ASSOCIATION OF 1890 RESEARCH DIRECTORS

This research has allowed the study of sediment fingerprinting from the urban Buffalo Bayou Watershed in Houston, Texas. Urbanization accelerates the conversion of natural and agricultural lands to urban soils with altered biogeochemical properties. The study has allowed monitoring of soil stable isotope tracers ($\delta^{13}C$ and $\delta^{15}N$), and implementation of a scientifically and statistically sound Decision Support Tool to quantify uncertainty in sediment provenance model under episodic, high intensity rainfall at watershed scale. This grant has supported students across three regional universities to receive training in field sampling and how to conduct research in physical and computational lab settings.

Hydrologic Influences on Soil Organic Carbon Loss Monitoring Using Stable Isotopes

Who cares and why?

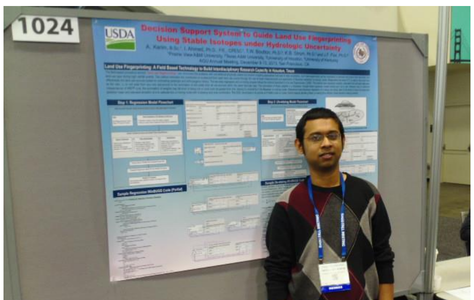
Accelerated soil erosion is responsible for about one third of all soil degradation. Urban soils play an important role in the ecosystem; they help minimize damages from intense precipitation and flooding, retain and immobilize many contaminants, and are good buffer from climate extremes. There is a need for decision support systems to help manage and protect our natural resources (e.g., soils) and environment from climate induced land degradation. There is a current trend in the scientific arena on the need to develop comprehensive computational models that allow the understanding of various ecological functions and processes in the hydrologic cycle to monitor green house gases in the atmosphere. A growing focus of the scientific body is on the development of coupled ecological and hydrologic process models. Successful implementation of coupled model requires field data based knowledge of the ecosystems; including urban, agricultural and forest ecosystems. The efforts under this research agenda has focused on the urban soil biogeochemical environment.

Carbon sequestration related concern was celebrated across boundaries and in remote location like Iceland in 2013 at a very successful meeting of the Joint European Commission on Soil Carbon Sequestration. The meeting, like others conducted by the American Geophysical Union, concluded that there exists a gap in the wealth of available scientific knowledge and implementation of projects guided by that knowledge base to find solution to the existing problems in natural resources (e.g., soil) conservation management. This study has allowed the project team to conduct applied research with field data driven validation of statistical computational sediment fingerprinting (or, soil erosion source monitoring) model, and quantify the associated uncertainty under episodic rainfall. The use of such models in the urbanized South Texas is a first time regional implementation, led by Prairie View A&M University (PVAMU), that has triggered interests among the citizens to see how decadal changes may be incorporated in the future research agenda. The goals of this multi-institutional study was to (i) train students to conduct research on the topic, (ii) develop an awareness among the citizens of the watershed on the role of soil in long-term ecosystem balance, (iii) develop and broaden research collaboration among the three universities, (iv) support graduate students via long term field work and produce graduate theses at PVAMU, and thus, (v) build long term research capacity at PVAMU. The multi-disciplinary collaboration has brought exposure to PVAMU in collaboration with Texas A&M University-TAMU and University of Houston-UH to reach a common goal.

What has the project done so far?

The research theme was geared towards creation of scientifically and statistically valid models to quantify percent sediment fraction yield from urban watershed using soil stable isotope tracer data ($\delta^{13}C$ and $\delta^{15}N$). Stable soil isotope tracer data is a biogeochemical property of soil that holds soil identification information at a location in the watershed. To date, 6 undergraduate and 7 graduate students (2 M.S., 5 Ph.D.) have been beneficiaries of the grant to help realize their potential through participation in interdisciplinary research activities. Most of these students have provided an extended period field support to assist PVAMU with the development and calibration of sediment fingerprinting model, and complete two M.S. research theses. The project has helped broaden the students' knowledge base in an area of ecosystem research that would otherwise remain unknown to them. Primary field tasks by students at UH and PVMAU have included long term (up to three years) collection of suspended sediment samples at both low and high-flow conditions along the Buffalo Bayou, and land samples. Given the time consuming nature of sampling on a 60 square mile urban watershed, and dependency on episodic high intensity rainfall, the long term research agenda allowed a schedule that facilitated the timely completion of annual research agenda through negotiations with local and federal agencies who volunteered to provide field support. The elemental and isotopic analyses of carbon (C) and nitrogen (N) in soils were conducted at TAMU (http://sibs.tamu.edu).

The $\delta^{13}C$ isotope values span nearly the entire range of values reported previously for terrestrial and aquatic organic matter derived from natural or anthropogenic sources. Spatial heterogeneity could thus be confirmed. The $\delta^{15}N$ values of land soil and suspended sediment samples also ranged almost the entire known range for environmental $\delta^{15}N$ values in terrestrial and aquatic systems. Collectively, the large range of values for both $\delta^{13}C$ and $\delta^{15}N$ values for our soils and sediments indicate that there are many isotopically distinct potential sources of organic matter in the study watershed. Therefore, these results made it feasible to use isotopic fingerprinting of sediment to make an ensemble prediction of the specific sub-watershed sources that contribute carbon and nitrogen to the Buffalo Bayou via soil erosion.



The grant has allowed local, national and international exposure through PVAMU faculty and student professional development activities. Project years 2012 and 2013 were marked with national and international knowledge sharing meetings of the North American Carbon Program, Joint European Commission's Soil Carbon Sequestration Conference in Reykjavik, Iceland, and the American Geophysical Union Annual Meeting. The current knowledge dissemination and broader impact assurance efforts include presentation of latest research findings to the scientific body on *Sediment Tracing in Watersheds* of the American Society of Civil Engineers' Environmental and Water Resources Institute.

Impact Statement

This project is a joint effort between Colleges of Agriculture & Human Sciences and the College of Engineering at Prairie View A&M University. The project has allowed one PVAMU graduate student to complete M.S. in Engineering Degree and pursue Ph.D. studies at Texas Tech University, and is currently supporting one other M.S. student at PVAMU with similar pursuit.

Spatial heterogeneity in urban soil biogeochemical properties confirms the potential for scale dependent soil erosion. Uncertainty in percent soil yield estimation can be assessed using the Decision Support Tool created. Review and test plot implementation of the statistical model has the potential to augment the current practice in soil conservation under episodic rainfall patterns derived from Rain Gauges, NEXRAD (Next Generation Radar), and Global Circulation Models.

What research is needed?

The project has allowed close observation of scale heterogeneity in local urban soil biogeochemical properties. There are no historic stable isotope data to compare current soil conditions. Great variation in stable soil isotope values was found in the highly urbanized Buffalo Bayou Watershed, leading to complex spatial heterogeneity. Future research needs to incorporate soil biogeochemical property monitoring scheme in rural watersheds outside of Houston City limits that are to see exponential growth and land use change. The complexity can be better understood using scientific tools developed under this study if soil tests could be initiated at undeveloped conditions and continued throughout a projected urban development over a decadal time span. This approach would also allow long term monitoring of the climate that plays an invaluable role in the determination of soil erosion potential leading to land degradation. The potential for systematic evolution of a database on soil biogeochemical properties could become an invaluable regional and national asset for future climate centered ecosystem research.

Want to know more?

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