments affect in-situ and ex-situ pXRF measurements?
- Do trace metal distributions and concentrations (particularly As, Cd, Pb, Cu, Zn, Mn) in urban soils depend on lithology, land-use history, or traditional parameters (pH, clay content, and organic matter content)?
- Can toxic metal concentrations in urban soils measured by pXRF be used to predict increased uptake of toxic metals in crops of urban gardens or native and invasive woody plants in urban forests?

University of Tennessee – Knoxville

Title: Predicting controls on soil organic carbon storage and loss in state and transition models in critical ecological sites across Tennessee

Soil organic carbon (SOC) is a critical soil property for ecosystem function and plays roles in increasing plant productivity, soil fertility, and reducing erosion. We know that land use and management significantly alters ecosystem function and SOC storage. However, we still have little information how the soil chemical, physical, and biological properties that control SOC stocks vary in relation to soil taxa and ecosystem state (Fig. 1). We propose to measure these dynamic soil properties and biological indicators in several critical Ecological Sites across Tennessee that are in different ecological states (cropland, pasture, reference/naturalized state). Our overall objective is to determine how SOC scales across soil types in state and transition models. We will determine which dynamic soil properties are most important for controlling SOC in different Ecosystem Site states.

Currently, NRCS is in the final phases of completing Provisional Ecological Sites (PES) for the United States. PES are first approximations that rely primarily on currently available data, which varies across states and regions. In some cases, very little data are available for incorporation into PES and therefore, refinement is needed. This is the case in much of Tennessee. Even at the approved level of ecological site development, quantitative data that strengthens State and Transition Models (STMs) is needed. This project meets the goals of Soil Survey by contributing to the Soil and Ecosystem Dynamics focus area, specifically dynamic soil properties as a driver for state changes in ecological sites (transition and restoration pathways). Ecological Site reports are broad-reaching and can be an invaluable aide for use in conservation programs such as the Environmental Quality Incentives Program, along with state conservation programs. Given such potential, the Ecological Site Descriptions (ESDs) developed may become an important product for guiding potential restoration activities and conservation actions. More science-based decision-making is needed to ensure the highest level of quality is delivered to NRCS's customers and partners.

We will partner with NRCS Soil Survey to quantify dynamic soil properties in key PES across the state of Tennessee. We will measure microbial biomass, respiration, and activities of a suite of soil enzymes which are key biological indicators of SOC. New technologies and methodologies that we will employ include quantification of the structure of bacterial and fungal communities, as well as the abundance and distribution of functional genes that control organic matter decomposition, and subsequent SOC accumulation and nutrient retention. We will relate these biological parameters to measures of the stability and turnover of SOC fractions including soluble, particulate, mineral-associated, and aggregate protected organic carbon. To assess changes in soil structure, samples will be sent to colleagues at the Kellogg Soil Survey Laboratory for determination of bulk density, aggregate stability, and total soil carbon. We will leverage support for field site identification, sampling protocols, and baseline dynamic soil property measurements by combining our sampling with that of an existing NRCS-supported study.

University of Texas - Rio Grande Valley

Title: Building soil science capacity through research at UT Rio Grande Valley, a premier Hispanic-Serving Institution in South Texas

As mandated in the "Agriculture Improvement Act of 2018" (2018 Farm Bill), special efforts are underway to reinforce the U.S. government's commitment to underserved, socially disadvantaged, beginning, and veteran populations and producers. As prioritized in this announcement for funding, The USDA Natural Resources Conservation Service (NRCS) aims to improve engagement with these groups while advancing the soil survey mission of the agency. The recent Notice for Funding. Partnership with the academic institutions such as the University of Texas Rio Grande Valley, a minority serving institution whose mission overlaps considerably with this mandate, can help maximize the return of this investment.

In addition to playing a considerable role in the educational and workforce development, public universities also are charged to advance research that impact regional and global prosperity. As a USDA-designated Hispanic Serving Agricultural College and University (HSACU) and one of the largest federally designated Hispanic Serving Institutions in the country, UTRGV is highly qualified to lead in this charge. With a regional presence across a four-county area in south Texas (which include USDA designated Strikeforce counties of Hidalgo, Starr, Cameron, and Willacy) UTRGV prioritizes community engagement, expanded educational opportunities, and research impacting the RGV and beyond. Ultimately, the goal of UTRGV is to serve the region—where 91 percent of the population is Hispanic (USCB 2012)–while becoming the nation's premier Hispanic-serving institution (UTRGV SPC, 2016). The comprehensive strategic plan for UTRGV centers on exceptional educational, research, and creative opportunities that serve as a catalyst for transformation in the Rio Grande Valley (RGV) and beyond.

Within the next 5-7 years, UTRGV aims to become an emerging research university and, given its strategic location in one for them most important agricultural areas in the state of Texas, has decidedly invested in research and teaching in agricultural related sciences. In the past three years, the College of Sciences have hired 10 new faculty in food and agriculture, including two entomologists, two soil scientists, a plant physiologist, a plant pathologist, an environmental geographer, and three food scientists. These new faculty have initiated certificate programs in soil sciences and geographic information systems to help qualify students for careers in these areas. Within the UTRGV's School for Earth, Environmental and Marine Sciences (SEEMS), faculty have launched a new BS degree in Sustainable Agriculture and Food Systems (launched Spring 2019) and an MS in Agricultural, Environmental, and Sustainability Sciences (launched Spring 2017). In 2017 UTRGV founded the Center for Sustainable Agriculture and Rural Advancement (SARA), a center aimed at integrating research and technical assistance to helping rural areas develop the capacity to advance well-being and prosperity in their communities. SARA promotes the economic, social, and environmental advancement of rural and urban areas as these relate to agriculture, through community-based participatory research, academic service learning, and outreach activities.

With these research, education, and community engagement initiatives, UTRGV is well positioned to address NRCS priorities—and the mandate included in the 2018 Farm Bill—as it reaches out to underserved and underrepresented farmers and students in the region. Faculty and staff work closely with UTRGV students and with local producers on research and on-farm trials that examine various ways to improve the sustainability of farms, including research on insect and weed pest management, cover crops, water management, and biodiversity conservation. Special efforts have been made to target producers in the region that has the highest concentration of Hispanic farmers in the country (USDA NASS, 2012). Through participatory research, technical assistance, training, and outreach events such as the Texas Hispanic Farmers and Ranchers Conference (sponsored by NRCS), UTRGV has quickly developed its As importantly, these faculty are helping develop a diverse workforce by preparing local area students with a unique integrative education and training experience that prepares them to meet the challenges and opportunities related to agricultural, food, and natural resources.

Funds requested in this project to partially support ongoing and research related to the impact of soils management through agricultural practices on soil health. The PI (Racelis) is currently engaged in collaborative work with USDA agencies (including NRCS) and other counterparts doing research and extension-related activities on cover crops in arid subtropical conditions, sponsored through an NRCS-Conservation Innovation Grant. Emerging from this work is the need to better understand tradeoffs in regard to the long-term and short-term implication of cover crops in regard to soil moisture, especially in arid conditions where no irrigation is available and where short term availability of moisture is the limiting factor, and for producers who are either certified organic, transitioning to organic, or exempt from organic certification. Significant funding is requested to enhance the quality of the education for UTRGV students by providing opportunities in experiential learning and engaged scholarship, through both student engagement in research and scientific projects relevant to the NRCS agency (i.e. involvement in faculty led research projects), and through of exposure to internship opportunities at NRCS, including as student interns/Earth Team Volunteers at NRCS offices at the Central Science and Technology Center in Ft. Worth, Texas, and at the National Soil Survey Center in Lincoln Nebraska.

University of Wyoming

Title: Development of immersive virtual reality experiences in the ecosystem sciences

Education and training in the natural resources and ecological disciplines requires immersive, field-based experiential learning opportunities. Due to constraints of cost, time, and logistics, travel to every ecosystem or the observation of all-natural features is impossible. We propose to create a set of 3-dimensional, 360^{o}, immersive ecosystem modules that transport the user into a variety of ecosystems that cannot reasonably be visited. In collaboration with the Shell 3D Viz Center at the University of Wyoming and others, we will generate ecosystem modules that can be shared on multiple platforms, from high-quality virtual reality goggles to the ubiquitous 2-dimensional phone or computer screen. The modules will be used to improve the learning environment and engage users by linking below-ground with above-ground processes on the landscape.

University of Wyoming

Title: Quantification of redoximorphic feature expression in seasonally saturated soils

A large body of research exists and is shared through many disparate sources (journal articles, theses and dissertations, NRCS project-level data, etc.) on the formation and expression of redoximorphic features in hydric and hydromorphic soils (e.g. Simonson and Boersma, 1972; Franzmeier et al., 1983; Elless et al., 1996, and others). We seek to mine these data to develop a model or models of redoximorphic feature expression with regard to soil physical and biogeochemical properties. Through the collection and analysis of these data, we will improve our understanding of the conditions required for the formation of redox features in the heterogeneous below-ground environment.

Virginia Institute of Marine Science

Title: Estimating blue carbon stocks in coastal marshes to enhance NRCS soil surveys

This was based on the priority research area as identified by the South Region of the National Cooperative Soil Survey.

Coastal blue carbon ecosystems are undergoing continuing loss, yet these systems are being recognized for their importance in carbon sequestration and links to climate change (Howard et al. 2019). The National Coastal Blue Carbon Assessment, a nationwide NRCS effort, recognizes that estimating blue carbon stocks is needed to improve Coastal Zone Soil Surveys. The Center for Coastal Resources Management at the Virginia Institute of Marine Science proposes to collaborate with NRCS scientists, bringing our extensive regional tidal marsh and GIS experience to complement their soil expertise, to estimate blue carbon stocks in tidal marshes in coastal Virginia and North Carolina.