Sustainable provision of food and water using an interdisciplinary, system-of-systems framework

A Global Systems Science (GSS) Destination Area (DA) Concept

Faculty Leads: John Little and Zach Easton
15 May, 2017

Table 1. The Virginia Tech (VT) Sustainable Food and Water Systems (SFWS) Team

Name	Relevant University Affiliations	College
Darrell Bosch	Agricultural and Applied Economics	CALS
Susan Clark	Horticulture; Civic Agriculture & Food Systems; Sustainability Institute	CALS
Kelly Cobourn	Forest Resources and Environmental Conservation, Policy DA Stakeholder	CNRE
Zach Easton	Biological Systems Engineering; Global Change Center; Data Analytics and Decision Sciences DA Stakeholder	CALS/COE
Adil Godrej	Civil and Environmental Engineering; Occoquan Watershed Laboratory	COE
Cully Hession	Biological Systems Engineering; Intelligent Infrastructure for Human-Centered Communities DA Stakeholder	CALS/COE
Erich Hester	Civil and Environmental Engineering	COE
Bruce Hull	Forest Resources and Environmental Conservation; Center for Leadership in Global Sustainability; Global Change Center; Center for Communicating Science	CNRE
John Little	Civil and Environmental Engineering; Global Change Center; Global Systems Science DA Stakeholder	COE
Achla Marathe	Agricultural and Applied Economics, Biocomplexity Institute	CALS
Sean McGinnis	Materials Science and Engineering; Green Engineering Program; Sustainability Institute	COE
Megan O'Rourke	Horticulture; Global Change Center	CALS
David Schmale	Plant Pathology, Physiology and Weed Science	CALS
Stephen Schoenholtz	Forest Resources and Environmental Conservation; Virginia Water Resources Research Center; Global Change Center; Global Systems Science DA Stakeholder	CNRE
Julie Shortridge	Biological Systems Engineering; Global Change Center	CALS/COE
Terry Swecker	Large Animal Clinical Sciences	CVM
Wade Thomason	Crop and Soil Environmental Sciences	CALS
Anil Vullikanti	Computer Science, Biocomplexity Institute	COE
Robin White	Animal and Poultry Sciences	CALS

1. VISION STATEMENT

The global population is expected to reach 9 billion by 2050 and burgeoning economic growth may allow 2-5 billion to enter into the global middle class by this time. Food and water systems will need to exhibit remarkable improvements to meet the rising demand. At the same time, expanding urban growth, shifting climates, and increasing energy demand will exert additional pressures on these food and water systems. Elucidation of the interrelationships among food and water systems requires a systems approach to account for the substantial interdependencies [1]. For example, extensive clearing of forestland, fresh water scarcity, and sharp increases in food prices may all be substantially exacerbated by the need to provide improved diets for a growing global population [2].

Although sustainability is an essential concept to ensuring the future of humanity and integrity of the resources and ecosystems on which we depend, identification of a comprehensive approach to assess and enhance sustainability is another grand challenge [3]. Fortuitously, in a ground-breaking re-conceptualization of the problem, we identified the collective limitations of the current suite of approaches used to assess sustainability and instead proposed [3, 4] a computational, system-of-systems framework that is causal, modular, tiered, and scalable (Figure 1). Our approach incorporates a comprehensive definition of sustainability as well as new educational structures to systematically and computationally connect across the disciplines. It also aspires to address the political, economic, and decision-making challenges that limit the applicability of science and technical solutions to wicked problems. Virginia Tech is, thus, exceptionally well-positioned to take on the complex challenges involved in the sustainable provision of food and water. Agriculture, water, advanced computing, and computational societal systems are traditional areas of strength. Sustainability is another area of strength, but one that cuts across the entire campus. The Sustainable Food and Water Systems Team (Table 1) will simultaneously build on and connect all these strengths, leveraging an impressive array of facilities, institutes, and programs (Table 2), and outstanding scientific collaborators (Table 3), enabling Virginia Tech to be an international leader in providing solutions to one of the toughest global challenges.

2. RELEVANCE

Relevance to Goals of the GSS DA: The GSS DA explicitly calls [5] for sustainable solutions that integrate the biogeophysical sciences, the sociocultural realm, as well as technology and tools (including advanced modeling and high-performance computing) for state-of-the-art predictive models. With respect to the curriculum, the call [5] is for an overriding conceptual framework that embraces systems thinking and complexity, crosses disciplinary boundaries, and encourages innovative approaches to intractable problems. Our sustainable food and water concept meets precisely these desired characteristics in all aspects of research, curriculum, and outreach.

There is growing recognition of the need for a systems approach when attempting to solve complex societal problems [3]. Building on our strengths, we will develop an interdisciplinary, system-of-systems framework that focuses on socioeconomic, political, engineering, and agronomic challenges in food and water systems (Figure 1). Taking advantage of existing modeling infrastructure and scientific expertise, we will use the Chesapeake Bay Watershed (CBW) as our initial study region (Figure 2). The CBW, which includes the largest estuary in the US, and where agriculture is valued at over $10 billion annually, is an excellent study area with an abundance of scientific data. As shown in Figure 1, we will employ a tiered framework with different levels of abstraction to model complex interdependent systems. Each system has a more detailed model at the process level and a more aggregated model at the systems level.

We will focus on process models of agriculture at the farm scale and water at the watershed scale. The CBP is responsible for the development of the Chesapeake Bay Model (CBM). The CBM (arguably one of the most conceptually complete and empirically detailed water quality models in the world) is a suite of linked models, including watershed, airshed, land-use change, and estuary models. We will create models for crops and livestock at the farm scale to represent agricultural activities within the CBW. A major gap in the coupling of such systems is our current inability to integrate spatially and temporally explicit economic models with spatially and temporally explicit models of agricultural and water systems. To close this gap, we choose an economic input-output model [6] that is comprised of a primal model in physical units and a dual model in associated financial costs, incomes, and prices. Proposed new faculty hires are described in Appendix II.

Opportunities for Extramural Funding: There are many NSF funding opportunities including: INFEWS (~$2.5M); CRISP (~$2.5M); CNH (~$1.8M); Macrosystems Biology (~$1M); Expeditions in Computing (~$10M); and NRI 2.0 Ubiquitous Collaborative Robots (~$1.8M). There are also many USDA solicitations, including AFRI and NIFA, and some international opportunities such as the Sustainable Urbanization Global Initiative (SUGI). We will also pursue center-level support from the Rockefeller and Gates Foundations. The system-of-systems concept generally has many potential applications across a wide range of funding agencies.

Connections to the other DAs: To address the sustainability of food and water, we must ultimately consider several other systems including climate, disease, energy, transportation, human health, and natural ecosystems, as well as other economic and social systems. Our system-of-systems framework is designed such that it can be extended to include additional systems in a modular fashion [4]. This means that we can link to infectious disease in the GSS DA, energy, transportation, and autonomous vehicles in the Intelligent Infrastructure for Human-Centered Communities (IIHCC) DA, the Data Analytics and Decision Science (DADS) DA, which has identified agricultural and environmental analytics as a VT strength, as well as to the Policy DA. Zach Easton, Cully Hession, and Kelly Cobourn, who are stakeholders in DADS, IIHCC, and Policy, respectively, will facilitate integration. In addition, John Little has assembled a cross-cutting "system-of-systems" working group which is comprised of stakeholders and program managers from every DA and SGA, and we will use this group to make meaningful connections to other DAs and SGAs. Indeed, it may be possible to use sustainability, which involves many coupled systems [3], to systematically connect across essentially all the DAs and SGAs.

3. CURRICULUM OPPORTUNITIES

Relevance to Goals of the GSS DA: As already mentioned, the GSS DA calls [5] for a curriculum with an overriding conceptual framework that embraces systems thinking and complexity, crosses disciplinary boundaries, and encourages innovative approaches to intractable problems. Consistent with Figure 1, we envision a new generation of specially-trained engineers, scientists (including natural and social scientists), and professionals (accountants, landscape architects, foresters, and business managers) who are familiar with models at both the process and the systems level, and whose role will be to couple the systems models in a common, integrating framework, while acting as facilitators for communication between the process level and the systems level. In this way we systematically and computationally connect the many cross bars of the "T" in the "VT" student model across many disciplines, something which does not exist, is clearly needed, and will give Virginia Tech a unique advantage.

Our goal is to integrate relevant VT Pathways and Minors using our system-of-systems framework, and including: the Civic Agriculture and Food Systems pathways minor (an interdisciplinary,

experiential-based minor exploring sustainable agriculture and food through systems thinking which engages students in addressing real-world issues related to agriculture and food (economics, socio-cultural-health, and environment) by working directly with a community partner); the newly established interdisciplinary BS Degree Program in Water: Resources, Policy, and Management; the Green Engineering minor; the programs offered by the Sustainability Institute; the Urban Computing program; the proposed new Interdisciplinary Graduate Degree Program in Water; the Sustainable Natural Environments minor; and the new Pathways to Sustainability minor (that helps students connect their majors and careers to the challenges of sustainable development through an integrated exploration of where environment, culture, and economics intersect). Relevant courses include ALS 4204/5234G Concepts in Community Food Systems; CEE 4134/5114 Environmental Sustainability – A Systems Approach; NR/GEOG 1115, 1116 Seeking Sustainability; and GEOG 4444 Practicing Sustainability. To the extent possible, we will consider all VT sustainability courses, thereby rationalizing our offerings across the entire campus and further strengthening Virginia Tech's sustainability brand.

4. DESCRIPTION OF RESOURCE NEEDS

Faculty hires: Given that VT has considerable strength in water and watersheds, we propose the following five faculty hires (see Appendix II for more detail):

- CALS: Crop and ecosystem modeling; Livestock systems modeling
- CVM: Agricultural systems management and integration with infectious disease
- CNRE: Computational social science in sustainable water/fiber/food systems
- COS: Food systems economics

Collectively, these hires will expand our capacity in the socio-policy-human area to complement our existing strength in the science and engineering of food and water systems. Resources are also needed to upgrade some of our facilities (Table 2).

5. REFERENCES

1. Bazilian, M., H. Rogner, M. Howells, S. Hermann, D. Arent, D. Gielen, P. Steduto, A. Mueller, P. Komor, R.S.J. Tol, and K.K. Yumkella, *Considering the energy, water and food nexus: Towards an integrated modelling approach.* Energy Policy, 2011. **39**(12): p. 7896-7906.
2. Springer, N.P. and F. Duchin, *Feeding nine billion people sustainably: Conserving land and water through shifting diets and changes in technologies.* Environmental Science & Technology, 2014. **48**(8): p. 4444-4451.
3. Little, J.C., E.T. Hester, and C.C. Carey, *Assessing and enhancing environmental sustainability: A conceptual review.* Environmental Science & Technology, 2016. **50**(13): p. 6830-6845.
4. Little, J.C., E.T. Hester, C.C. Carey, G.M. Filz, S. El Sawah, T. Iwanaga, and A.J. Jakeman, *A common interdisciplinary framework to assess and enhance sustainability.* Environmental Modelling & Software, In Preparation.
5. *Global Systems Science*. Available from: http://provost.vt.edu/destination-areas/da-global-systems.html.
6. Duchin, F., *A world trade model based on comparative advantage with m regions, n goods, and k factors.* Economic Systems Research, 2005. **17**(2): p. 141–162.

APPENDIX I

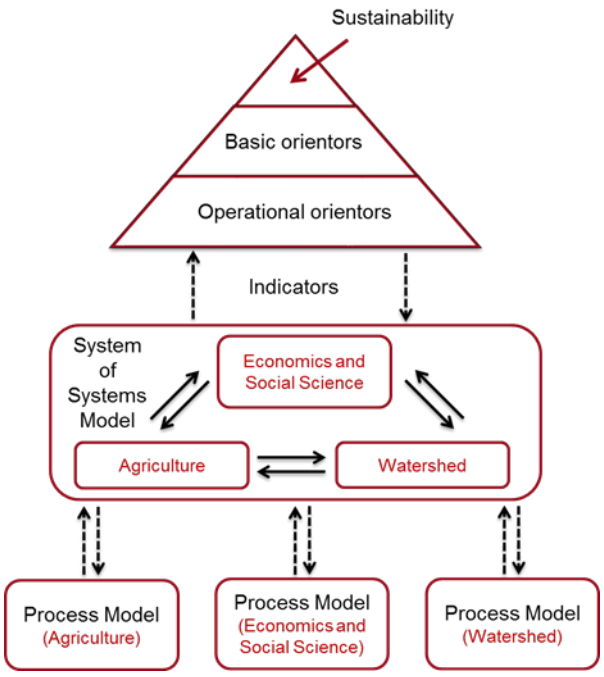

Figure 1. Tiered computational framework with process models up-scaled to the systems level where they are used to assess and enhance sustainability [3].

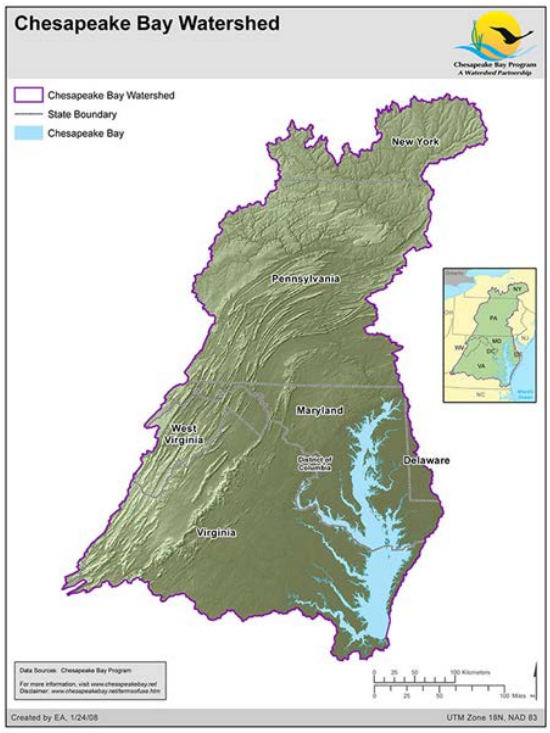

Figure 2. The Chesapeake Bay Watershed (CBW) is managed by the Chesapeake Bay Program (CBP). The CBP is led by EPA, and involves USDA and USGS.

Table 2. Closely Associated Facilities, Institutes, Centers, and Programs

Associated Facility, Institute, or Program	Affiliated Team Member(s)
Agricultural Experiment Station	Several SFWS Team Members
Biocomplexity Institute	Achla Marathe and Anil Vullikanti
Center for Communicating Science	Bruce Hull
Center for Leadership in Global Sustainability	Bruce Hull, Director
Chesapeake Bay Watershed and Program	Zach Easton, CBP Scientific and Technical Advisory Committee Member
Claytor Lake and Appalachian Power	David Schmale
Global Change Center	Several SFWS Team Members (see Table 1)
Green Engineering Program	Sean McGinnis, Director
Kentland Farm	Wade Thomason and David Schmale
Occoquan Watershed Laboratory	Adil Godrej, Director
Sustainability Institute	Several SFWS Team Members (see Table 1)
Virginia Water Resources Research Center	Stephen Schoenholtz, Director

Table 3. National and International Scientific Collaborators

Name	Affiliation
William Ball	Director of the Chesapeake Research Consortium; Professor, Environmental Health and Engineering, Johns Hopkins University, Baltimore, Maryland, USA
Claudia Binder	Swiss Mobiliär Chair in Urban Ecology and Sustainable Living; Professor at EPFL, Lausanne, Switzerland
Kathleen Boomer	Chesapeake Bay Restoration Project Watershed Scientist, The Nature Conservancy, Bethesda, Maryland, USA
Faye Duchin	Professor, Economics, Rensselaer Polytechnic Institute, Troy, New York, USA
David Dzombak	Chair, National Academies Committee on Transition Toward Sustainability; Hamerschlag University Professor, Carnegie Mellon University, Pittsburgh, Pennsylvania, USA
Sondoss El Sawah	Senior Lecturer, Capability Systems Centre, University of New South Wales, Canberra, Australia
Anthony Jakeman	Director of the Integrated Catchment Assessment and Management Centre; Professor, Australian National University, Canberra, Australia
Paula Jasinski	Chair, Citizens' Advisory Committee to the Chesapeake Executive Council, Richmond, VA, USA
Ermias Kebreab	Professor, Sesnon Endowed Chair, and Deputy Director of the Agricultural Sustainability Institute, U.C. Davis
Tsair-Fuh Lin	Coordinator, Discipline of Sustainable Development, Ministry of Science and Technology, Taiwan; Distinguished Professor, National Cheng Kung University, Tainan, Taiwan
Lewis Linker	EPA Modeling Coordinator, Chesapeake Bay Program, Annapolis, Maryland, USA
Gary Schenk	USGS Watershed Model Team Leader, Chesapeake Bay Program, Annapolis, Maryland, USA
Gregory Thoma	Bates Teaching Endowed Professorship, Chemical Engineering, University of Arkansas
Bernhard Wehrli	Professor of Aquatic Chemistry at ETH and Eawag, Zurich, Switzerland
Min Yang	Vice Director of the Research Center for Eco-Environmental Sciences; Professor, Chinese Academy of Sciences, Beijing, China

APPENDIX II

Virginia Tech: Global Systems Science (GSS) Destination Area
Sustainable Food and Water Systems (SFWS) Cluster Hire

Virginia Tech invents the future by harnessing the assets of our faculty, the ingenuity of our students, and the commitment of our partners across the globe. The SFWS Team will address complex, intractable, food and water challenges by leveraging our intellectual excellence to innovate and secure sustainable food and water systems in equitable ways. Destination Areas are building interdisciplinary, multicultural teams of experts because diversity helps us ask better questions, find innovative solutions, and stimulate new ways of thinking that strengthen our world-class, land-grant university mission of education, research, and engagement.

These five tenure-track faculty positions are likely to be at the level of assistant professor, although exceptional candidates at higher ranks will be considered. We seek candidates with training in interdisciplinary systems-level approaches around the complex interrelationships and problems inherent within agriculture and water systems. Candidates will have appointments within one of four tenure-granting Colleges (Agriculture and Life Sciences, Veterinary Medicine, Natural Resources and Environment, and Science). The SFWS Team seeks applicants whose research and interest are at the forefront of solving complex "wicked problems" that integrate agriculture, water, and socioeconomics within an interdisciplinary "systems-of-systems" framework. Successful candidates are expected to: (1) actively participate in the interdisciplinary activities of the SFWS Team; (2) bring together new and existing faculty to collaborate on cross–disciplinary teaching and research initiatives; (3) build cohesion and capability (graduate training and joint courses) within the SFWS Team; and (4) develop a successful and internationally-recognized interdisciplinary research program.

The SFWS Team seeks faculty candidates in the following five areas:

- Crop and ecosystem modeling with emphasis on the use of mechanistic, dynamic, crop simulation models that link genetics, physiology, and ecology to predict crop responses to changing management and climate scenarios at regional, national, and global scales.
- Livestock systems modeling with emphasis on the development of mechanistic, dynamic, farm system models that predict production responses to genetics, physiology, and thermal environment. This position will interface with existing efforts focused on modeling ruminant farm systems and the candidate should have expertise in modeling management effects in monogastric farming systems.
- Agricultural systems management with focus on closely integrating activities of the GSS SFWS Team, the GSS Infectious Disease Team, and the agricultural production community. The position will facilitate transfer of knowledge among agricultural stakeholders and the GSS Teams to ensure availability of high-resolution management data and translation of research outcomes at the farm level.
- Computational social science in sustainable water/fiber/food systems with expertise in the complex dynamics governing interplay between socioeconomic systems and water/fiber/food systems.
- Food systems economics with expertise in experimental economics, behavioral economics, economic input-output models, computable general equilibrium models, and with experience or interest in developing systems-based research across the food system.

APPENDIX III

Sustainable provision of food and water using an interdisciplinary, system-of-systems framework

A Global Systems Science Destination Area Concept

Faculty Leads: John Little and Zach Easton

The Sustainable Food and Water Systems Team comprises a diverse group of 19 faculty members (see Table 1). Biosketches for each of the team members follow in alphabetical order.

Darrell Bosch, Professor, Virginia Tech (540) 231 5265, bosch@vt.edu

PROFESSIONAL PREPARATION

Ph.D.	Agricultural Economics	University of Minnesota	1984
M.S.	Agricultural Economics	University of Tennessee	1980
B.A.	Political Science	Central College	1971

APPOINTMENTS

1999-present Professor, Dept. of Agric. and Applied Econ., Virginia Tech.
1990-1999 Associate Professor, Dept. of Agric. and Applied Econ., Virginia Tech.
1984-1990 Assistant Professor, Department of Agric. and Applied Econ., Virginia Tech.
1980-1984 Research Assistant, Dept of Agric. and Applied Econ., Univ. of Minnesota.
1978-1980 Research Assistant, Dept. of Agric. Econ. and Rural Soc., Univ. of Tennessee.

RESEARCH AND CREATIVE ACTIVITIES

Sponsored Research and Other Grant Awards: $15,570,857
PI/PD : $319,152
Co-PI : $15,251,705
Scientific Contributions

- **Book chapters : 5**
- **Refereed journal articles : 57**
- **Conference proceedings articles : 13**
- **Conference proceedings edited : 1**
- **Peer reviewed journal abstracts : 17**
- **Other abstracts : 7**
- **Book reviews : 5**
- **Invited presentations : 25**

MAJOR TEACHING ACTIVITIES (2010-2017)

AAEC 3014 Analytical Methods in Applied Economics: 3 hrs (2010—2017)
AAEC 4404 Agricultural Management and Problem Solving: 4 hrs (2010) (with White)
AAEC 5114 Applied Microeconomic Theory: 3 hrs (2010—2015) (with Peterson)
AAEC 5104 Research Project Planning: 1 hr (2010-2017)
ALS/NR 4614 Watershed Assessment, Management, and Policy: 2 hrs (2011—2017) (with Wolfe, Schoenholz, McGuire)
AAEC 3015 SANREM Ecuador Internship Program: 1 hr (2011, 2103) (with Alwang, Norton)

ADVISING

Major or Co-Major Advisor to 11 Ph.D. (9 completed) and 19 M.S. (17 completed) students.
Advisor to 18 undergraduate interns participating in SANREM-sponsored research in Ecuador (with Alwang, Norton)
Mentor to one Visiting Scholar

HONORS AND AWARDS

Honorable Mention, Land, Water and Environmental Economics Section Outstanding Poster Award for “Costs of Meeting Water Quality Goals under Climate Change in Urbanizing Watersheds: Difficult Run, Virginia” (with Jonathon Giuffria, Daniel Taylor, and Nasrin Alamdari) Agricultural and Applied Economics annual meeting, Boston, July 30-August 2, 2016.
Visiting Scholar at LAMETA (Institute of Applied and Theoretical Economics), a joint research institute of the French National Institute for Agricultural Research, University of Montpellier,

French National Center for Scientific Research, and the International Center for Agronomic Sciences, January-July, 2008.

Agricultural and Resource Economics Review Outstanding Journal Article 2007 (with Todd Metcalfe, James Pease, Mark Alley, and Steve Phillips)

Soil and Water Conservation Society honorable mention for Best Journal of Soil and Water Conservation Feature Article, 1999 (with L. S. Van Dyke, J. W. Pease, and J. C. Baker).

Agricultural Economics Association of South Africa (AEASA) award for best published article in 1995 (Article published in Water SA with James H. F. Botes and L. Klopper Oosthuizen).

SSJ de Swart Award from AEASA for best published article in Agrekon in 1994 (with James H. F. Botes and L. Klopper Oosthuizen).

Visiting Scholar, Resources and Technology Division, Economic Research Service, U.S. Department of Agriculture, August 1992-July 1993.

SELECTED SERVICE TO PROFESSION

Advisor to Chesapeake Research Consortium for a project to implement an optimization tool for water quality protection in the Chesapeake Bay, 2016-2018.

Co-Editor, Journal of Agricultural and Applied Economics, 2010-2013 (with Mary Marchant)

Associate Editor, Journal of Soil and Water Conservation, 2009-2012

Program Chair, Integrated Decision-Making for Watershed Management Symposium: Processes and Tools. Hosted by Virginia Tech in Chevy Chase, Md., January 7-9, 2001.

Editorial Council Member, Southern Journal of Agricultural Economics, 1990-1992.

SELECTED REFEREED JOURNAL PUBLICATIONS (2012-2017)

* denotes former/current students

1. Giuffria, J.M.*, D.J. Bosch, D.B. Taylor, and N. Alamdari*. Costs of Water Quality Goals under Climate Change in Urbanizing Watersheds: Difficult Run, Virginia. *Journal of Water Resources Planning and Management*, In press.
2. Ferraro, N.*, D.J. Bosch, J.W. Pease, and J. S. Owen. Costs of Capturing and Recycling Irrigation Water in Container Nurseries. *HortScience* (In press).
3. Cultice, A.*, D. J. Bosch, J.W. Pease, K.J. Boyle, and W. Xu*. Horticultural Growers' Willingness to Adopt Recycling of Irrigation Water. *Journal of Agricultural and Applied Economics*. 48(1)(2016): 99-118.
4. Tanellari, E.*, D. Bosch, K. Boyle, and E. Mykerezi*. On Consumers' Attitudes and Willingness to Pay for Improved Drinking Water Quality and Infrastructure. *Water Resources Research.* 51(2015): 47–57, doi:10.1002/2013WR014934.
5. Pan, A., D.J. Bosch, and H. Ma. Assessing Water Poverty in China Using Holistic and Dynamic Principal Component Analysis. *Social Indicators Research.* (2015): doi:10.1007/s11205-015-1191-3. URL http://link.springer.com/article/10.1007/s11205-015-1191-3
6. Bosch, D.J., J.W. Pease, R. Wieland, and D. Parker. Paying for Performance: Using Cover Crops to Improve Water Quality, *Agricultural and Resource Economics Review*. 42(3) (December 2013): 491-507.
7. Lee, J.*, E. Kleczyk*, D. J. Bosch, A. M. Dietrich, and V. K. Lohani. Homeowners' Decisionmaking In A Pipe Failure Prone Area. *Journal of American Water Works Association* 105(No. 5)(2013): E231-E241.
8. Bosch, D., J. Pease, M.L. Wolfe, C. Zobel, J. Osorio*, T. Denckla Cobb, and G. Evanylo. Community DECISIONS: Stakeholder Focused Watershed Planning. *Journal of Environmental Management*. 112(2012): 226-232. http://dx.doi.org/10.1016/j.jenvman.2012.07.031

BIOGRAPHICAL SKETCH

NAME: Susan F. Clark

eRA COMMONS USER NAME (credential, e.g., agency login): clark55

POSITION TITLE: Associate Professor of Horticulture and Director, Civic Agriculture and Food Systems

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Virginia Polytechnic Institute & State University	B.S.	6/77	Human Nutrition & Foods
University of Kentucky	M.S.	8/78	Clinical Nutrition
Virginia Polytechnic Institute & State University	Ph.D.	12/90	Human Nutrition & Foods
Commission on Dietetics Accreditation	R.D.	6/79	Registered Dietitian

A. Personal Statement

I have the expertise, leadership, training, and motivation necessary to carry out the proposed research and interdisciplinary curriculum development and assessment. My broad background in human nutrition and biochemistry, sustainable or civic agriculture and foods systems along with expertise in pedagogy and curriculum design and assessment, collective impact, collaborative decision-making, community based participatory research (CBPR), ethnographic and survey research align with the proposed project. My recent research scholarship includes qualitative data analysis on the complexities inherent within agri-food systems specific to community food security within rural Appalachia Virginia, North Carolina and West Virginia. My other scholarship also includes assessment of student learning in the sustainable agriculture and food systems curriculum. As PI or co-Investigator on several university and USDA-NIFA-AFRI-funded grants, I have developed interdisciplinary, experiential-based sustainable agriculture and food systems curriculum, and developed methodology for community-based food security assessments. By using a collaborative decision-making governance framework, we engaged and built relationships and trust with diverse community stakeholders, which allowed us to recruit, and track participants over time. In addition, I have successfully administered many interdisciplinary projects (e.g. staffing, research protections, budget), collaborated with other researchers, and produced peer-reviewed publications from each project. Given these previous experiences, I value the importance of developing effective communication among project members and of cultivating collaborative governance and decision-making processes to ensure successful management of any research and curriculum plan, timeline, and budget. The current proposal builds logically on my prior work through the lens of holistic systems thinking related to agriculture and food to effectively navigate complexity and address the world's most pressing, critical problems that are facing agriculture and food through effective transdisciplinary engagement. Several publications resulting from my most recent funding follow.

1. Niewolny K, Moreno-Schroder M, Mason G, McWhirt A, Clark S. (2017). Participatory Praxis for Community Food Security: A Community-Student Engaged Approach to Graduate Education, *Journal of Agriculture, Food Systems and Community Development* (under review 2017).
2. Appalachian Foodshed Project Regional Report Community Food Security (2017) www.appalachianfoodshed.org.
3. Appalachian Virginia Community Food Security Assessment, Final Report (2016) www.appalachianfoodshed.org.
4. Clark SF, Byker CB, Niewolny K, and Helms J. (2013). Framing an Undergraduate Minor through the Civic Agriculture and Food Systems Curriculum, *North American Teachers and Colleges of Agriculture*, 57(2): 56-67.

B. Positions and Honors

Positions and Employment

2005 – Associate Professor/Director, Civic Agriculture and Food Systems, Department of Horticulture and
2005-12 Dietetics Director, Human Nutrition, Foods and Exercise, Virginia Tech, Blacksburg, VA
1996-2005 Associate Professor, Graduate Dietetic Internship Coordinator, Radford University, Radford, VA
1995- Instructor, Department of Human Nutrition, Foods and Exercise, Virginia Tech, Blacksburg, VA
1991-94 Assistant Professor, Department of Biology/Chemistry, Hollins College, Roanoke, VA
1991 Instructor, Department of Chemistry, Roanoke College, Salem, Virginia
1981-84 Clinical Research Faculty, Department of Surgery, University of Michigan Medical School, Ann Arbor, Michigan
1979-84 Clinical Instructor, Department of Clinical Nutrition, University of Kentucky, Lexington, Kentucky

Other Experience and Professional Memberships

1979 – Member, Academy Nutrition and Dietetic (AND)
1990 – Member, Academy Nutrition and Dietetic – Hunger & Environmental Nutrition Practice Group
2005 – Member, North America Colleges and Teachers of Agriculture and Journal Reviewer
2010 –12 USDA Higher Education Challenge Grant Peer Review Committee
2010 – Member, Agriculture, Food, and Human Values Society
2010 – Member, Sustainable Agricultural Education Association
2015 – Executive Board Member, Local Education Agriculture Project, Roanoke, VA; 2014-present

Honors

2009–10 Favorite Faculty Award, Virginia Tech, Blacksburg, VA
2010 Research Scholar of the Week, Virginia Tech Office of Vice President, Research, Blacksburg, VA
2010 Agriculture Women of the Year, Sigma Alpha, Pi Chapter, Virginia Tech, Blacksburg, VA
2011 Scholar of the Week, Virginia Tech, Office of International Affairs and Outreach. Blacksburg, VA
2011 University Exemplary Award, Virginia Tech, CIDER. Blacksburg, VA
2012 Virginia Tech's University Nominee, U.S. Professor of the Year
2012 Woman in International Development Award, Heifer International
2015-16 Beyond Boundaries. Student Working Group, Virginia Tech, Blacksburg, VA
2015 – Sustainability Institute Fellow, Virginia Tech
2015 –17 Pathways Scholar, Pathways for General Education, Virginia Tech, Blacksburg, VA
2017 Teacher of the Week, Virginia Tech, Blacksburg, VA

C. Contributions to Science *(Recent Relevant Selections)*

1. Niewolny K, Moreno-Schroder M, Mason G, McWhirt A, Clark S. (2017). Participatory Praxis for Community Food Security: A Community-Student Engaged Approach to Graduate Education, *Journal of Agriculture, Food Systems and Community Development* (under review 2017).

2. Helms J, Niewolny K, Clark S, McConnell K, & Friedel C. (2016). Learning through Collaboration and Interdisciplinary Teaching: A Case Study of Faculty Work as Learning in Sustainable Agriculture Education, *North American Teachers and Colleges of Agriculture* 60(2): 219-226.

3. Andress E and Clark S. (2015) Canning Clubs and Community Gardens in *Remaking Home Economics: Resourcefulness and Innovation in Changing Time.* Editors, Sharon Y. Nickols and Gwen Kay; Georgia Press.

4. Byker CB, Serrano E, Clark S. (2014). A Head Start Farm to Family Pilot Program Increased Fruit and Vegetable Intake among Families. *Journal of Human Sciences and Extension* 2(1):37-50.

5. Bryant L, Niewolny K, Clark S, and Watson C. (2014). *C*omplicated Spaces: Negotiating collaborative teaching and interdisciplinarity in higher education, *The Journal of Effective Teaching*; 14(2): 83-101.

C. Contributions to Science *(continued)*

6. Clark SF, Byker CB, Niewolny K, and Helms J. (2013). Framing an Undergraduate Minor through the Civic Agriculture and Food Systems Curriculum, *North American Teachers and Colleges of Agriculture*, 57(2): 56-67.

7. Niewolny K, Grossman JM, Byker CB, Helms JL, Clark SF, Cotton JA, and Jacobsen K. (2012) Sustainable Agriculture Education and Civic Engagement: The Significance of Community-University Partnerships in the New Agricultural Paradigm. *Journal of Agriculture, Food Systems and Community Development*, 2(3): 27-42.

8. Clark SF. Vitamins and Trace Elements. In: The A.S.P.E.N. Nutrition Support Core Curriculum: A Case-Based Approach – The Adult Patient, 3ed 2012:129-162.

9. Galt R, Clark SF and Parr D (2012). Engaging Values in Sustainable Agriculture and Food Systems Education. *Journal of Agriculture, Food Systems and Community Development*, 2(3): 43-54.

10. Schroeder-Moreno MS, Clark SF, Byker CB and Zhao X (2012). Internationalizing Sustainable Agriculture Education. *Journal of Agriculture, Food Systems and Community Development*, 2(3):55-68.

11. Niewolny K, Grossman JM, Byker CB, Helms JL, Clark SF, Cotton JA, and Jacobsen K. (2012) Sustainable Agriculture Education and Civic Engagement: The Significance of Community-University Partnerships in the New Agricultural Paradigm. *Journal of Agriculture, Food Systems and Community Development*, 2(3): 27-42.

OTHER REPORTS & MEDIA

1. Appalachian Foodshed Project Regional Report Community Food Security (2017); www.appalachianfoodshed.org.
2. Appalachian Virginia Community Food Security Assessment, Final Report (2016); www.appalachianfoodshed.org.
3. Heifer International: Sustainable Community Development and Study Abroad http://www.heifer.org/blog/2012/05/experiential-learning-for-va-tech-students-in-honduras.html

D. Additional Information: Research Support and/or Scholastic Performance

USDA, NIFA-AFRI 2011-68004-30079 Clark (PI) 03/01/11-02/28/17
Enhancing Food Security By Cultivating Resilient Food Systems & Communities: Place-Based Foodshed Analysis From Research To Community Practice, (Appalachian Foodshed Project).
Role: PI

USDA, NIFA-AFRI 2009-00879 Clark (PI) 08/01/09 – 07/31/13
Restoring Community Foodsheds: A Multidisciplinary Curriculum Translating Science into Practical, Innovative and Sustainable Solutions for Economic Viability, Food Security & Health.
Role: PI

Virginia Cooperative Extension Community Viability Grant (pending)
Community Innovation and Capacity Building for Regional Food Systems Change: An Appalachian Foodshed Partnership (AFP) Initiative.
Role: CoPI

Pathways Delivery Grant, Virginia Tech Clark (PI) 03/15/16 – 02/28/18
Civic Agriculture and Food Systems Pathways Minor.
Role: PI

Virginia Cooperative Extension Community Viability Grant 09/01/15 – 10/01/16

Creating a Regional Food Systems Roadmap: Building a multi-state network and leveraging area resources.
Role: CoPI

Virginia Cooperative Extension Community Viability Grant Clark (PI) 2012-2013
Strengthening Rural Communities through the Appalachian Foodshed Project.
Role: PI

College of Agriculture and Life Sciences Competitive Grant, VA Tech 2012-2013
Developing and Integrating a Service-learning Course with the VCE Master Food Volunteer Program: Promoting Safe Preservation, Handling, and Serving of Foods to Virginia Citizens.
Role: CoPI

College Agriculture & Life Sciences Grant, Virginia Tech 2012-2014
Building Capacity for an Agrarian Living Learning Community.
Role: CoPI

College Agriculture & Life Sciences Grant, Virginia Tech Clark (PI) 2010 –2011
Transforming Agricultural and Life Science Education: Exploring the Role of Collaborative-based Curriculum and Instruction to Enhance Interdisciplinary Teaching and Learning.
Role: PI

Center for Excellence in Undergraduate Teaching Grant, Virginias Tech Clark (PI) 2008-2009
Faculty and Students Collaborate Using E-Portfolio Design to Enhance the Scholarship of Student Learning.
Role: PI

College of Agriculture and Life Sciences Grant, Virginia Tech Clark (PI) 2008- 2009
Educating Tomorrow's Agents of Change Through an Innovative Curriculum Initiative on Sustainable Agriculture and Food Systems
Role: PI

Teaching and Assessment Grant, Virginia Tech Clark (PI) 2007-2008
Multidisciplinary Student Service Learning; Assessment of Student Outcome Learning (SOLs) Through e-Portfolio Technology
Role: PI

Kelly M. Cobourn

Department of Forest Resources and Environmental Conservation, Virginia Tech
310 West Campus Drive, Blacksburg, Virginia 24061
Phone: 540-231-0338; Fax: 540-231-3698; kellyc13@vt.edu

Professional Preparation

University of Virginia	Economics	B.A., High Distinction, 2001
University of Maine	Resource Econ. & Policy	M.S., 2004
University of California, Davis	Ag. & Resource Econ.	Ph.D., 2009

Appointments

Assistant Professor, 2013–present, Virginia Tech
Adjunct Graduate Faculty, 2013–2015, Boise State University
Assistant Professor, 2009–2013, Boise State University
Research Associate, 2005, University of Maine
Legislative Intern, 2003–2004, Maine State Office of Policy & Legal Analysis, Committee on Agriculture, Conservation, and Forestry

Five Relevant Products

Cobourn, K.M., L. Elbakidze, and S. Ghosh. 2016. "Conjunctive Water Management in Hydraulically Connected Regions in the Western U.S." in *Competition for Water Resources: Experiences and Management Approaches in the U.S. and Europe*, eds. J. Ziolkowska and J. Peterson.

Cobourn, K.M. 2015. "Externalities and Simultaneity in Surface Water-Groundwater Systems: Challenges for Water Rights Institutions," *American Journal of Agricultural Economics*, 97(3): 786-808.

Ghosh, S., K.M. Cobourn, and L. Elbakidze. 2014. "Water Banking, Conjunctive Administration, and Drought: The Interaction of Water Markets and Prior Appropriation in Southeastern Idaho," *Water Resources Research*, 50(8): 6927-6949.

Elbakidze, L., and K.M. Cobourn. 2013. "Economic Foundations for Interdisciplinary Modeling in Water Resources Management," *Journal of Contemporary Water Research and Education*, 152: 32-41.

Cobourn, K.M., and N.F. Crescenti. 2011. "The Implications of Surface-Ground Water Hydrology for Optimal Conjunctive Management," *Western Economics Forum*, 10(2): 50-63.

Five Additional Products

Chance, E.W., K.M. Cobourn, V.A. Thomas, B. Dawson, A.N. Flores. "Normalized Difference Moisture Index Method for Identifying Irrigated Areas in the Snake River Plain, Idaho," revise and resubmit, *Remote Sensing*.

Cobourn, K.M., E.R. Landa, G.E. Wagner. 2014. "Of Silt and Ancient Voices: Water and the Zuni Land and People," *National Center for Case Study Teaching in Science*.

Mooney, S., D.L. Young, K.M. Cobourn, and S. Islam. 2013. "Multidisciplinary Research: Implications for Agricultural and Applied Economists," *Journal of Agricultural and Applied Economics*, 45(2): 187-202.

Cobourn, K.M., R.E. Goodhue, and J.C. Williams. 2013. "Managing a Pest with Harvest Timing: Implications for Crop Quality and Price," *European Review of Agricultural Economics*, 40(5): 761-84.

Cobourn, K.M., H.J. Burrack, R.E. Goodhue, J.C. Williams, and F.G. Zalom. 2011. "Implications of Simultaneity in a Physical Damage Function," *Journal of Environmental Economics and Management*, 62(2): 278-289.

Synergistic Activities

PI for *NSF CNH-L: Linking Land-Use Decision Making, Water Quality, and Lake Associations to Understand Human-Natural Feedbacks in Lake Catchments* (2016-2018) with Kevin Boyle (Virginia Tech, Co-PI), Cayelan Carey (Virginia Tech, Co-PI), Christopher Duffy (Pennsylvania State Univ., Co-PI), and Paul Hanson (Univ. of Wisconsin, Co-PI). Direct the science activities and oversee the administration of a $1.8 million award involving >22 faculty and graduate students at 8 institutions.

PI and co-PI on three active projects related to water use for agricultural irrigation in the western United States: *USDA NIFA: Understanding the Hydrologic and Socioeconomic Impacts of Water Use and Resource Allocation in Agricultural Regions under Different Climate and Policy Scenarios* (PI: Marco Maneta, Univ. of Montana); *NASA ROSES LCLUC: Water Institutions and Agricultural Land-use Change across the Western U.S.* (PI: Cobourn); and *VT ICTAS: Identifying the Effects of Climate Change on Irrigated Agriculture using Remote Sensing and Geospatial Water Rights Data* (PI: Cobourn).

Elected member of the Board of Directors for the Universities Council on Water Resources (UCOWR, 2016-2019), strategic planning team member (2017-2019) and member of the annual meeting planning committee (2017-2018). Develop mission statement and strategic plan for the organization, work to expand membership and increase the profile of the UCOWR journal *Contemporary Journal of Water Research and Education*.

Elected officer to the Committee on Women in Agricultural Economics (2010-2016). Past Chair (2015-2016); Chair (2014-2015); Chair-elect (2013-2014); Secretary/Treasurer (2010-2013). Increase diversity in the Agricultural and Applied Economics Association, create and promote workshops and annual meeting sessions on topics relevant to female professionals and academics, promote professional awards and recognition for female scholars.

Economics and Policy Modeling science team lead for NSF EPSCoR: *Water Resources in a Changing Climate* (2011-2013). Manage $15 million state-wide grant involving multiple institutions and disciplines.

Collaborators and other affiliations

Collaborators: G. Amacher (VT), K. Boyle (VT), H. Burrack (NC State), C. Carey (VT), C. Duffy (Penn State), L. Elbakidze (U Idaho), S. Ewing (Montana State), A. Flores (Boise State), W. Gardner (Montana State), Y. Gil (USC), R. Haight (USFS), P. Hanson (U Wisconsin), E. Hester (VT), T. Holmes (USFS), S. Islam (Boise State), K. Jencso (U Montana), A. Kemanian (Penn State), J. Kimball (U Montana), J. Klug (Fairfield U), E. Landa (U Maryland), L. Lavine (Washington State), B. Maxwell (Montana State), F. Merry (VT), J. Pierce (Boise State), L. Rudstam (Cornell), J. Ryu (U Idaho), P. Soranno (Michigan State), M. Sorice (VT), R. Stewart (VT), R. Taylor (U Idaho), Q. Thomas (VT), V. Thomas (VT), J. Tracey (U Idaho), M. Vanni (Miami U), G. Wagner (U South Carolina), D. Walsh (Washington State), K. Weathers (Cary Institute), P. Wiseman (VT), D. Young (Washington State), J. Ziolkowska (U Oklahoma);
Graduate advisors: K. Bell (U Maine), T. Dalton (Kansas State), R. Goodhue (UC Davis), S. Smith (U Maine), J.C. Williams (UC Davis), F. Zalom (UC Davis); **Graduate students:** G. Beebe (Boise State), E. Chance (VT), X. Ji (VT), E. Murray (Boise State), S. Scott (VT), S. Siriwardena (VT), C. Wade (VT), W. Weng (VT); **Postdoctoral scholars**: S. Ghosh (Northeastern State), A. Hetherington (VT), W. Xu (Boise State).

Zachary M. Easton, PhD
Dept. Biological Systems Engineering; Virginia Tech
205 Seitz Hall, 155 Ag Quad Lane, Blacksburg, VA 20461
Ph: 540-231-0689 Email: zeaston@vt.edu

1. Professional Preparation

Undergraduate Institution	**Location**	**Major**	**Degree & Year**
UMass Amherst	Amherst MA	Soil Science	B.S. 2000
Graduate Institution	**Location**	**Major**	**Degree & Year**
Cornell University	Ithaca NY	Bio & Environ. Eng	M.S 2004
Cornell University	Ithaca NY	Bio & Environ. Eng	PhD 2007
Postdoctoral Institution	**Location**	**Area**	**Inclusive Dates**
Cornell University	Ithaca NY	Bio & Environ. Eng.	2007-2009

2. Appointments

Associate Professor Dept. Biological Systems Engineering, Virginia Tech, 2016-current
Assistant Professor, Dept. Biological Systems Engineering, Virginia Tech, 2012-2015
Research Assoc., Dept. Biological & Environmental Engineering, Cornell University, 2009-2011

3. Five Products Most Relevant to Proposed Project

1. Wagena, M.B., A.R. Sommerlot, E.M. Bock, D.R. Fuka, and Z.M. Easton. 2017. Development of a nitrous oxide routine for the SWAT model to assess greenhouse gas emissions from agroecosystems. *Environ. Model. Software*. http://dx.doi.org/10.1016/j.envsoft.2016.11.013.
2. Sommerlot. A.R., M.B. Wagena, D.R. Fuka and Z.M. Easton. 2016. Coupling the short-term Global Forecast System weather data with a variable source area hydrologic model. *Environ. Model. Software*. http://dx.doi.org/10.1016/j.envsoft.2016.09.0081364-8152.
3. Wagena, M, A. Sommerlot, A. Abiy, D.R. Fuka, A.S. Collick, S. Langan, and Z.M. Easton. 2016. Regional climate change In the Blue Nile Basin: Implications for water resource availability and sediment transport. *Climatic Change*. doi: 10.1007/s10584-016-1785-z.
4. Fuka, D.R., A.S. Collick, P. Kleinman, D. Auerbach, D, Harmel, Z.M. Easton. 2016. Improving the spatial representation of soil properties and hydrology using topographically derived initialization processes in the SWAT model. *Hydrol. Proc.* doi: 10.1002/hyp.10899.
5. Easton, Z.M., D.R. Fuka, M.T. Walter, D.M. Cowan, E.M. Schneiderman, and T.S. Steenhuis. 2008. Re-conceptualizing the Soil and Water Assessment Tool (SWAT) model to predict runoff from variable source areas. *J. Hydrol.* 348: 279-291.

Five Other Significant Products

1. Fuka, D.R., M.T. Walter, C.A. MacAllister, A.T. Degaetano, and Z.M. Easton. 2013. Using the Climate Forecast System Reanalysis dataset to improve weather input data for watershed models. *Hydrol. Proc*. DOI: 10.1002/hyp.10073.
2. Easton, Z.M., M.T. Walter, D.R. Fuka, E.D. White, T.S. Steenhuis. 2011. A simple concept for calibrating runoff thresholds in quasi-distributed variable source area watershed models. *Hydrol. Proc*. doi:10.1002/hyp.8032, 2011.
3. Easton, Z.M., P. Gerard-Marchant, M.T. Walter, A.M. Petrovic, and T.S. Steenhuis. 2007. Identifying dissolved phosphorus source areas and predicting transport from an urban watershed using distributed hydrologic modeling. *Water Resources Research.* 43. W11414. doi:10.1029/2006WR005697.

4. Schneiderman, E.M., T.S. Steenhuis, D.J. Thongs, Z.M. Easton, M.S. Zion, G.F. Mendoza, M.T. Walter, and A.L. Neal. 2007. Incorporating variable source area hydrology into the curve number based Generalized Watershed Loading Function model. *Hydrol. Proc.* 21:3420-3430. doi: 10.1002/hyp6556.
5. Easton, Z.M., P. Gérard-Marchant, M.T. Walter, A.M. Petrovic, and T. S. Steenhuis. 2007. Hydrologic assessment of an urban variable source watershed in the northeast United States. *Water Resources Research.* 43. W03413. doi:10.1029/2006WR005076.

6. Synergistic Activities

- EPA Chesapeake Bay Scientific and Technical Advisory Committee (STAC) member.
  - Advise the EPA Chesapeake Bay Program on scientific and technical issues related to water quality, landscape management, climate change and policy implications of management decisions on Bay and watershed function as it relates to the TMDL.
- Chair Southern Region Water Program (SERA-43).
  - Serve as the inaugural chair for the Southern Extension and Research Activity (SERA) water program. Provide leadership for the 136 members of the program from 23 institutions. SERA-43 serves as a clearing house for research and extension activities in the region related to water resources.
- Expert Panel Member and Project Collaborator. International Water Management Institute. "Modeling and Spatial Analysis for the Challenge Program on Water and Food".
  - Provide data access and discovery expertise in data scares regions, particularly the Blue Nile basin in Ethiopia. Develop protocols for data sharing across participating institutions.
- Software Development:
  1. SWATmodel: http://cran.r-project.org/web/packages/SWATmodel/index.html
     - Generalizable watershed modeling framework that allows model initialization with minimum data. Includes a flexible optimization routine.
  2. Ecohydrology: http://cran.r-project.org/web/packages/EcoHydRology/index.html
     - Collection of functions related to hydrology and earth system modeling implemented in R. Functions include: radiation. The software models important hydrologic processes that are a function of the radiation budget including snowmelt and snow accumulation and potential evapotranspiration.
  3. TopoSWAT: filebox.vt.edu/users/zeaston/TopoSWAT-BD.gdb.zip
     - A python based model plugin that provides data access and manipulation of model input data, including elevation models, soils data and climate data for any land surface location on earth (excluding the poles). Allows users to model variable source area hydrology and energy budget processes,
  4. HydroMet: http://r-forge.r-project.org/projects/hydromet/
     - Provides access and formatting of meteorological and climate data for hydrologic modeling applications in R.
  5. CFSR: http://cfsr.bse.vt.edu/swat-cfsr-v02.pl
     - Redimensioned Climate Forecast System Reanalysis model data interpolated to user defined point. This data access portal has had over 56,000 data downloads.
  6. BCube EcoHydro-Broker: http://gradlab4.bse.vt.edu:8080/gi-cat-10.0.2/gi-portal/index.jsp
     - NSF funded EarthCube data brokering interface that provides data sources in common formats used for watershed modeling and spatial analysis.

Adil N. Godrej

Occoquan Watershed Monitoring Laboratory, Department of Civil and Environmental Engineering, Virginia Tech, Manassas, Virginia 20110; agodrej@vt.edu; www.cee.vt.edu/people/godrej.html; (703) 361-5606 x114

(a) Professional Preparation

Birla Inst. of Tech. & Science	Pilani, India	Chemical Engineering	**B.E. (Hons.)**	1979
Virginia Tech	Blacksburg, Virginia	Sanitary Engineering	**M.S.**	1982
Virginia Tech	Blacksburg, Virginia	Civil Engineering	**Ph.D.**	1989
Virginia	Professional Engineer	License # 53217	**P.E.**	2015

(b) Appointments

2004-present:	Research Associate Professor, Department of Civil and Env. Engr., Virginia Tech.
1989-present:	Associate Director, Occoquan Watershed Monitoring Laboratory, Dept. of Civil and Environmental Engineering, Virginia Tech
1992-2004:	Visiting Assistant Professor, Department of Civil and Env. Engineering, Virginia Tech
1989-1992:	Senior Research Associate, Department of Civil Engineering, Virginia Tech
1981-1988:	Graduate Teaching/Research Assistant, Dept. of Civil Engineering, Virginia Tech
1979:	Engineer-Trainee, Gwalior Rayon (Nagda, India)

(c) Select Publications

i. Five Related Publications

1. Kumar, Saurav, **Adil N. Godrej**, and Thomas J. Grizzard (2016), *Pre-development conditions to assess the impact of growth in an urbanizing watershed in Northern Virginia*, Journal of Hydrology, 540, 1066-1077; doi: 10.2166/j.hydrol.2016.07.011.

2. Kumar, S., **A. N. Godrej**, and T. J. Grizzard (2015), *A web-based environmental decision support system for legacy models*, Journal of Hydroinformatics. Nov 2015, 17 (6) 874-890; doi:10.2166/hydro.2015.007.

3. Cubas, Francisco J., Novak, John T., Godrej, Adil N., Grizzard, Thomas J. (2014). *Effects of Nitrate Input from a Water Reclamation Facility on the Occoquan Reservoir Water Quality*. Water Environment Research, 86(2), pp. 123-133. doi:10.2175/106143013X13596524517067.

4. Kumar, Saurav, Godrej, Adil N. , Grizzard, Thomas J. (2013), *Watershed size effects on applicability of regression-based methods for fluvial loads estimation*, Water Resources Research, 49, 7698–7710, doi:10.1002/2013WR013704.

5. Xu, Z, A. N. Godrej, and T. J. Grizzard. "The Hydrologic Calibration and Validation of a Complexly-Linked Watershed-Reservoir Model for the Occoquan Watershed, Virginia." Journal of Hydrology, Vol. 345, pp 167-183, 2007, doi:10.1016/j.jhydrol.2007.07.015.

ii. Other Relevant Publications

1. Alexander, Kathleen A., **Adil Godrej** (2015). *Greywater Disposal Practices in Northern Botswana—The Silent Spring?*, International Journal of Environmental Research and Public Health, 2015, *12*, 14529-14540; doi: 10.3390/ijerph121114529.

2. Dougherty, M., Dymond, R. L., Grizzard Jr., T. J., Godrej, A. N., Zipper, C. E., Randolph, J., and Anderson-Cook, C. M., "Empirical Modeling of Hydrologic and NPS Pollutant Flux in an Urbanizing Basin", *Journal of the American Water Resources Association*, **42** (5), October 2006, pp.1405-19.

3. Cubas, Francisco J., Novak, John T., Godrej, Adil N., Grizzard, Thomas J. "The Effects of Nitrate on Nutrient Cycling at the Sediment-Water Interface on a Thermally Stratified Water Supply Reservoir", 2nd IWA Symposium on Lake and Reservoir Management: Sustainable Approaches to Enhance Water Quality, Grenada, Spain, 13-17 June 2011.

4. Kou, Yufeng, Liu, Changtien, Godrej, Adil, Grizzard, Thomas, and Post, Harold, "A Web-based Data Visualization and Analysis System for Watershed Management", *Geographic Information Sciences*, 11(1), June 2005, pp. 40-49.

5. Dougherty, M., Dymond, R.L., Grizzard, T., Godrej, A., Zipper, C., and J. Randolph, "Quantifying long-term NPS pollutant flux in an urbanizing watershed", *ASCE - Journal of Environmental Engineering*, Vol. 132, No. 4, pp 547-554, 2006.

(d) Synergistic Activities

1. Member, Metropolitan Washington Council of Governments' Regional Monitoring Subcommittee, 1995-present. The subcommittee works toward coordinating monitoring efforts in the regional water bodies and the Potomac River. As part of this, the subcommittee also discusses outcomes of the Chesapeake Bay model.

2. Member, EPA Chesapeake Bay Program Data Integrity Workgroup (formerly the Analytical Methods and Quality Assurance Workgroup), 1992-present. This group works toward standardizing monitoring and sample analysis protocols for all water quality monitoring work done in the Chesapeake Bay watershed.

3. Member, Northern Virginia Regional Commission's Occoquan Model Technical Advisory Committee, 1996-present. The committee oversees continued development and application of the Occoquan Model. The Occoquan Model itself resides at Virginia Tech and the development of it is performed under my direction.

4. Reviewer for the following journals: ASCE Journal of Environmental Engineering, Environmental Engineering Science, Inland Waters, International Journal of Digital Earth, Journal of the American Water Resources Association, Journal of Environmental Informatics, Journal of Hydrologic Engineering, Journal of Hydrology, Water, Water Environment Research, Water Resources Management, Water Resources Research.

W. Cully Hession
Biological Systems Engineering, Virginia Tech
540-231-9480; chession@vt.edu

A. Professional Preparation

Virginia Tech	Agricultural Engineering	B.S. 1984
Virginia Tech	Agricultural Engineering	M.S. 1988
Oklahoma State University	Biosystems Engineering	Ph.D. 1995

B. Appointments

2012 – present	Professor, Biological Systems Engineering, Virginia Tech
2005 – 2012	Assoc. Professor, Biological Systems Engineering, Virginia Tech
1999 – 2005	Assist. & Assoc. Professor, Civil and Environmental Eng., Univ. of Vermont
1995 – 1999	Assist. Curator, Patrick Center, Academy of Natl. Sciences, Philadelphia, PA
1992 – 1995	PhD Candidate, Biosystems Engineering, Oklahoma State University
1989 – 1992	Sr. Environ. Engineer, VA-DCR, Richmond, VA.
1987 – 1989	Watershed Modeler, USDA-ARS, Morris, MN

C. Publications (** indicates undergraduate students; * indicates graduate students)

(i) Five Relevant Publications

Polys, N.F., P. Sforza, W.C. Hession, and J. Munsell (2016), Extensible experiences: Fusality for stream and field, Proceedings of the 21st International Conference on Web3D Technology, 179-180. doi: 10.1145/2945292.2945320.

Abel, S., L.C. Hopkinson, W.C. Hession (2016), Hydraulic and physical structure of runs and glides following stream restoration, River Res. App., 32, 1890-1901.

Jones, C.N.*, D.T. Scott, C. Guth*, E.T. Hester, and W.C. Hession (2015), Seasonal variation in floodplain biogeochemical processing in a restored headwater stream, Environmental Science & Technology, 49, 13190-13198.

Hofmeister, K.L.**, C.M. Cianfrani, and W.C. Hession (2015), Complexities in the stream temperature regime of a small mixed-use watershed, Blacksburg, VA, Ecological Engineering, 78, 101-111.

Liao, H.*, L.H. Krometis, W.C. Hession, R. Benitez**, R. Sawyer**, E. Schaberg**, E. Wagoner**, and B.D. Badgley (2015), Storm loads of culturable and molecular fecal indicators in an inland urban stream, Science of the Total Environment, 530-531, 347-356.

(ii) Five Other Significant Publications

Ludwig, A.L., W.C. Hession, D. Scott, and D. Gallagher (2016), Simulated flood of a small constructed floodplain wetland in Virginia: Even-scale pollutant attenuation, Trans. ASABE, 59(5), 1321-1331.

Ludwig, A.L.*, and W.C. Hession (2015), Groundwater influence on water budget of a small constructed floodplain wetland in the Ridge and Valley of Virginia, USA, Journal of Hydrology: Regional Studies, 4, 699-712.

Liao, H.*, L.H. Krometis, W.C. Hession, L.L. House, K. Kline, and B.D. Badgley (2014), Hydrometeorological and physicochemical drivers of fecal indicator bacteria in urban stream bottom sediments, Journal of Environmental Quality, 43, 2034–2043.

Fahrenfeld N., K. Knowlton, L.A. Krometis, W.C. Hession, K. Xia, E. Lipscomb*, K.B. Libuit**, K.B. Green**, and A. Pruden-Bagchi (2014), Effect of manure application on

abundance of antibiotic resistance genes and their attenuation rates in soil: Field-scale mass balance approach. Environmental Science & Technology, 48, 2643-2650.
Brown, K.R.*, K.J. McGuire, W.C. Hession, and W.M. Aust (2016), Can the Water Erosion Prediction Project model be used to estimate best management practice effectiveness from forest roads? Journal of Forestry, 114(1), 17-26.

D. Synergistic Activities

Research Infrastructure Development, Design, and Construction:

- *Stream Research, Education, and Management Laboratory* (StREAM Lab, Blacksburg, VA). Installing extensive monitoring/sensor array for real-time website access for research, education, and outreach. Includes four flow and water quality monitoring stations, a full weather station, groundwater wells, and web cameras utilizing wireless communication technologies.
- *Prices Fork Research Farm* (Blacksburg, VA). Reviving three small watershed hydrology research sites. Currently conducting interdisciplinary research related to pasture management.
- *Urban Horticultural Center* (Blacksburg, VA). Designed and installed 33 small, flexible plots (3 x 3 m) with collection systems for evaluating water and sediment runoff from various land use practices.

Interdisciplinary Research and Education:

- *Director of Virginia Tech's StREAM Lab* (Blacksburg, VA; 2010-current). Utilized to promote interdisciplinary research, education, and outreach. Sixteen classes from across campus use the lab for field excursions, laboratories, and research projects. More than 20 graduate students have done all or portions of MS or PhD research using data from the site. http://vtstreamlab.weebly.com/.
- *Director NSF-REU Site: Dynamics of Water and Societal Systems, An Interdisciplinary Research Program at the Virginia Tech StREAM Lab* (Blacksburg, VA; 2012-14). An interdisciplinary undergraduate research experience.
- *PI USDA-REEU: Training Future Leaders to Solve Resource Challenges at the Confluence of Water and Society* (Blacksburg, VA; Due March 24, 2016). Interdisciplinary research and extension training program with five co-PIs and fifteen Faculty Mentors from eleven different departments.
- *Co-PI USDA-AFRI: Identification and Management of Critical Control Points in the Spread of Antibiotic Resistance from Manure to Raw Produce* (Virginia Tech; 2015-2017). Extremely interdisciplinary research effort (~$2.25 M) seeks to identify critical control points for the spread of antibiotic resistance from farm to fork. Includes eight co-PIs from six different departments.
- *Co-PI Virginia Tech-ICAT Science, Engineering, Art, and Design Grant: Fusality for Stream and Field* (Virginia Tech; 2015-17). Interdisciplinary effort to collect, fuse, and deliver of geo-referenced data to Web3D environments for research, education, and outreach. We are working to publish environmental monitoring data and citizen sensors to create compelling and scientific experiences of local places using human-centered computing.
- *Member University Water Degree Steering Committee* (Virginia Tech; 2011-current). University-wide committee that developed a new interdisciplinary undergraduate degree at Virginia Tech – "Water: Resources, Policy, and Management".

Erich T. Hester, Ph.D., P.E.
Department of Civil and Environmental Engineering, Virginia Tech, Blacksburg, Virginia 24061
ehester@vt.edu; www.flow.cee.vt.edu; (540)231-9758

(a) Professional Preparation

Dartmouth College	Hanover, NH	Biology	**A.B.**, 1992
Stanford University	Stanford, CA	Civil and Env Engineering	**M.S.**, 1998
University of North Carolina	Chapel Hill, NC	Ecology	**Ph.D.**, 2008

(b) Appointments

2016-Present	Dept of Civil and Env Engineering, Virginia Tech	Associate Professor
2009-2015	Dept of Civil and Env Engineering, Virginia Tech	Assistant Professor
2002-2003	Herrera Environmental Consultants	Water Resources Engineer
2001-2002	Philip Williams and Associates	Water Resources Engineer
1998-2001	LFR, Inc.	Project Engineer
1993-1995	Ecology and Environment, Inc.	Staff Scientist

(c) Select Publications:

(i) Five Related Publications

1. Little, J. C., **E.T. Hester**, and C.C. Carey. 2016. Assessing and enhancing environmental sustainability - A conceptual review. Environmental Science & Technology 50(13):6830-6845.
2. **Hester, E.T.**, B. Hammond, and D.T. Scott. 2016. Effects of inset floodplains and hyporheic exchange induced by in-stream structures on nitrate removal in a headwater stream. Ecological Engineering 97:452-464.
3. Jones, C.N., D.T. Scott, C.R. Guth, **E.T. Hester**, and W.C. Hession. 2015. Seasonal variation in floodplain biogeochemical processing in a restored headwater stream. *Environmental Science & Technology* 49:13190-13198.
4. **Hester, E.T.**, K.I. Young, and M.A. Widdowson. 2014. Controls on mixing-dependent denitrification in hyporheic zones induced by riverbed dunes: a steady-state modeling study. *Water Resources Research* 50(11):9048-9066.
5. **Hester, E.T.**, and J.C. Little. 2013. Measuring environmental sustainability of water in watersheds. *Environmental Science & Technology* 47(15): 8083–8090.

(ii) Other Relevant Publications:

1. Evans, D., C.E. Zipper, **E.T. Hester**, and S. Schoenholtz. 2015. Hydrologic effects of surface coal mining in Appalachia (USA). *Journal of the American Water Resources Association* 51(5):1436-1452.
2. Menichino, G.T., and **E.T. Hester.** 2015. The effect of macropores on bi-directional hydrologic exchange between a stream channel and riparian groundwater. *Journal of Hydrology* 529(3):830-842.
3. Azinheira, D.L., D.T. Scott, W.C. Hession, and **E.T. Hester**. 2014. Comparison of effects of inset floodplains and hyporheic exchange induced by in-stream structures on solute retention. *Water Resources Research* 50(7):6168-6190. DOI: 10.1002/2013WR014400.
4. **Hester, E.T.**, and K.S. Bauman. 2013. Stream and retention pond thermal response to heated summer runoff from urban impervious surfaces. *Journal of the American Water Resources Association* 49(2):328-342.
5. **Hester, E. T.** and M. N. Gooseff. 2010. Moving beyond the banks: Hyporheic restoration is fundamental to restoring ecological services and functions of streams. *Environmental Science & Technology* 44: 1521-1525. DOI: 10.1021/es902988n.

(d) Synergistic Activities

1. Dr. Hester is Associate Editor for *Water Resources Research*
2. Dr. Hester serves on the Board of Directors of the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI).
3. The proposed project complements the following efforts in the Hester lab at Virginia Tech to assess the environmental sustainability of water management in watersheds:
    a. Dr. Hester and Dr. Little have collaborated in the sustainability area for years. They published a Feature article in *Environmental Science &* Technology in 2013 (see publications, above) that summarizes the wide range of existing metrics that are currently used to quantify some aspect of the environmental sustainability of watershed management. While there are many existing metrics, a complete picture of the environmental sustainability of watershed management will require a more holistic approach that incorporates many of the existing metrics, as well as others not currently in use. They published another article in *ES&T* in 2016 that proposed a common framework modeling platform to integrate the quantification of the myriad fields that affect water management sustainability from agriculture to transportation (also in publications, above). Existing approaches are truly too piecemeal to solve the problem.
    b. Dr. Hester is PI on several existing NSF projects (Awards #1066817, 1437021) that are determining where on the landscape natural processes can best be harnessed to remove excess nutrients from water to solve eutrophication problems in downstream water bodies. One project is evaluating the ability of stream restoration practices to enhance removal of pollutants in surface runoff by enhancing retention in hyporheic zones and floodplains. Another project is evaluating mixing-dependent reaction of pollutants in groundwater plumes as they traverse the hyporheic zone before exiting to surface water such as rivers. Such reactions can mitigate pollutants that are otherwise not degraded in surface water or deeper groundwater, and can be enhanced by various management techniques. These approaches are envisioned to complement traditional wastewater treatment plants, stormwater best management practices, and groundwater remediation techniques as part of a “sustainable landscape” that is more resilient to fluctuations in human impacts and climate. Several example articles from this work are listed in “publications”, above.
    c. Dr. Hester has conducted several feasibility assessments of micro hydropower energy production capacity and environmental impacts for various projects within Virginia.

BIOGRAPHICAL SKETCH

NAME: Robert Bruce Hull IV

POSITION TITLE: Professor

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Davis and Elkins College	NA	1975-77	Humanities
Virginia Tech	BS	05/1979	Environ Conservation
Virginia Tech	MS	05/1981	Natural Resources
University of Arizona	NA	1982	Environ Psychology
Virginia Tech	PhD	1984	Human Dimensions Natural Resources

A. Personal Statement

I write and teach about leadership for sustainable development in the Anthropocene and how to influence change in the cross sector space where government, business, and civil society intersect. I've researched and published on social science topics that support environmental management, but in last decade or so realized that I can have a greater impact by helping professionals enhance their impact and influence, i.e., leadership. I argue that, here on the cusp of the Anthropocene, sustaining development depends more on mobilizing people to meet current challenges than it depends on better science and technology. Towards that end, I've helped develop an executive, professional development graduate degree for sustainability professionals working at the intersection of business, government, and civil society and have started a new research program studying content and pedagogy needed for that purpose (i.e., the XMNR in Arlington). More recently, I've also focused my teaching of leadership and collaboration on graduate global change science students. As part of that effort, I lead or co-lead graduate study abroad programs to India for the MNR and co-teach seminar and capstone courses for the Global Change IGEP. Also, I am President of the Board of a nonprofit, Climate Solutions University, whose mission is to help communities adapt to climate change, work across jurisdictional boundaries, and protect vulnerable citizens and the natural resources on which they depend.

B. Positions and Honors

Positions and Employment

1984-1987 Research Fellow, Faculty of Architecture, University of Melbourne, Australia
1988-1994 Associate Professor, College of Architecture, Texas A&M University
1995-2001 Associate Professor, College of Natural Resources and Environment, Virginia Tech
2001-now Professor, College of Natural Resources and Environment, Virginia Tech

Other Experience

2000-2010 Advisory Board Member, US Forest Service Land Use Interface Advisory Board Region 2.
2004-now Fellow Virginia Natural Resource Leadership Institute
2010-now Board President, Climate Solutions University
2012-now Senior Fellow, Center for Leadership in Global Sustainability, Virginia Tech
2015-now Fellow, Advisory Board Member, and (recently) co-director of PhD IGEP, Center for Global Change, Virginia Tech
2017-now Advisory Board Member, Center for Communicating Science

C. Contributions to Science

My early work focused on contributions of social science to environmental management. The research was used, for example, to inform state and federal programs that work at the interfaces of land use change. For example,

- Gobster, P. and Hull, R.B. (Eds.) 2000. *Restoring Nature: Perspectives from the Social Sciences and Humanities.* Washington DC: Island Press
- Goldstein, B. and Hull, R.B. 2008. Socially Explicit Fire Regimes. *Society and Natural Resource*s. 21:469–482
- Kendra, Angelina; Hull, R. Bruce 2005. Motivations and Behaviors of New Forest Owners in Virginia. *Forest Science,* 51 (2): 142-154
- Hull, R.B., Robertson, D.P., Buhyoff., G.J. 2004. Boutique Forestry: New forest practices in urbanizing landscapes. *Journal of Forestry*: 102 (1): 14-19.
- Robertson, D.P. and Hull, R.B. 2003. Public ecology: an environmental science and policy for global society. *Environmental Science & Policy* 6 (5): 399-410
- Dedrick, J., Hall, T, Hull, RB., and Johnson, J. 2000. The Forest Bank: an experiment in Managing Fragmented Forests. *Journal of Forestry* 98 (3): 22-25.
- Hull, R.B. 2010. Valuing Urban Forests: Lessons to Learn from Hurricanes In K.G. Tidball and M Krasny (eds). *Greening in the Red Zone: Disaster, Resilience, and Community Greening.* Springer. Chapter 19: 165-172.
- Hull, R.B. 2011. Forestry's Conundrum: High Value, Low Relevance. *Journal of Forestry:* 109 (1): 50-56.

The next phase of my work focused on using social science tools to help facilitate local economic activities for sustainable development. Toward that end we established and studied two local cooperatives that still exist although in different guises: Grayson Landcare and Catawba Landcare. For example,

- Kimmel, C. E., R. B. Hull, Stephenson, M.O., D. P. Robertson and K. Cowgill (2012). "Building community capacity and social infrastructure through landcare: a case study of land grant engagement." Higher Education **64**: 223-235.
- Robertson, D., Hull, RB., Moles, J, et al. 2008. Landcare in America. In D. Catacutan & C. Neely (Eds*) Landcare: Local Action-Global Progress*. Landcare International. Adams Printers Pty Ltd. Melbourne, Australia.
- Kimmel, C. and Hull, R.B. 2011. Ecological Entrepreneurship Support Networks: Roles and Functions for Conservation Organizations. *Geoforum 43:* 58–67

Most of my current work does not contribute to science directly. Instead, I focus on content and pedagogy of teaching leadership to sustainability professionals. For example,

- Hull, RB. 2006. *Infinite Nature*. University of Chicago Press.
- Wasserman, A., Hull, R. B., & McCutchan, B. (2014). How Cargill cultivated greener soybean production in the Amazon. *GreenBiz*. April. Online.
- Hull, RB, Kimmel, C., Robertson, D. and McCutchan, B. 2014. Collaborative Leadership for Sustainable Development in Global Supply Chains: Linking Agriculture and Deforestation in the Amazon to Consumers in Europe and Asia. *Solutions* 5(4): 51-59.
- Hull, R.B. (2017) Leadership for Adaptive Management. *Companion to Environmental Ethics.* Edited by Benjamin Hale and Andrew Light. Routledge.
- Hull, R. Bruce, et al. (2016) "International field experiences promote professional development for sustainability leaders." *International Journal of Sustainability in Higher Education* 17(1):86-104.
- I also blog a bit on the topic, eg.,

- What will you do after marching for science? www.globalchange.vt.edu/2017/04/18/what-will-you-do-after-marching-for-science
- Scientific Facts Don't Win Arguments: http://www.globalchange.vt.edu/2017/03/06/scientific-facts-dont-win-arguments/
- The end of expertise: http://www.globalchange.vt.edu/2017/02/24/the-end-of-expertise/
- Population is not the problem. http://cligs.vt.edu/population-not-problem/
- Leadership 101 for Global Sustainability: http://www.constructingsustainability.com/leadership101.html
- Leadership as simple as DAC: http://www.constructingsustainability.com/leadership-as-simple-as-dac.html

John C. Little

Department of Civil and Environmental Engineering, Virginia Tech, Blacksburg, Virginia 24061
jcl@vt.edu; www.cee.vt.edu/people/little.html; (540) 231-0836

Professional Preparation

University of Cape Town	Cape Town, S. Africa	Chemical Engineering	**B.Sc.** 1985
University of Cape Town	Cape Town, S. Africa	Physical Chemistry	**M.Sc.** 1984
University of California	Berkeley, CA	Environmental Engineering	**M.S.** 1988
University of California	Berkeley, CA	Environmental Engineering	**Ph.D.** 1990
California	Professional Engineer	Certificate # CH 4738	**P.E**. 1992

Appointments

2012- Present: Charles E. Via, Jr. Professor, Virginia Tech, Civil and Environmental Engineering
2004-2012: Professor, Virginia Tech, Civil and Environmental Engineering
1998-2004: Associate Professor, Virginia Tech, Civil and Environmental Engineering
1993-1998: Assistant Professor, Virginia Tech, Civil and Environmental Engineering
1985-1987: Project Engineer, Binnie & Partners, Environmental Engineering Consultants

Products (Most closely related to the proposed project)

Chen, S., Lei, C., Carey, C. C., Gantzer, P. A. and **Little, J. C.** 2017. A Coupled Three-Dimensional Hydrodynamic Model for Predicting Hypolimnetic Oxygenation and Epilimnetic Mixing in a Shallow Eutrophic Reservoir. *Water Resources Research*. DOI: 10.1002/2016WR019279

Little, J. C., Hester, E.T., and Carey, C. C. 2016. Assessing and Enhancing Environmental Sustainability – A Conceptual Review. *Environmental Science & Technology*. 50: 6830-6845. DOI: 10.1021/acs.est.6b00298

Hester, E.T., and **Little, J.C.** 2013. Measuring Environmental Sustainability of Water in Watersheds. *Environmental Science & Technology*. 47: 8083-8090. DOI: 10.1021/es400513f

Bryant, L. D., Hsu-Kim, H., Gantzer, P. A. and **Little, J. C**. 2011. Solving the Problem at the Source: Controlling Mn Release at the Sediment-Water Interface via Hypolimnetic Oxygenation. *Water Research*. 45: 6381-6392. DOI: 10.1016/j.watres.2011.09.030

Bryant, L. D., Gantzer, P. A. and **Little, J. C**. 2011. Increased Sediment Oxygen Uptake Caused by Oxygenation-Induced Hypolimnetic Mixing. *Water Research*. 45: 3692-3703. DOI: 10.1016/j.watres.2011.04.018

Products (Five other significant products)

Singleton, V. L., Rueda, F. J. and **Little, J. C**. 2010. A Coupled Bubble Plume-Reservoir Model for Hypolimnetic Oxygenation. *Water Resources Research*. 46: W12538. DOI: 10.1029/2009WR009012

Bryant, L. D., Lorrai, C., McGinnis, D. F., Brand, A., Wüest, A. and **Little, J. C**. 2010. Variable Sediment Oxygen Uptake in Response to Dynamic Forcing. *Limnology and Oceanography* 55: 950-964. DOI: 10.4319/lo.2010.55.2.0950

Gantzer, P. A., Bryant, L. D. and **Little, J. C**. 2009. Controlling Soluble Iron and Manganese in a Water-Supply Reservoir using Hypolimnetic Oxygenation. *Water Research*. 43: 1285-1294. DOI: 10.1016/j.watres.2008.12.019

Singleton, V. L., Gantzer, P. and **Little, J. C**. 2007. Linear Bubble Plume Model for Hypolimnetic Oxygenation – Full-Scale Validation and Sensitivity Analysis. *Water Resources Research*. 43: W02405. DOI: 10.1029/2005WR004836

Singleton, V. L. and **Little, J. C.** 2006. Designing Hypolimnetic Aeration and Oxygenation Systems – A Review. *Environmental Science & Technology*. 40: 7512-7520. DOI: 10.1021/es060069s

Synergistic Activities

1. Chair, International Water Association (IWA) Specialist Group on Lake and Reservoir Management. In collaboration with an international group of colleagues, I formed a new IWA Specialist Group on Lake and Reservoir Management. In this group, we take a strong international perspective, bringing together expertise from regions of the world where it is rapidly being acquired, and applying it in regions where it is most needed. Our first IWA Symposium on Lake and Reservoir Management was held in Taiwan in 2009 with a second held in Spain in 2011. I was chair of the organizing committee of the third IWA Symposium, which was held at Mountain Lake in Pembroke, Virginia in August 2015. Our fourth IWA Symposium will be held in Shanghai, China, in May 2017. I organized and led international workshops on oxygenation of stratified lakes and reservoirs at both the second and third IWA Symposiums.

2. Strong record of advising excellent doctoral students: For example, one PhD student, Lee Bryant, received the 2011 CH2M Hill/AEESP Outstanding Doctoral Dissertation Award. The award recognized Lee for completing the top PhD thesis in the environmental science and engineering field during 2010. In addition, another PhD student, Ying Xu, received the 2011 Yaglou Award from the Academy of Indoor Air Sciences. The Yaglou Award recognizes the most promising young researcher (under the age of 37) in the indoor air sciences, and is only awarded once every three years.

3. Extensive international collaboration: I have held positions as visiting professor in The School of Civil Engineering, University of Sydney, Sydney, Australia (Jul 2013 – Dec 2013); The Department of Building Science, Tsinghua University, Beijing, China (May 2007; Sep 2007; Jun 2009; Jan 2012 – present); The University of Granada, Granada, Spain (Apr 2007 – Jun 2007); The Swiss Federal Institute for Aquatic Science and Technology (Eawag), Kastanienbaum, Switzerland (Jan 2000 – Dec 2000; Jan 2007 – Mar 2007; Jul 2007 – Dec 2007); and The Department of Environmental Engineering, National Cheng Kung University, Tainan, Taiwan (Jul 1999).

4. Editor and editorial board member for several international journals: Editorial Board Member, Sustainable Cities and Society; Editor, Sustainable Environment Research; Editorial Board Member, Environmental Engineering Research; Editorial Board Member, Indoor Air – An International Journal of Indoor Environment and Health; Editorial Board Member, Building Simulation – An International Journal.

5. Director of $3.1M NSF IGERT Project: EIGER – Exploring Interfaces through Graduate Education and Research. I played a central role in developing the overall concept for the project and served as EIGER Director for over half the duration of the project. Human and institutional interfaces both facilitate and constrain interdisciplinary research. In EIGER, social science research was applied to the education, training, and research components of the program, studying interdisciplinary teams and identifying which were most effective, and the necessary steps to overcome inter-personal, cultural and institutional barriers. EIGER resulted in a major institutional transformation at Virginia Tech, leading to the Interdisciplinary Graduate Education Program (IGEP), which now has 14 individual cross-disciplinary programs, all using the approach pioneered by EIGER.

Biographical Sketch: *Achla Marathe* Biocomplexity Institute of Virginia Tech
Virginia Polytechnic Institute and State University 1015 Life Science Circle, MC 0477
(540) 231-9210, amarathe@vbi.vt.edu Blacksburg, VA 24061

(a) Professional Preparation

University of Delhi	New Delhi, India	Economics	BA,1986
University at Albany, SUNY	Albany, NY	Economics	MA, 1990
University at Albany, SUNY	Albany, NY	Economics	1994
Los Alamos National Laboratory	Los Alamos, NM	Postdoctoral	1994–1997

(b) Appointments

2014-present	Professor. Biocomplexity Institute and the Department of Agricultural and Applied Economics, Virginia Tech
2014-present	Faculty of Health Sciences, Virginia Tech
2005-2013	Associate Professor. Bicomplexity Institute and the Department of Agricultural and Applied Economics, Virginia Tech
2005-present	Lead Economist and Social Scientist. Network Dynamics and Simulation Science Laboratory, Biocomplexity Institute, Virginia Tech
1997-2004	Technical Staff Member, Computational and Computer Science, Los Alamos National Laboratory
1994-1997	Postdoctoral research fellow, Computers, Information and Communication Division, Los Alamos National Laboratory
1994	Consultant, International Finance Corporation, World Bank Group
1993	Summer Intern, World Bank, Washington DC

(c) Publications

1. C. Barrett, S. Eubank, **A. Marathe**, M. Marathe, S. Swarup 2014. Synthetic Information Environments for Policy Informatics: A Distributed Cognition Perspective, in *Governance in the Information Era: Theory and Practice of Policy Informatics*, edited by Erik W. Johnston and Kevin C. Desouza. Taylor and Francis.
2. N Dorratoltaj, **A Marathe**, B Lewis, S Swarup, S Eubank, K Abbas. Epidemiological and Economic Impact of Pandemic Inuenza in Chicago: Priorities for Vaccine Interventions. PLoS Computational Biology, Forthcoming 2017.
3. R Subbiah, A Pal, E Nordberg, **A Marathe,** M Marathe. Energy Demand Model for Residential Sector: A First Principles Approach. IEEE Transactions on Sustainable Energy,Forthcoming 2017.
4. J Chen, S Chu, Y Chungbaek, M Khan, C Kuhlman, **A Marathe**, H Mortveit, A Vullikanti, D Xie. Eect of Modeling Slum Populations on Inuenza Spread in Delhi. BMJ Open, vol. 6, issue 9, 2016.
5. Ramakrishnan, Naren ; Lu, Chang-Tien ; Marathe, Madhav ; **Marathe, Achla** ; Vullikanti, Anil; Eubank, Stephen ; Leman, Scotland ; Roan, Michael ; Brownstein, John S. ; Summers, Kristen ; Getoor, Lise ; Srinivasan, Aravind ; Choudhury, Tanzeem ; Gupta, Dipak ; Mares, David. Model-Based Forecasting of Signicant Societal Events. IEEE Intelligent Systems, Issue 5, vol. 30, 2015, pp: 86-90.
6. C. Barrett, K. Channakeshava, F. Huang, J. Kim, A. Kumar, **A. Marathe**, M. Marathe, and G. Pei, 2012. Human Initiated Cascading Failures in Societal Infrastructures. *PLoS ONE*, vol. 7, no. 10, October. PMID: 23118841

7. K. Atkins, J. Chen, A. Vullikanti, M. Macauley and **A. Marathe**, 2009. Locational Market Power in Network Constrained Markets. *Journal of Economic Behavior and Organization*, vol. 70, issues 1-2, May, pages 416-430.
8. J. Chen, M. Macauley and **A. Marathe**, 2009. Network Topology and Locational Market Power. *Computational Economics*, vol. 34, number 1, August, pp 21-35.
9. R. Beckman, K. Channakeshava, F. Huang, J. Kim, **A. Marathe**, M. Marathe, S. Saha, G. Pei and A. Vullikanti, 2013. Integrated Multi-Network Modeling Environment for Spectrum Management. *IEEE Journal on Selected Areas in Communication* (JSAC), special issue on Network Science, Summer 2013.
10. S. Chandan, S. Saha, C. Barrett, S. Eubank, **A. Marathe**, M. Marathe, S. Swarup, A. Vullikanti 2013. Modeling the Interaction between Emergency Communications and Behavior in the Aftermath of a Disaster. *International Conference on Social Computing, Behavioral-Cultural Modeling*, *and Prediction (SBP)*, Washington DC, April 2-5, pages 476-485.
11. C. Barrett, K. Bisset, J. Leidig, **A. Marathe** and M. Marathe, 2010. An Integrated Modeling Environment to Study the Co-evolution of Networks, Individual Behavior and Epidemics. *AI Magazine*, vol. 31, no. 1, spring, pages 75-87.
12. P. Mozumder, W. Mazariegos, **A. Marathe**, 2011. Consumers' Preference for Renewable Energy in the Southwest USA. *Energy Economics*, vol 33, Issue 6, November, pages 1119-1126.
13. P. Mozumder and **A. Marathe**, 2004. Implications of an Integrated Market for Tradable Renewable Energy Contracts. *Ecological Economics*, vol. 49, issue 3, July, pages 259-272.

(d) Synergistic Activities

(1) I have two decades of experience in working with socially coupled physical systems. These have been used to model interactions between individuals and the built infrastructures, identify vulnerabilities in the physical infrastructures such as transportation, communication and energy, and understand interdependencies between them. I have done multiple studies on planning and response in the aftermath of natural and human initiated cascading failures in infrastructures under programs like UIS (Urban Infrastructure Suite), NISAC (National Infrastructure Simulation and Analysis Center), National Planning Scenario and other tabletop exercises guided by NIH and DoD.
(2) Under a recently DOE funded program by the DOE's SunShot Initiative, SEEDS-II (**PI: A. Marathe**) our team seeks to understand social and behavioral factors that influence the adoption of solar power in rural and semi-urban areas. Using diffusion models that integrate a variety of complex data, the project will allow solar providers to understand how to effectively support the needs of consumers in rural areas.
(3) Under the NSF-ICES grant (PI: A. Vullikanti, **Co-PI: A. Marathe**) we study the foundations of policy design for controlling epidemics, using a broad class of epidemic games on complex networks involving uncertainty in network information, temporal evolution and learning. Under the NSF-DESE NRT grant (PI: Naren Ramakrishnan, **Co-PI: A. Marathe**), we are preparing the next generation of students for urban computing which is a novel STEM program.
(4) For the NIH funded R01 (**PI: A. Marathe**) I develop computational methods to study the social and economic aspects of intervention strategies that are aimed at mitigating the spread of infectious diseases over large social networks. This entails understanding of population dynamics, social contact networks, disease transmission, social distancing techniques, demographics and behavior of individuals.
(5) My background and training in economics will help identify inter-disciplinary research opportunities and provide economic perspective to engineering issues. I have a long history (22 years) of working in a trans-disciplinary team.

Biographical Sketch – Sean P. McGinnis

(a) Professional Preparation

University of Minnesota	Minneapolis, MN	Chemical Engineering	BS 1990
University of Minnesota	Minneapolis, MN	Materials Science	BS 1990
Stanford University	Palo Alto, CA	Materials Science	PhD 1995
Uppsala University	Uppsala, Sweden	Inorganic Chemistry	PostDoc 1995 - 97

(b) Appointments

A list, in reverse chronological order, of all the individual's academic/professional appointments beginning with the current appointment.

Director - Green Engineering Program
College of Engineering, Virginia Tech, Blacksburg, VA — Oct 2005 - present

Associate Professor of Practice
Materials Science & Engineering, Virginia Tech, Blacksburg, VA — Apr 2015 – present

Associate Research Professor
Materials Science & Engineering, Virginia Tech, Blacksburg, VA — Aug 2010 – Apr 2015

Senior Research Scientist
Materials Science & Engineering, Virginia Tech, Blacksburg, VA — Oct 2005 – July 2010

Chief Technical Officer — Sept 2006 – present
High Performance Optics (HPO), Roanoke, VA

Manager – R&D Coating Group
Spectacle Lens Group of Johnson & Johnson Vision Care, Roanoke, VA — 2003 - 2005

Manager – Vacuum Coating Group
Spectacle Lens Group of Johnson & Johnson Vision Care, Roanoke, VA — 2000 - 2003

Senior Research Scientist
Spectacle Lens Group of Johnson & Johnson Vision Care, Roanoke, VA — 1998– 2000

Applications Engineer
Intevac, Santa Clara, CA — 1997 – 1998

(c) Publications

1. P. Pati, S. McGinnis, and P. Vikesland, Waste Not Want Not: Life Cycle Implications of Gold Recovery and Recycling from Nanowaste, Environmental Science: Nano, 3(5) 1133 – 43, 2016.
2. M. Vance, T. Kuiken, E. Vejerano, S. McGinnis, M. Hochella, D, Rejeski, and M. Hull, Nanotechnology in the real world: Redeveloping the nanomaterial consumer products inventory, Beilstein Journal of Nanotechnology, 6, 1769 – 1780, 2015.
3. P. Pati, S. McGinnis, and P. Vikesland. "Life Cycle Assessment of "Green" Nanoparticle Synthesis Methods," *Environmental Engineering Science*, 31(7), (2014), 410-420.
4. Q. Li, S. McGinnis, A. Wong, Cutter Sydnor and S. Renneckar, "Nanocellulose Life Cycle Assessment," ACS Sustainable Chemistry & Engineering, 1 (8), 919-928, 2013. http://pubs.acs.org/doi/abs/10.1021/sc4000225
5. M. Borrego, C. Newswander, L. McNair, S. McGinnis, and M. Paretti, "Using Concept Maps to Assess Interdisciplinary Integration of Green Engineering Knowledge," *Advances in Engineering Education*, 1(3), Winter 2009. *http://advances.asee.org/vol01/issue03/index.cfm*

(d) Synergistic Activities

1. Faculty Fellow – VT College of Natural Resources and Environment Sustainability Institute
2. Director - Virginia Tech Green Engineering Program which has goals that include: (1) providing students with engineering skills through coursework, projects, and research in the areas of product and process design to reduce environmental and health impacts, and (2) engaging faculty from engineering and other disciplines to promote interdisciplinary research and curricula development
3. Faculty Participant - VT Sustainable Nanotechnology Interdisciplinary Graduate Education Program (IGEP)
4. Instructional Scholars Teaching Certificate, - VT Center for Instructional Development and Educational Research (CIDER), May 2015
5. Life Cycle Assessment Certified Professional and Education Committee Member - American Center for Life Cycle Assessment (ACLCA)

Biographical Sketch

Megan O'Rourke
Assistant Professor of Sustainable Food Production Systems
401-D Saunders Hall (0327)
490 West Campus Dr.
Blacksburg, VA 24061
540-231-5781
megorust@vt.edu

A. EARNED DEGREES AND TRAINING

College/University	Major	Degree & Year
SUNY Stony Brook	Biology	B.S., May 2002
Iowa State University	Entomology	M.S., May 2005
Cornell University	Ecology	Ph.D., Dec. 2009
Cornell University	Horticulture	Post-Doc, Jan.-June 2010

B. RESEARCH AND PROFESSIONAL EXPERIENCE

- Assistant Professor of Sustainable Food Systems, Virginia Tech, Aug. 2013- present
- Senior Environment Advisor, USAID-Cambodia Mission, Aug. 2012-Aug. 2013
- Climate Change Advisor, USDA-Foreign Agricultural Service, Sept. 2010-Aug. 2012

C. GRANTS RECEIVED

Norton, G.W., Christie, M.E., Miller, S., **O'Rourke, M.E.**, Rajotte, E.G., Rayapati, N., Reyes, M., Richter, S., and. Rosa, C. 2015-2019. $2,000,000. Integrated pest management strategies for vegetable and mango pests in Asia. USAID IPM Innovation Lab.

O'Rourke M.E., T. Anderson, S. Karpanty, and M. Sorice. 2014-2018. $499,980. Harnessing plant biodiversity at multiple spatial scales to enhance ecosystem services in agricultural systems. USDA NIFA Foundational program.

O'Rourke, M.E. (*internal USAID grant*). 2013. $450,000 granted to USAID Cambodia Mission. Developing a social and environmental impacts scorecard for economic land concessions in Cambodia.

O'Rourke, M.E. (*internal State Dept. grant*). 2011. $2,000,000 granted to USDA's Office of Capacity Building & Development. Enhancing capacity for low emissions development strategies in the agricultural sector. US State Dept.

D. TEACHING EXPERIENCE

ALS 3404 Ecological Agriculture: Theory and Practice, Virginia Tech, Instructor
HORT 4986 Food Systems Field Course, Instructor

E. SYNERGISTIC ACTIVITIES

- Wrote and negotiated the MOU between the U.S. and Cambodia for "Enhancing Capacity for Low Emission Development Strategies." (2013)

- Represented the U.S. during the first working session devoted to agriculture at the United Nations Framework Convention on Climate Change's (UNFCCC) Subsidiary Body for Scientific and Technical Advice in Bonne. (2012)
- Represented the U.S. at the Organization of Economic Cooperation and Development's (OECD) working group on Agriculture and the Environment (2011)
- Designed a new $2,000,000 international training program under the U.S. Department of Agriculture to jumpstart U.S. – international researcher collaborations on greenhouse gas mitigation. (2011)
- Faculty Senate Representative, Dept. Horticulture, Virginia Tech (2014-present)

F. SELECT HONORS & AWARDS

- **Fralin Life Sciences New Investigator Award**, Virginia Tech $10,000 (2014)
- **Ambassador's Certificate of Appreciation**, Cambodia (2013)
- **AAAS Science & Technology Policy Fellowship**, ~$500,000 (2010-2013)
- **EPA STAR Fellowship**, $85,000 (2007-2009)
- **NSF Training Scholarship**, International Rice Research Institute, Philippines (2007)
- **NSF IGERT Fellowship,** Biogeochemistry, Cornell University; $80,000 (2005-2007)
- **NSF Honorable Mention**, pre-doctoral fellowship competition (2004)
- **Plant Sciences Fellowship**, Iowa State University; $60,000 (2002-2005)

G. ADVISEES

- Foust-Meyer, Nathan: M.S. 2015
- Seman-Varner, Rachel: Ph.D. 2016
- McCullough, Chris: current Ph.D. student
- Graham, Michael: current Ph.D. student
- Angelella, Gina: current post-doc

H. RECENT PUBLICATIONS

- Seman-Varner, R.* Varco, J., and **M.E. O'Rourke**. (*in review*). Nitrogen benefits of cover crop and fall-applied poultry litter to corn. Agronomy Journal.
- **O'Rourke, M.E.**, and J. Peterson. 2016. Reduced Tillage Impacts on Pumpkin Yield, Weed Pressure, Soil Moisture, and Soil Erosion. HortScience. 51: 1524-1528.
- Foust-Meyer, N. and **M.E. O'Rourke**. 2015. High tunnels for local food systems: subsidies, equity, and profitability. *Journal of Agriculture, Food Systems, and Community Development*. 5: 1-12.
- **O'Rourke M.E.**, and L.E. Jones. 2011. Landscape-scale pest dynamics and insecticide use: an empirical and modeling study. *Ecological Applications*. 21: 3199-3210.
- Chaplin-Kramer, R., **O'Rourke M.E.**, Blitzer E.J., and C. Kremen. 2011. A meta-analysis of crop pest and natural enemy responses to landscape complexity. *Ecology Letters*. 14: 922-932.
- **O'Rourke M.E.**, Rienzo-Stack K., and A.G. Power. 2011. A multi-scale, landscape approach to predicting insect populations in agro-ecosystems. *Ecological Applications*. 21: 1782-1791.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Schmale III, David Garner Burton

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of California, Davis	B.S.	04/2001	Biological Sciences
Cornell University	Ph.D.	01/2006	Plant Pathology

A. Personal Statement

One of the goals of my research program is to understand how microorganisms are transported over long distances in the atmosphere. To do this, I have developed technologies with drones (unmanned aerial vehicles or UAVs) to peer into the life of microorganisms flying tens to hundreds of meters above the surface of the earth. These drones are equipped with unique sampling devices to collect and analyze microorganisms during flight. We were the first to document the transport of microorganisms along unique atmospheric features known as Lagrangian coherent structures (LCSs)—dynamic boundaries between air masses that shape atmospheric transport over long distances. We showed that a unique strain of a fungus collected with drones likely moved into the state of Virginia via LCSs. We applied the language of LCSs to the transport of fungi in the genus *Fusarium*—one of the most important groups of pathogenic fungi in the world. This work was recognized by *Popular Science* Magazine (I was named one of the Brilliant Ten in 2013), *Scientific American* (an invited feature article in early 2017), and TedX Virginia Tech.

B. Positions and Honors

Positions and Employment

2001-2005, Graduate Research Assistant, Cornell University, Dept of Plant Pathology, Ithaca, NY
2006-2011, Assistant Professor, Dept of Plant Path, Phys, & Weed Sci, Virginia Tech, Blacksburg, VA
2011-2016, Associate Professor, Dept of Plant Path, Phys, & Weed Sci, Virginia Tech, Blacksburg, VA
2016-Present, Professor, Dept of Plant Path, Phys, & Weed Sci, Virginia Tech, Blacksburg, VA

Other Experience and Professional Memberships

2006-2008 Elected Chair, Committee on Academic Programs & Policies, Virginia Tech
2007-2010 Elected Secretary-Treasurer/ Vice-President/ President, APS Potomac Div.
2010-2013 Associate Editor, Plant Disease
2012-2015 Chair, Pathogen Genetics and Biology RAC, USDA-USWBSI
2012-2014 Elected Divisional Councilor, American Phytopathological Society
2013-2015 Chair, Academy of Teaching Excellence, Virginia Tech
2014-Present Director, Biological Transport (BIOTRANS Graduate Program, Virginia Tech

Honors

2010 Favorite Faculty Award, Office of Residence Life at Virginia Tech
2010 Member, Virginia Tech Academy of Teaching Excellence
2010 Sporn Award, Virginia Tech Undergraduate Teaching Excellence
2013 Recipient of the *Popular Science* 2013 Brilliant Ten Award

2013 TEDx Virginia Tech Speaker, “Drone-ing for life in the atmosphere”

C. Contributions to Science

1. We developed the first autonomous (self-controlling) drone to sample plant pathogens in the atmosphere hundreds of meters above crop fields. This work has changed the technological landscape for crop biosecurity; new technologies with drones are now available to detect and track the movement of pathogens in the atmosphere, and transport models validated with field experiments can now be used to predict the risk of disease spread between neighboring fields.

a) Schmale, D. G., Dingus, B. R., and Reinholtz, C. F. 2008. Development and application of an autonomous unmanned aerial vehicle for precise aerobiological sampling above agricultural fields. Journal of Field Robotics 25:133-147.
b) Techy, L., Schmale, D. G., and Woolsey, C. A. 2010. Coordinated aerobiological sampling of a plant pathogen in the lower atmosphere using two autonomous unmanned aerial vehicles. Journal of Field Robotics 27:335-343.

2. We were the first to document the transport of microorganisms along unique atmospheric features known as Lagrangian coherent structures (LCSs)—dynamic boundaries between air masses that shape atmospheric transport over long distances. We showed that a unique strain of a fungus collected with drones likely moved into the state of Virginia via LCSs. We applied the language of LCSs to the transport of fungi in the genus *Fusarium*, and LCSs are now considered to be an important mechanism by which microorganisms can invade new territories.

a) Tallapragada, P., Ross, S.D., and Schmale, D.G. 2011. Lagrangian coherent structures are associated with fluctuations in airborne microbial populations. Chaos 21:033122-033122-16.
b) Schmale, D. G., Ross, S.D., Fetters, T.L., Tallapragada, P., Wood-Jones*, A.K., and Dingus*, B. 2012. Isolates of *Fusarium graminearum* collected 40-320 meters above ground level cause Fusarium head blight in wheat and produce trichothecene mycotoxins. Aerobiologia 28:1-11.
c) Schmale, D.G., and Ross, S.D. 2015. Highways in the sky: Scales of atmospheric transport of plant pathogens. Annual Review of Phytopathology, 53: 591-61.

3. Another goal of my research program is to develop strategies to detect, monitor, and control mycotoxins. We have also quantified mycotoxins in a nutrient-rich co-product of fuel ethanol production (dried distiller’s grains with solubles, or DDGS) that is a significant food source for domestic animals.

a) Khatibi, P.A., Berger, G., Liu, S., Brooks, W.S., Griffey, C.A., and Schmale, D.G. 2012. Resistance to Fusarium head blight and deoxynivalenol accumulation in Virginia barley. Plant Disease 96:279-284.
b) Khatibi*, P.A., McMaster*, N., Musser, R., and Schmale, D.G. 2014. Survey of Mycotoxins in Corn Distillers' Dried Grains with Solubles from Seventy-Eight Ethanol Plants in Twelve States in the U.S. in 2011. Toxins 6(4): 1155-1168.

D. Additional Information: Research Support

Ongoing Research Support

Tokekar, P., and Schmale, D.G. $900,835. NSF. NRI: Coordinated Detection and Tracking of Hazardous Agents with Aerial and Aquatic Robots to Inform Emergency Responders. 10/2016-9/2019. Co-Principal investigator, ~50% of funding. *The goal of this project is to coordinate unmanned robots in the air and water to assist in the identification of hazardous agents in water.*

Peacock, T., Shadden, S., Rypina, I., Lermusiaux, P., Ross, S, Schmale, D., Woolsey, C., Kirincich, A., and Gawarkiewicz, G. $2,677,195. NSF. HAZARDS SEES: Uncovering the hidden skeleton of environmental flows: advanced Lagrangian methods for hazard prediction, mitigation, and response. 9/2015-8/2019. Co-PI; ~5% of funding. *The goal of this project is to use unmanned robots in the air and water to develop, test, and validate models to track hazardous agents in marine environments.*

Schmale, D.G. $80,027. USDA-USWBSI. Diagnostic testing services for deoxynivalenol in the eastern U.S. 05/2015 to 04/2016. Principal investigator. *The goal of this project is to provide mycotoxin testing services.*

Christner, B., Vinatzer, B., Schmale, D.G., Weber, C., Morris, C., and Sands, D. $1,997,876. NSF. Research on Airborne Ice-Nucleating Species (RAINS). 1/1/13 to 12/31/16. Co-Principal investigator. *The goal of this project is to examine the diversity of ice-nucleating microbes in precipitation.*

Stephen H. Schoenholtz
Director and Professor
Virginia Water Resources Research Center and
Department of Forest Resources and Environmental Conservation
Virginia Tech
Phone (540) 231-0711; Fax (540) 231-6673; Email Stephen.Schoenholtz@vt.edu

A. Professional Preparation

Pennsylvania State University	Forest Science	B.S. with Distinction, 1979
Pennsylvania State University	Biology	B.S. with Distinction, 1979
Virginia Tech	Forest Biology	M.S. 1983
Virginia Tech	Forest Soils	Ph.D. 1990
Virginia Tech	Restoration Ecology	Postdoc. 1990

B. Appointments

Virginia Tech, Blacksburg, Virginia
Virginia Water Resources Research Center, *Director,* 2006-Present
Department of Forest Resources and Environmental Conservation, *Professor,* July 2006 to Present

Oregon State University, Corvallis, Oregon
Department of Forest Engineering, Resources, and Management, *Associate Professor, Professor,* 2001-2006, *Courtesy Professor,* 2006-2012

Mississippi State University, Mississippi State, Mississippi
Department of Forestry, *Assistant Professor, Associate Professor, Professor,* 1990-2001, *Adjunct Professor,* 2001-Present
Mississippi Water Resources Research Institute, *Director,* 2001

New Zealand Forest Research Institute, Rotorua, New Zealand
Soil and Site Productivity Research Group, *Visiting Senior Research Fellow,* January-July 1998 and January-February 2015

Virginia Tech, Blacksburg, Virginia
Department of Crop and Soil Environmental Sciences, *Postdoctoral Research Associate* 1990

Texas Forest Service, College Station, Texas
Staff Forester II, 1984-1986

Columbia University, Palisades, New York
Lamont-Doherty Earth Observatory, Tree-Ring Laboratory, *Research Assistant,* 1983-1984

C. Recent Relevant Refereed Journal Publications

Krenz III, R.J., **S.H. Schoenholtz**, and C.E. Zipper. 2016. Riparian subsidies and hierarchical effects of ecosystem structure on leaf breakdown in Appalachian coalfield constructed streams. *Ecological Engineering* 97:389-399.

Boehme, E.A., C.E. Zipper, **S.H. Schoenholtz**, D.J. Soucek, and A.J. Timpano. 2016. Temporal dynamics of benthic macroinvertebrate communities and their response to elevated specific conductance in Appalachian Coalfield headwater streams. *Ecological Indicators* 64: 171-180.

Christopher, S.F., **S.H. Schoenholtz**, and J.E. Nettles. 2015. Water quantity implications of regional-scale switchgrass production in the southeastern U.S. *Biomass and Bioenergy* 83: 50-59.

Evans, D.M., C.E. Zipper, E.T. Hester, and **S.H. Schoenholtz**. 2015. Hydrologic effects of surface coal mining in Appalachia (USA). *Journal of American Water Resources Association* 51(5): 1436-1452.

Slesak, R.A., **S.H. Schoenholtz**, and D.M. Evans. 2015. Hillslope erosion from high-risk sites following wildfire and salvage logging in southern Oregon, USA. *Forest Ecology and Management* 342: 1-7.

Timpano, A.J., **S.H. Schoenholtz**, D.J. Soucek, and C.E. Zipper. 2015. Salinity as a limiting factor for biological condition in mining-influenced Central Appalachian headwater streams. *Journal of American Water Resources Association* 51(1): 240-250.

Little, C., J.G. Cuevas, A. Lara, M. Pinto, and **S. Schoenholtz**. 2014. Buffer effects of streamside native forests on water provision in watersheds dominated by exotic forest plantations. *Ecohydrology*. doi: 10.1002/eco.1575

Evans, D.M., **S.H. Schoenholtz**, P.J. Wigington, Jr., S.M. Griffith, and W.C. Floyd. 2014. Spatial and temporal patterns of dissolved nitrogen and phosphorus in surface waters of a multi-land use basin. *Environmental Monitoring & Assessment* 186(2):873-887.

Danehy, R.J., R.E. Bilby, R.B. Langshaw, D.M. Evans, T.R. Turner, W.C. Floyd, **S.H. Schoenholtz**, and S.D. Duke. 2012. Biological and water quality responses to hydrologic disturbances in third order forested streams. *Ecohydrology* 5(1):90-98.

Northington, R.M., E.F. Benfield, **S.H. Schoenholtz**, A.J. Timpano, J.R. Webster, and C.E. Zipper. 2011. An assessment of structural attributes and ecosystem function in restored Virginia coalfield streams. *Hydrobiologia* 671(1):51-63.

Floyd, W.C., **S.H. Schoenholtz**, S.M. Griffith, J.P. Wigington, Jr., and J.J. Steiner. 2009. Nitrate-N, landuse/landcover, and soil drainage associations at multiple spatial scales. *Journal of Environmental Quality* 38(4): 1473-1482.

D. Grants and Contracts Received

- Virginia Tech -- $3,030,000 for my individual research program
  - Administer annual budget for Virginia Water Resources Research Center of $750,000-$1,000,000
- Oregon State University -- $1,164,000 for my individual research program
- Mississippi State University -- $2,198,000 for my individual research program

E. Graduate Students and Post-docs Supervised

- Virginia Tech – 8 MS 5 PhD 2 Post-docs
- Oregon State University – 9 MS 3 PhD
- Mississippi State University – 13 MS 2 PhD

F. Synergistic Activities

- Developed new courses: Properties and Processes of Forested Watersheds, Forest Hydrology, Forest Soils, Advanced Forest Soils, Wetland Ecology and Management at Mississippi State Univ. & Oregon State Univ.
- Coordinated development and now oversee new interdisciplinary B.S. degree program in Water: Resources, Policy, and Management, Virginia Tech.
- *National Institutes for Water Resources*, President-Elect 2015-2016, President 2016-2017
- *Soil Science Society of America*, Former Chair, Forest, Range, and Wildland Soils Division
- *American Water Resources Association, Ad Hoc* Science Advisory Council member
- External reviewer for promotion and tenure: Univ. Alberta, Oregon State Univ., Univ. Arizona, Univ. Colorado, Univ. Georgia, SUNY-ESF, Louisiana State Univ., Texas A&M Univ., West Virginia Univ.
- Testified on behalf of the Mississippi State Univ. Forest and Wildlife Research Center before U.S. House of Representatives Subcommittee on Forests and Forest Health
- Organizing Committee, 10th, 12th, and 13th North American Forest Soils Conferences
- Committee Chair, Virginia Department of Environmental Quality Academic Advisory Committee
- International water-resources service activities in Armenia, Chile, Costa Rica, New Zealand, Sweden

Julie E. Shortridge, PhD
Dept. Biological Systems Engineering; Virginia Tech
205 Seitz Hall, 155 Ag Quad Lane, Blacksburg, VA 20461
Ph: 540-231-2797 Email: jshortridge@vt.edu

A. Professional Preparation

College/University	Major	Degree, Year
University of California, Berkeley	Environmental Engineering Science	B.S., 2005
Johns Hopkins University	Geography and Environmental Engineering	M.S., 2012
	Geography and Environmental Engineering	PhD., 2012

B. Academic/Professional Appointments

Assistant Professor, Dept. Biological Systems Engineering, Virginia Tech, 2016-current
Disaster preparedness consultant, United Nations Environment Programme, 2009-2010
Engineer and Project Manager, ARCADIS U.S., Inc., 2005-2009

C. Products

Five Publications Most Relevant to Proposed Project

1. Shortridge, J.E., Guikema, S.D., and Zaitchik, B.F. (2017) Robust decision making in data scarce contexts: addressing data and model limitations for infrastructure planning under transient climate change. *Climatic Change* 140, 323-337. doi:10.1007/s10584-016-1845-4
2. Shortridge, J.E., Aven, T., and Guikema, S.D. (2017) Risk assessment under deep uncertainty: a methodological comparison. *Reliability Engineering and System Safety* 159, 12-23. doi: 10.1016/j.ress.2016.10.017
3. Shortridge, J.E., Guikema, S.D, and Zaitchik, B.F. (2016) Machine learning methods for empirical streamflow simulation: a comparison of model accuracy, interpretability, and uncertainty in seasonal watersheds. *Hydrology and Earth Systems Sciences* 20, 2611-2628. doi:10.5194/hess-20-2611-2016.
4. Shortridge, J.E., and Guikema, S.D. (2015) Scenario discovery with multiple criteria: an evaluation of the robust decision making framework for climate change adaptation. *Risk Analysis.* Early view published online in February 2016. DOI: 10.1111/risa.12582
5. Shortridge, J.E., Falconi, S.M., Zaitchik, B.F., and Guikema, S.D. (2015). Statistical prediction of undernourishment using non-linear regression and data mining techniques. *Journal of Applied Statistics*. 42(11), 2367-2390.

Other Significant Publications or Products

1. Shortridge, J.E., and Guikema, S. D. (2014). Public health and pipe breaks in water distribution systems: analysis with internet search volume as a proxy. *Water Research*. 53(15), 26-34.

D. Synergistic Activities

1. Extension Specialist, Virginia Tech (2016-present)
   Work with agricultural water users, water management agencies, and water utilities to develop guidance materials and training on climate-risk management and climate-resilient water resources development in Virginia.
2. Project Director, VT Irrigation Risk Management Project (2017 through present)
   Developing interactive software and educational programming to assist agricultural producers in managing financial, regulatory, and production risks associated with irrigation.
3. Instructor, Johns Hopkins University (August-December, 2014)
   Developed, planned and taught an undergraduate seminar on advances in research and engineering practice related to climate change impacts, adaptation, and risk management
4. Trainer, Debre Markos University, Ethiopia (May 2013)
   Trained graduate students on the use of field equipment for agricultural and meteorological monitoring to support climate-resilient agricultural development for joint NSF-funded project with JHU.
5. Member, Society for Risk Analysis, American Geophysical Union, American Society of Agricultural and Biological Engineers, American Society of Civil Engineers

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: William S Swecker, Jr

eRA COMMONS USER NAME (credential, e.g., agency login):TERRYSWECKER

POSITION TITLE: Professor and Director, Veterinary Teaching Hospital

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Virginia Tech, Blacksburg, Va	B.S.	06/1980	Animal Science
Virginia Maryland Regional College of Veterinary Medicine, Blacksburg, Va	DVM	06/1984	Veterinary Medicine
Virginia Tech, Blacksburg, Va	Ph.D	06/1990	Biomedical Sciences: Nutrition

A. Personal Statement

My primary appointment through the years has been didactic teaching in the Veterinary curriculum and clinical management of research herds. My research appointment has been minimal, but has focused on increasing the productivity and health of animals through nutrition. Focus areas of research have included the role of trace elements on immune function in beef cattle and management of grazing systems for beef cattle production. A recent focus was to provide cattle health and production expertise to a USDA / ARS Cooperative Agreement: Economic Pasture Based Beef Systems for Appalachia. This effort involved one ARS unit and 3 Universities (Clemson, VT, and West Virginia) The group included Animal Scientists, Forage Scientists, Soil Scientists, Meat Scientists, and Economists. I believe I have experience in working with large groups across multiple disciplines to accomplish common goals.

Sample publications from the project:

Duckett, S. K., C. Fernandez Rosso, G. Volpi Lagreca, M. C. Miller, J. P. Neel, R. M. Lewis, W. S. Swecker, and J. P. Fontenot. 2014. 'Effect of frame size and time-on-pasture on steer performance, longissimus muscle fatty acid composition and tenderness in a forage-finishing system', *J Anim Sci*. Oct;92(10):4767-74. doi: 10.2527/jas.2014-7411.

Lucas, A. S., W. S. Swecker, Jr., D. S. Lindsay, G. Scaglia, J. P. Neel, F. C. Elvinger, and A. M. Zajac. 2014. 'A study of the level and dynamics of Eimeria populations in naturally infected, grazing beef cattle at various stages of production in the Mid-Atlantic USA', *Vet Parasitol*, 202: 201-6.

Fincham, J. R., J. P. Fontenot, W. S. Swecker, J. H. Herbein, J. P. Neel, G. Scaglia, W. M. Clapham, and D. R.Notter. 2009. 'Fatty acid metabolism and deposition in subcutaneous adipose tissue of pasture- and feedlot-finished cattle', *J Anim Sci*, 87: 3259-77.

Scaglia, G., W. S. Swecker, Jr., J. P. Fontenot, D. Fiske, J. H. Fike, A. O. Abaye, W. Clapham, and J. B. Hall. 2008. 'Forage systems for cow-calf production in the Appalachian region', *J Anim Sci*, 86: 2032-42.

B. Positions and Honors

1984 Associate Veterinarian, Troutville Veterinary Clinic
1986 Resident and Doctoral Candidate, Va-Md Regional College of Veterinary Medicine
1990 Assistant Professor, Va-Md Regional College of Veterinary Medicine
1997 Tenure and promotion awarded, Associate Professor, Va-Md Regional College of Veterinary Medicine
2008 Professor, Virginia Polytechnic Institute and State University
2015 Director, Veterinary Teaching Hospital, Va-Md College of Veterinary Medicine

Specialty Board Certification:

Diplomate of the American College of Veterinary Nutrition - 1989

C. Contributions to Science

1. Selenium supplementation of beef cattle. Selenium is an essential trace element that is found in marginal or deficient quantites in forages and grains grown in many regions of the US. Consequently, cattle raised on these feedstuffs are at risk of two primary problems: 1) Muscle damage or myopathies that are most damaging to neonates and young growing cattle and 2) Immune system impairment. This focus area started with my PhD program but has continued throughout my career. Farmers can rely on injectible Selenium products for short term support, however long term risk is managed through oral supplementation.

Swecker, W. S., Jr., K. H. Hunter, R. K. Shanklin, G. Scaglia, D. A. Fiske and J. P. Fontenot (2008). "Parenteral selenium and vitamin E supplementation of weaned beef calves." J Vet Intern Med **22**(2): 443-449.

Bass, R. T., 2nd, W. S. Swecker, Jr. and C. C. Stallings (2000). "Effects of supplemental parenteral administration of vitamin E and selenium to Jerseys and Holsteins during the nonlactating period." Am J Vet Res **61**(9): 1052-1056.

Swecker, W. S., Jr., C. D. Thatcher, D. E. Eversole, D. J. Blodgett and G. G. Schurig (1995). "Effect of selenium supplementation on colostral IgG concentration in cows grazing selenium-deficient pastures and on postsuckle serum IgG concentration in their calves." Am J Vet Res **56**(4): 450-453.

Swecker, W. S., Jr., D. E. Eversole, C. D. Thatcher, D. J. Blodgett, G. G. Schurig and J. B. Meldrum (1989). "Influence of supplemental selenium on humoral immune responses in weaned beef calves." Am J Vet Res **50**(10): 1760-1763.

2. Technology tranfer. As a clincal scientist, my role has been more as a co-investigator than PI. Thus I have been able to transfer the technology gained through over the years through over 100 presentations to national or international veterinary groups and organizations and over 80 presentations or publications to stakeholder groups (mostly farmers)
3. Effect of alternate or low stress weaning methods on calf health. In current beef production sytems, calves are weaned / separated from their dams at 6-10 months of age. The historical model was to perform an abrupt separation of the dam and calf. This method resulted in changes in behavior of the calves like increased vocalization and walking and changes in health status with an increased in morbidity and mortality to respiratory diseases. Our group took a concept named alternate or low-stress weaning and explored the outcomes of these methods on both health and behavioral parameters. Broadly, performance, as measured by weight gain, did not differ between weaning treatments, however, behavior was markedly different between treatments and the low stress methods

resulted in less aberrant behavior. These findings have been shared through multiple field presentations to producers and veterinary conferences. Relevant citations are below

Boland, H. T., G. Scaglia, W. S. Swecker, and N. C. Burke. 2008. 'Effects of Alternate Weaning Methods on Behavior, Blood Metabolites, and Performance of Beef Calves', *The Professional Animal Scientist*, 24: 539-51.

Burke, N. C., G. Scaglia, H. T. Boland, and W. S. Swecker, Jr. 2008. 'Influence of two-stage weaning with subsequent transport on body weight, plasma lipid peroxidation, plasma selenium, and on leukocyte glutathione peroxidase and glutathione reductase activity in beef calves', *Vet Immunol Immunopathol*, 127: 365-70.

Lucas, A. S., W. S. Swecker, D. S. Lindsay, G. Scaglia, F. C. Elvinger, and A. M. Zajac. 2007. 'The effect of weaning method on coccidial infections in beef calves', *Vet Parasitol*, 145: 228-33

D. Additional Information: Research Support and/or Scholastic Performance

USDA-ARS Cooperative Agreement 1932-21630-002-01S
Swecker, Lewis (PI) 08/07-05/13
“Economic Pasture Based Beef Systems for Appalachia”

VITA

Wade E. Thomason
Professor, Crop and Soil Environmental Sciences
Virginia Tech, Blacksburg, VA 24061-0403

Education

Ph.D. Oklahoma State University, 2001
M.S. Oklahoma State University, 1998
B.S. Oklahoma State University, 1996

Professional Positions Held

- Professor/Extension Grains Specialist, Virginia Tech, 2015-present.
- Associate Professor/Extension Grains Specialist, Virginia Tech, 2010-2015.
- Assistant Professor/Extension Grains Specialist, Virginia Tech, 2004-2010.
- Soil Fertility and Crops Specialist, Samuel R. Noble Foundation, 2001- 2003.
- Senior Agriculturist, Dept. of Plant and Soil Sciences, Oklahoma State University, 1999-2001.

Executive Summary

Dr. Thomason's primary responsibilities are outreach/extension education and research for the Virginia corn and small grains industries. The core focus of his extension education program is integration of corn, wheat, barley, and other crops into profitable cropping systems for the eastern U.S. Practical, economical, and environmentally sound production techniques are major areas of emphasis.

Selected Honors and Awards

- Land Grant University Award – Virginia Agribusiness Council, 2014.
- No-Till Innovator Award, Organization Division–Virginia No-tillage Alliance. Syngenta Crop Protection and No-Till Farmer Magazine, 2014.
- Excellence Award in Applied Research. Virginia Tech College of Agriculture and Life Sciences, 2013.
- ASABE (American Society of Agricultural and Biological Engineers) Blue Ribbon award for outstanding effort and achievement in the development of noteworthy educational aids – "Precision Farming Tools: Variable-Rate Application." 2012.
- Friend of Agriculture award. Presented by the Virginia Grain Producers Association, 2011.
- Excellence in Technology Transfer award, USDA-ARS Federal Laboratory Consortium, Mid-Atlantic Region. For: Winter Barley Ethanol Initiative for Improving Energy Independence of the Mid-Atlantic, 2010
- Distinguished Service to Virginia Agriculture award. Presented by the Virginia Crop Improvement Association, 2009
- No-Till Innovator Award - Organization Division. Syngenta Crop Protection and No-Till Farmer Magazine, 2006.
- Epsilon Sigma Phi – State Extension Team Award, 2005.

Refereed Journal Articles (2016-2017) *- indicates graduate student advised

- Chim, B.K.*, D. Holshouser, H. Behl, M. Balota, K. Xia, W.H. Frame, T. Black and W.E. Thomason. 2017. Comparison of full season and double crop soybean and grain sorghum systems in central and southeast Virginia. Agron. J. doi: 10.2134/agronj2016.10.0577
- Zhang, X., Q, Yang, E. Rucker, W.E. Thomason and P. Balint-Kurti. 2017. Fine mapping of a quantitative resistance gene for gray leaf spot of maize (Zea mays L.) derived from teosinte (Z. mays ssp. parviglumis). Theor. App. Genet. DOI 10.1007/s00122-017-2888-2.
- Yang, Y., G. Ferreira, C.L. Teets, B.A. Corl, W.E. Thomason and C.A. Griffey. 2017. Effects of feeding hull-less barley on production performance, milk fatty acid composition and nutrient digestibility of lactating dairy cows. J. Dairy Sci. 100:1-8.
- Edwards, C.L. R.O. Maguire, G.B. Whitehurst, W.E. Thomason and M.M. Alley. 2016. Using synthetic chelating agents to decrease phosphorus binding in soils. Soil Sci. 181:377-385.
- Bamber, K.W., G.K. Evanylo and W.E. Thomason. 2016. Importance of soil properties on recommended biosolids management for winter wheat. Soil Sci. Soc. Am. J. 80:919-929.
- Lynch, M.J.*, M.J. Mulvaney, S.C. Hodges, T.L. Thompson and W.E. Thomason. 2016. Decomposition, nitrogen and carbon mineralization from food and cover crop residues in the central plateau of Haiti. SpringerPlus 5(1):1-9. doi: 10.1186/s40064-016-2651-1.
- Kulesza, S.B., R.O. Maguire, W.E. Thomason and D.H. Pote. 2016. Injecting poultry litter into orchardgrass hay. Comm. Soil Sci. Plant Anal. doi:10.1080/00103624.2016.1178761
- Trail, P., A.O. Abaye, W.E. Thomason, T.L. Thompson, F. Gueye, I. Diedhiou, M. Diatta and A. Faye. 2016. Evaluating intercropping (living cover) and mulching (desiccated cover) practices for increasing millet yield in Senegal. Agron. J.
- Edwards, C.L., R.O. Maguire, M.M. Alley, W.E. Thomason and G.B. Whitehurst. 2016. Plant-available phosphorous after application of synthetic chelating agents. Comm. Soil Sci. Plant Anal. 47: 433-446.

Publications Summary

- Refereed Journal Articles – 76
- Book Chapters - 3
- Trade Journals, State-Govt. Pub. Etc. – 188
- Proceedings – 20
- Abstracts - 115

Grants and Contracts

- FY12 $480,000
- FY13 $574,000
- FY14 $633,000
- FY15 $570,000
- FY16 $440,000

Biographical Sketch: *Anil Kumar S. Vullikanti*

Biocomplexity Institute of Virginia Tech, and
Dept. of Computer Science
Virginia Polytechnic Institute and State University 1015 Life Science Circle, MC 0477
(540) 231-3968, akumar@vbi.vt.edu Blacksburg, VA 24061

(a) Professional Preparation

Indian Institute of Technology	Kanpur, India	Comp Sci & Eng	B.Tech, 1993
Indian Institute of Science	Bangalore, India	Computer Science	Ph.D., 1999
Max-Planck Institute for Computer Science	Saarbruken, Germany	Postdoctoral Associate	1999-2001
Los Alamos National Laboratory	Los Alamos, NM	Postdoctoral Associate	2001-2003

(b) Appointments

2011–present Associate Professor, Department of Computer Science and Biocomplexity Institute of Virginia Tech, Virginia Tech, and Courtesy appointment in the ECE Dept., Virginia Tech

2005–2011 Assistant Professor, Department of Computer Science and Biocomplexity Institute of Virginia Tech, Virginia Tech

2003–2005 Technical Staff Member, Los Alamos National Laboratory

1993–1994 Software Engineer, Tata Information Systems Limited, India

(c) Most Relevant Publications[1]

1. Maksudul Alam, Maleq Khan, **Anil Vullikanti** and Madhav Marathe. An Efficient and Scalable Algorithmic Method for Generating Large–Scale Random Graphs, *The International Conference for High Performance Computing, Networking, Storage and Analysis* (SC), 2016 (Nominated for Best Paper Award)
2. J. Cadena, **A. Vullikanti** and C. Agarwal. On Dense Subgraphs in Signed Network Streams, *Proc IEEE International Conference on Data Mining* (ICDM), 2016.
3. Madhav Marathe and **Anil Kumar S. Vullikanti**. Computational Epidemiology, *Communications of the ACM*, 56(7), pp. 88-96, 2013.
4. A. Adiga, C. Kuhlman, H. Mortveit and **A. Vullikanti**. Sensitivity of Diffusion Dynamics to Network Uncertainty, *Journal of AI Research, Vol 51, pp. 207-226*, 2014 (Invited). Preliminary version appeared in *Proc. of AAAI*, 2013. Selected for Honorable Mention.
5. Eubank, S., H. Guclu, **V. S. Anil Kumar**, M.V. Marathe, A. Srinivasan, Z. Toroczkai and N. Wang. 2004. Monitoring and Mitigating SmallPox Epidemics: Strategies Drawn from a Census Data Instantiated Virtual City. *Nature*, May 13, 2004.

Other Significant Publications

6. Sudip Saha, Abhijin Adiga, B. Aditya Prakash and **Anil Kumar S. Vullikanti.** Approximation Algorithms for Reducing the Spectral Radius Control Epidemic Spread, *Proc*. *SIAM International Conference on Data Mining* (SDM), 2015.
7. Sudip Saha, Abhijin Adiga, **Anil Vullikanti**. Equilibria in Epidemic Contain- ment Games, The 28th AAAI Conference on Artificial Intelligence (AAAI), 2014

[1] Please note that my name appears as V.S. Anil Kumar on some of my publications

8. Z. Zhao, G.Wang, A. Butt, M. Khan, **V.S. Anil Kumar**, M. Marathe. SAHad: Subgraph analysis in massive networks using hadoop. The *Proceedings of 26th IEEE International Parallel & Distributed Processing Symposium* (IPDPS), May 21-25, Shanghai, 2012.

9. **V.S. Anil Kumar**, M. V. Marathe, S. Parthasarathy and A. Srinivasan. A unified approach to scheduling on Unrelated Parallel Machines, *Journal of the Association of Computing Machinery* (JACM), 56(5), article 28 (31 pages), 2009.
10. M. E Halloran, N. M. Ferguson, S. Eubank, I. M. Longini Jr., D.A.T. Cummings, B. Lewis, S. Xu, C. Fraser, **A. Vullikanti**, T. C. Germann, D. Wagener, R. Beckman, K. Kadau, C. Barrett, C. A. Macken, D. S. Burke, and P. Cooley. Modeling targeted layered containment of an influenza pandemic in the United States. *Proceedings of the National Academy of Sciences* (PNAS), March 25, vol. 105 (12), pp. 4639-4644, 2008. PMID: 18332436

(d) Synergistic Activities and Honors:

1. Virginia Tech College of Engineering Faculty Fellow 2017
2. Development of the area of networked epidemiology. Have contributed in developing the area of networked epidemiology, and its use in public health policy planning. Co-authored one of the first papers on this approach in Nature 2004, which has over 900 citations, and have co-developed a highly scalable epidemiological simulation tool (EpiFast), which now forms the computational backbone of SIBEL, a cyber-infrastructure for epidemiological analysis. Have participated in numerous studies on public health policy analysis, including: (i) a study for the Office of Homeland Security right after 9/11 to evaluate plans and response strategies in the event of a smallpox-based bio-terror attack and published in Nature 2004, (ii) a study reviewed by the Institute of Medicine on the targeted layered containment strategy advocated in the *National strategy for pandemic flu*, and published in PNAS 2008.
3. *Education and outreach activities related to epidemiology.* Have co-authored a survey in CACM 2013, and have presented two tutorials on computational epidemiology. Have also co-developed an exhibit called VirusTracker, for demonstrating how epidemics spread, using wristbands and mobile apps. This has been used at the USA Science and Engineering Festival (USASEF) in 2010, 2012, 2014, and 2016, and other science fairs.
4. *Professional service activities.* Associate Editor for the ACM Transactions on Algorithms. Co-chair, SIAM Network Science Meeting, 2015. Have been active member of a number of technical program committees of different conferences, such as IEEE INFOCOM.
5. DOE Early Career award, 2010-2015 and CAREER award from the NSF CNS program, 2009-2014.

BIOGRAPHICAL SKETCH

NAME: White, Robin R.

POSITION TITLE: Assistant Professor of Animal and Poultry Science

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Washington State University, Pullman, WA	B.S.	05/2010	Animal Science
Washington State University, Pullman, WA	Ph.D.	05/2014	Animal Science
National Animal Nutrition Program, Blacksburg, VA	Postdoctoral	12/2015	Nutrition Modeling
USDA ELI Postdoctoral Fellow, Blacksburg, VA	Postdoctoral	12/2016	Heat Stress Physiology

A. Personal Statement

My long-term research objective is to integrate basic, applied and systems-oriented investigations to identify management strategies that improve sustainability of U.S. livestock production. Specific research efforts include: improving our understanding of mechanisms governing volatile fatty acid production and absorption; defining feeding strategies to enhance efficiency; and evaluating environmental impacts of ruminant production.

B. Positions and Honors

Positions and Employment

2016- Assistant Professor, Department of Animal and Poultry Science, Virginia Tech, Blacksburg, VA

Other Experience and Professional Memberships

2010- Member, American Society of Animal Science
2010-2014 Member, American Dairy Science Association

Honors

2011 1st Place in Land O'Lakes, Purina Feed LLC Graduate Student Poster Contest (M.S. Division), American Dairy Science Association
2013 Wilson G. Pond Appreciation Club International Travel Award, American Society of Animal Science
2013 1st Place in Pacific Northwest Animal Nutrition Graduate Student Poster Contest, Pacific Northwest Animal Nutrition Conference
2014 1st Place in Dr. William R. Wiley Research Expo, Graduate and Professional Student Association, Washington State University
2014 Harriett B. Rigas Outstanding Woman in Doctoral Studies, Washington State University
2014 Department of Animal Sciences Outstanding Ph.D. Student

C. Contributions to Science

My research focuses on three critical areas: 1) basic mechanisms governing nutrient utilization in livestock; 2) strategies for improving feed efficiency and resilience to stress; and 3) environmental impact of livestock production systems. Total research publications in the last 5 years include 23 peer-reviewed publications, 7 invited presentations, and over 35 abstracts.

Contributions to understanding of basic mechanisms governing nutrient utilization in livestock include:

- W.T. Dai, **R.R. White**, J.X. Liu, and H.Y Liu. *In Press*. Comparative proteomic analysis of the lactating and non-lactating bovine mammary gland. Journal of Dairy Science.

- W.T. Dai, Q. Chen, Q. Wang, **R.R. White**, J.X. Liu, and H.Y Liu. *In Press*. Complementary transcriptomic and proteomic analyses reveal regulatory mechanisms of milk protein production in dairy cows consuming different forages. Nature Scientific Reports.
- G.M. Liu, M.D. Hanigan, X.Y. Lin, K. Xhao, F.G. Jiang, **R.R. White**, Y. Wang, Z.Y. Hu, and Z.H. Wang. *In Press.* Methionine, leucine, isoleucine, and threonine effects on mammary cell signaling and pup growth in lactating mice. Journal of Dairy Science.

Contributions to strategies to improve feed efficiency and resilience to stress include:

- **White, R.R.**, P. Kononoff, and J.L. Firkins. *In Press*. Technical Note: Methodological and feed factors affecting prediction of ruminal degradability and intestinal digestibility of essential amino acids. Journal of Dairy Science.
- **White, R.R.** Y. Roman-Garcia, J.L. Firkins, M.H. VandeHaar, T. McGill, R. Garnett, and M.D. Hanigan. *In Press.* Evaluation of the 2001 Dairy NRC, 2: biases in duodenal N flows. Journal of Dairy Science.
- **White, R.R.** Y. Roman-Garcia, J.L. Firkins, M.H. VandeHaar, L. Armentano, W.P. Weiss, T. McGill, R. Garnett, and M.D. Hanigan. *In Press.* Evaluation of the 2001 Dairy NRC, 1: biases in total tract fiber, protein, fat, and non-fiber carbohydrate digestibility. Journal of Dairy Science.
- **White, R.R.,** Y. Roman-Garcia, J.L. Firkins. 2016. Meta-analysis of post-ruminal microbial protein flows in dairy cattle. II. Approaches to and implications of more mechanistic prediction. Journal of Dairy Science. 99:7932-7944

Contributions to understanding livestock's environmental impact include:

- **White, R.R.**. 2016. Increasing energy and protein use efficiency improves opportunities to decrease land use, water use, and greenhouse gas emission from dairy production. Agricultural Systems. 146:20-29
- **White, R.R.,** M. Brady, J.L. Capper and K.A. Johnson. 2015. Cow-calf reproductive, genetic and nutritional management to improve sustainability of whole beef production systems. Journal of Animal Science. 93:3197-3211
- **White, R.R.**, M. Brady, J.L. Capper and K.A. Johnson. 2014. Optimizing diet and pasture management to improve sustainability of U.S. beef production. Agricultural Systems. 130:1-12
- **White, R.R.** and M. Brady. 2014. Can consumers' willingness to pay incentivize adoption of environmental impact reducing technologies in meat animal production? Food Policy. 49:41-49
- **White, R.R.** and J.L. Capper. 2014. Precision nutrition to improve performance and profitability across various climates: Modeling the implications of increasing the formulation frequency of dairy cattle diets. Journal of Dairy Science. 97:1563-1577

D. Additional Information: Research Support and/or Scholastic Performance

Total support obtained for my research to-date is $3,366,015. Selected projects include:

- $10,008 - Virginia Agricultural Council. *Enhancing opportunities for pasture-based production research at Virginia Tech and the outlying research an extension centers*. **R.R. White,** V.R.G. Mercadante, T.B. Wilson, and A.D. Ealy.
- $499,903 - USDA-NIFA Foundational Program. A field application model for lactation responses to amino acid. M.D. Hanigan, **R.R. White**, and G. Ferriera
- $1,943,727 - Agriculture and Agrifood Canada. Integration of feeding, animal and manure management practices to reduce whole farm GHG emissions and improve nutrient utilization in cow-calf operations. K. Ominski, M. Tenuta, C. Rawluk, D. Flaten, G.L. Gizaw, M. Grahn, T. McAllister, E. McGeough, **R.R. White**, and K. Wittenberg
- $198,670 - John L. Pratt Fellowship Program. Integration of livestock feeding strategies into a nutrient loading watershed model. Mark D. Hanigan, **R.R. White**, Z. Easton, and D. Bosch.
- $82,678 - John L. Pratt Fellowship Program. A role for valerate, isovalerate, and isobutyrate in rumen fermentation kinetics. **R.R. White,** J.L Firkins, and M.D. Hanigan
- $27,583 - Novus International. Determination of the biological of a methionine analog with application to the dairy NRC ration formulation model. M.D. Hanigan and **R.R. White**
- $15,838 - Virginia Agricultural Council. *Low cost nutritional intervention to improve growth and fertility of replacement heifers grazing endophyte infected tall fescue.* **R.R. White**, Alan D. Ealy, Michelle L. Rhoads, Vitor Mercadante, and Bain Wilson.
- $145,567 - AFRI Competitive Grants Program, Food, Agriculture, Natural Resources, and Human Sciences Education and Literacy Initiative Postdoctoral Fellowship. *Rumen Digestive and Absorptive Adaptations to Heat Stress.* **R.R. White**, M.D. Hanigan and K. Daniels.
- $91,220 - John Lee Pratt Animal Nutrition Grant Program. *Identification of biological targets at the tissue level that could be manipulated to achieve improved feed efficiency*. M.D. Hanigan, **R.R. White** and R. Cockrum.
- $249,146 - Alberta Livestock and Meat Agency. *Using predicted and residual ruminal volatile fatty acid concentrations to predict feed efficiency, carcass yield, and carcass composition in beef cattle.* L.L. Guan, M.D. Hanigan, **R.R. White**, G. Plastow, Z. Wang.