

J. G. Boswell Endowed Chair in Soil Science

Dr. William Horwath, Professor of Soil Biogeochemistry
Land, Air and Water Resources
lawr.ucdavis.edu ● wrhorwath@ucdavis.edu

College Celebration

Friday
OCTOBER
14
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5:30 - 8:00 p.m.

Pavilion
UC Davis

We hope you will be able to join us.

ENDOWMENT PURPOSE

The James G. Boswell Foundation Soil Science Endowment Fund was established in 2004 by the James G. Boswell Foundation. The income is to be used to provide supplemental financial support for teaching, research and outreach, which may include funding for undergraduate and graduate students, the purchase of research equipment, as well as expenses related to attending or participating in professional meetings and conferences. The chair holder will be selected on the basis of merit in the field of soil science.

RESEARCH

My fascination to explore the nature and function of soil health remains my major research emphasis. I am addressing carbon sequestration, nutrient cycles, agricultural water issues and greenhouse gas emissions (GHG) in this effort. I have reinvigorated my passion to examine specific soil mineral and organic fractions, particularly the role of iron in soil reduction and oxidation (redox) processes. I study mainly agricultural systems although I have some notable papers published in Nature and Science journals over the past year. I am especially interested in climate variability and change and issues with soil health, water resources and quality and how they impact the sustainability of California agriculture. I attract funding from a wide range of sources in areas ranging from climate change, sustainable agriculture and forestry, GHG emissions and mitigation, and ecosystem restoration. Funding sources include state, federal, foundations and gifts. My program builds on international collaborations with university, industry and government agencies in Brazil, China, Israel, India and Mexico. I recognize that this research is made possible through funding graduate students and supporting advanced analytical J. G. Boswell Endowed Chair in Soil Science.

My current administrative duties during the review period include serving as the chairman of the Agricultural and Environmental Chemistry Graduate Group since 2010, Master Faculty Advisor for the Sustainable Agriculture and Food Systems Major and numerous college, departmental, national and scientific

society committees. I am a board member of the Soil Science Society of America. I have a number of editorial positions and am currently the technical editor for the Soil Biology and Biochemistry and Forest, Range and Wild land Soils divisions for the Soil Science Society of America Journal and Chief Editor for the Elsevier Soil Science Book Series "Developments in Soil Science.

Over the past year, I have advised 12 graduate students, one post doc, two project scientists, 10 undergraduate assistants (internships) and two Specialists. I hosted 3 international scientists that worked on various new and continuing projects. The undergraduate student interns and assistants are foundational to my program and provide the curiosity that drives science discovery. I encourage all lab members to mentor undergraduates with a grand vision that they will pursue a career in science, particularly agriculture. I am an active member of 4 graduate groups (Soil Biogeochemistry, Hydrology, International Agriculture Development and Agricultural and Environmental Chemistry) and have graduate students from them.

My contributions to the agriculture and environment sciences are acknowledged at the international level through peer reviewed publications and international collaborations. I have presented numerous invited and keynote talks at scientific conferences and seminars during the last year. I was awarded the "Chinese Academy of Sciences Visiting Professorship For Senior International Scientists". I continue to advise international research programs in Morocco, Mexico, India and Brazil on curriculum and research priority development. I mentored 4 PhD students from China and Brazil in my lab. My contribution to international research is recognized through publications, with total publications numbering 191, with over 7,345 citations, H-index of 44 (44 articles cited at least 44 times) and an iH-index of 115 (115 articles cited at least 10 times each). These statistics are noteworthy and distinguish me as an accomplished researcher. In the present review period, I authored and coauthored 25 publication

During the past year my research program can be divided into the following areas: 1.) agricultural water issues 2.) soil carbon process including metal-organic interactions , 3.) soil enzymes and organic nitrogen utilization, 4.) climate and CO2 influence on annual and tree crop water use efficiency, and 5.) quantifying and modeling GHG emissions.

The influence of irrigation practices and use of alternative water sources on water quality has been a continuing research interest. In an ongoing San Francisco-San Joaquin Bay Delta Island restoration project that examines ways to improve the quality of agriculture drain water using rice systems in place of forage and vegetable crops. The rice systems mimic previous Delta conditions of expansive wetlands that promoted soil carbon sequestration. The subsided islands are in desperate need to reverse soil subsidence caused by agricultural practices that

drained island causing soil loss through microbial oxidation. The subsided islands are causing ongoing levee instability issues. Planting rice can reverse soil subsidence, reduce levee instability and provide farmers an alternate crop to restore the islands. we showed that mercury uptake was minimal by fish in constructed wetlands used to improve the quality of rice drain water before it is pumped into the San Joaquin River. I am continuing to examine mercury issues caused by continuous flooding in rice systems. In a project concluding this year, we examined the use of chemical coagulants to improve water quality in constructed wetlands that farmer could manage themselves. Are results are promising and show improve water quality and soil subsidence reversal. In addition, no adverse effects of metal (iron and aluminum) coagulants were observed. These approaches using rice and small managed wetlands metal coagulants to treat agricultural drain water are potential tools that will be available to farmers to restore the islands and maintain a century of farming tradition in the Delta.

I am working on consumptive water uses issues in Fresno County with the intent of examining the consequences of recharging ground water with winter floodwaters from the Fresno River and slough. The main issue is the effect of recharge on aquifer water quality. Preliminary modeling results done by one of my masters student showed minimal impact to the quality of groundwater from leaching of residual fertilizer nitrates and soil salts using winter runoff water to recharge aquifers. Another PhD. Student is working to further calibrate modeling efforts using 30-foot soil cores to understand nitrate movement. Preliminary results show that nitrate in the soil profile exceeds what was applied over the last 50 years. Despite the nitrate levels, which measure 1 to 3 ppm, we expect that recharge is still a viable option to recharge aquifers and maintain water quality. However, more work in this area is needed to confirm these results. My lab continues to publish papers on crop and tree-ring carbon isotope composition (d13C) as a proxy to estimate water use efficiency using stable isotopes. In general even though water use efficiency is increasing in trees across the earth, there is a general decline in productivity, likely from the lack of soil nutrients. We would not expect this in California trees crops where nutrients are not limiting, however, the effects of elevated CO2 may impact other tree processes. In a publication from a Columbian student, we observed negative effects on coffee tree growth related to the compromised ability to metabolize nitrates. Similar results have been shown in wheat. We are examining this in almonds presently and have access to longer term wheat data sets that we hope will provide more information on optimizing water inputs for maximum efficiency in tree crops.

I continue my work on carbon and nutrient cycles and accompanying biogeochemical processes. One of the issues facing new Cap and Trade carbon markets is the determination of soil carbon inventories and sequestration potential. The work on iron interactions and thermodynamic properties of organo-mineral interactions is an area of research I have always embraced. Metal-organic matter interactions are responsible

for controlling carbon stability in soils. This information will be useful in designing practices and formulating soil inputs such as biochars and other wastes (biosolids, food processing, etc.) to increase and maintain soil carbon storage. This is important since greater soil carbon is the foundation of soil health and can increase soil water storage and resilient crop production.

I continue to measure greenhouse gas (GHG) emissions from soils. The work supports California's effort to establish GHG emission reductions in California agriculture to conform to the requirements of AB32 "The Global Climate Change Solutions Act". Overall the results show that the adoption of microirrigation systems, particularly subsurface drip, dramatically reduces nitrous oxide emissions from California crops, both tree and row crops. California agriculture with microirrigation systems is very nitrogen use efficient and many crops have emission factors below the established for other crops in different regions globally. As California Agriculture adopts more micro-irrigation systems to increase water use efficiency, emission of GHG will continue to decline.

TEACHING

Teaching provides me the opportunity to stay on the cutting edge of research and engagement while providing the best information and experiential learning opportunities for students, the next generation of farmers, policy makers and scientists.

I taught my undergraduate level SSC 109 Sustainable Nutrient Management and SAS 5 Forests and Society this last year. I am in charge of three graduate seminars annually for the Agricultural and Environmental Chemistry Graduate Group where I served as chairman of the group. In addition to these classes, I regularly hold lab meetings where my graduate students discuss their research or associated areas of research in soil science. The lab meeting is required for SSC 298 unit credit. The lab meetings include undergraduate interns and student assistants. This includes a Colloquium where students present their research in a two-day marathon during winter quarter. In addition to my teaching duties, I finished my interim duties as the Master Faculty Advisor for the Sustainable Agriculture and Food Systems major and continue as the Master Advisor for Track 1 (Agroecology). I fought long for this major, chairing a number of committees that lead to the formation of the major. It now has 100 students and growing. The endowment also supports many undergraduate internships in my lab.

Sustainable Nutrient Management

The undergraduate class in sustainable nutrient management provides insight and specialized topics on the management and fate of nutrients in agricultural, specialty crops such as grapes and other managed systems such as plantation forests. I continue to update the class and now incorporate a section on the economics of nutrient use. The class material covers the sustainability of alternative agricultural management, the impact of ecosystem management (i.e., plantation forests) on the fate nutrients, development of comprehensive nutrient management plans and the role of nutrient management in mitigating environmental issues, such as water quality and greenhouse gas emissions. In the laboratory portion of the class, I continue to better integrate the applied side of the lecture to deliver an experiential learning component. The laboratory exposes students to analytical techniques and quality control in sample preparation and data analysis. In addition, this class provides students to synthesize lab results in a scientific report format and in a presentation to the entire class. The lab is intended to provide hands on experience needed to integrate into industry and government opportunities.

Forests and Society

I have taught this Science and Society class for 6 years. Since all my undergraduate and graduate degrees are forestry related this class provides an outlet for me to expose students to forest issues. The class provides students concepts of natural resource management with an emphasis on how society copes with issues that arise in managing natural resources. It covers the natural history of trees and forests, the importance of forest to ancients and the role of forests in today's global ecosystem and natural resource needs. I use many present day examples such as wildfire, palm oil plantations, third world reliance on forests for food and fuel, medicine etc., to teach the importance of forests to humanity. The class is intended to satisfy general education writing and science GE requirements.

Independent Study, Internships and Research
I take great pleasure in motivating students in the laboratory. The endowment supports many undergraduate students in my lab. I mentor visiting students and scientists from both developed and developing countries. I especially enjoy mentoring undergraduate students and where possible I give these students independent projects to work on. The students' laboratory experience includes learning protocols and the significance of producing information to solve problems. I stress quality control in the laboratory, a skill needed to succeed in industry and academic careers. In addition, they are required to keep detailed notebooks and present a presentation at lab meetings. The interaction with visiting scholars is extremely enlightening and it provides for information exchanges including cultural. In addition to the above mentioned curriculum activities, I have served on numerous Ph.D. qualifying examination committees and thesis and dissertation committees. I spend a significant amount of time advising graduate students, post docs, specialists, visiting scientists on an individual basis. I also mentor a significant number of undergraduate interns and student assistants.

STUDENTS

Most of the endowment support pays the salaries of graduate students and their research and undergraduate assistants in my lab. Though most students have stipends from grant funded projects, the endowment allows for them to use and pay for advanced analytical techniques in their research. I use some of the funds to maintain mass spectrometers, HPLC and other instrumentation in my lab. In addition, a significant part of the money pays for stable isotope analysis. All of my research endeavors use stable isotope to probe nutrient cycles and metabolic pathways in soils and microorganisms. This ensures the graduate education and their mentoring using state of the art scientific techniques and principles to conduct cutting edge research. The undergraduate assistants are assigned internships with graduate students, and they benefit from the exposure to advanced scientific analysis and interpretation as they assist graduate students in their research.

OUTREACH

My research and outreach program is directed towards fulfilling the mission and philosophy of the Agricultural Experiment Station. By developing protocols to define agricultural sustainability at the basic and practical level I provide the necessary information to define and improve the sustainability of agricultural practices. I served on a California Dept. Food and Agriculture committee on soil health to provide direction on the State's effort to address healthy soils. I am advising the state on the use of biochars through meetings with California Dept. Food and Agriculture. My ongoing effort supported by the J. G. Boswell Endowment and California Dept. Food and Agriculture FREP provides California growers comprehensive guidelines for top 30 California crops on a website that provides specific nutrient management guidelines for major crops in California. The site can be accessed at the following link http://apps.cdfa.ca.gov/frep/docs/guidelines.html. This project in particular I feel is a tremendous contribution to the J.G. Boswell Endowed Chair in Soil Science and the Agricultural Experiment Station of California.

ACTIVITIES SUPPORTED BY FUND

- Awarded the "Chinese Academy of Sciences Visiting Professorship For Senior International Scientists" for 2016 to 2017.
- Elected board member of the Soil Science Society of America.
- Published 25 peer reviewed journal articles.

1. Ye, R, TA Doane, J Morris, WR Horwath. 2015. The effect of rice straw on the priming of soil organic matter and methane production in peat soils. Soil Biology and Biochemistry 81, 98-107
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3. Mitchell, JP, A Shrestha, WR Horwath, RJ Southard, N Madden, J Veenstra, DS Munk. 2015. Tillage and cover cropping affect crop yields and soil carbon in the San Joaquin Valley, California. Agronomy Journal 107: 588-596.
4. Kirk, ER, C van Kessel, WR Horwath, BA Linquist. 2015. Estimating annual soil carbon loss in agricultural peatland soils using a nitrogen budget approach. PloS one 10 (3), e0121432.
5. Chen, Wei, LiLi Zhang, XinYu Li, RongZhong Ye, Qi Li, JianGuo Zhu, NaNa Fang, LingLi Wang, Zhi, Jie Wu, William R Horwath. 2015. Elevated ozone increases nitrifying and denitrifying enzyme activities in the rhizosphere of wheat after 5 years of fumigation. Plant and Soil. 392:279-288.
6. Ackerman, JT, T Kraus, J Fleck, DP Krabbenhoft, WR Horwath, S Bachand, MP Herzog, CA Hartman, PAM Bachand. 2015. Experimental Dosing of Wetlands with Coagulants Removes Mercury from Surface Water and Decreases Mercury Bioaccumulation in Fish. Environ. Sci. Technol. 49: 6304-6311.
7. Silva, L. C. R. , G. Pedroso1, T.A. Doane, F.N.D. Mukome1, W.R. Horwath. 2015. Beyond the cellulose: Oxygen isotope composition of plant lipids as a proxy for terrestrial water balance. Geochem. Persp. Let. 1:33-42.
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11. Silva, LCR, A. Salamanca-Jimenez, T. A. Doane and W. R. Horwath. 2015. Carbon dioxide level and form of soil nitrogen regulate assimilation of atmospheric ammonia in young trees. Scientific Reports. 5:13141 | DOi: 10.1038/srep13141.
12. Roberts, BA, Fritschi, FB, Horwath, WR, and Bardhan, S. 2105. Nitrogen mineralization potential as influenced by microbial biomass, cotton residues and temperature. J. Plant Nutrition. 38: 311-324.
13. Henneberry, Y., T. E. C. Kraus, D. P. Krabbenhoft, and W. R. Horwath. 2016. Investigating the Temporal Effects of Metal-Based Coagulants to Remove Mercury from Solution in the Presence of Dissolved Organic Matter. Environmental Management. 57: 220-228.
14. Zhu-Barker, X., A. R. Cavazos, N. E. Ostrom, W. R. Horwath, J. B. Glass. 2015. The importance of abiotic reactions for nitrous oxide production. Biogeochem. 126: 251-267.
15. Lazcano, C, Wade, J, Horwath, WR; Burger, M. 2015. Soil sampling protocol reliably estimates preplant nitrate in SDI tomatoes. California Agriculture. 69: 222-229.
16. Ye., R. T. A. Doane and W. R Horwath. 2016. Comparison of isotope methods for partitioning methane production and soil C priming effects during anaerobic decomposition of rice residue in soil. Soil Biology and Biochemistry. 95: 51-59.
17. Salamanca-Jimenez, A, Doane, TA; Horwath, WR. 2016. Performance of coffee seedlings as affected by soil moisture and nitrogen application. Advances in Agronomy.136: 221-244.
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19. Zhu-Barker, X, Burger, M, Horwath, WR, Green, P. 2016. Direct green waste land application: How to reduce its impacts on greenhouse gas and volatile organic compound emissions? Waste Management. 52: 318-325.
20. Lazcano, C, Tsang, A, Doane, TA; Pettygrove, G S, Horwath, WR; Burger, M. 2016. Soil nitrous oxide emissions in forage systems fertilized with liquid dairy manure and inorganic fertilizers. "Agriculture, Ecosystems & Environment. 225: 160-172.
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22. Aegerter, B, Barcellos, T, Beck, D, Bottens, M, Cordova, D, Cordova, T, Crowell, M,Diener, J, Ferris, H, Fisher, J. 2016. Conservation agriculture: Systems thinking for sustainable farming. California Agriculture. 70: 53-56.
23. Ye, R. and W. R Horwath. 2016. Nitrous oxide uptake in rewetted wetlands with contrasting soil organic carbon contents. Soil Biology and Biochemistry. 100: 110-117.
24. Miao, S, Ye, R, Qiao, Zhu-Barker, X, Doane, TA, Horwath, WR. 2016. The solubility of carbon inputs affects the priming of soil organic matter. Plant and Soil: DOI 10.1007/s11104-016-2991-1.

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THANKS

The endowment ensures that cutting edge research and outreach efforts will continue to benefit California agriculture and farmers. The future of California agriculture is promising, but this can only be assured through innovative research to address emerging issues such as climate change, water limitations and healthy soils. The endowment ensures that the latest science, advanced instrumentation and people power are used to solve problems and to provide direction to bolster the sustainability of California Agriculture.