Dear Friends,

The Sustainable Environment Research Laboratory (SERL) enjoyed great success at all level during 2019 as this annual report details. The breadth and depth of our research continue to expand with new research directions, new funding sources, and all of the research activities of our talented graduate students.

Undoubtedly the biggest highlights of the year were the numerous professional awards and high impact publications that SERL students have accomplished, indicating that their contribution to the wastewater research and innovation was recognized in the U.S. and across the world. SERL would not have had such a successful year without the strong funding support from our new and continued sponsors such as AlexRenew, Arlington County, HRSD, ICTAS, Loudoun Water, UOSA, USDA, VAC, WSSC, and 4-VA.

Thank you for helping us make 2019 a landmark year of growth and innovation for the wastewater research. With your support, we will achieve even greater success in 2020 ahead!

Regards,

Zhiwu Wang
2019 is a bumper year for SERL, which also means 2020 is going to be a super busy year for SERL. We feel grateful for receiving unprecedented funding support from new sponsors such as Loundoun Water, ICTAS, and WSSC along with the continued support from 4-VA, AlexRenew, Arlington County, UOSA, USDA, VAC, and HRSD. The new research directions we are going to explore in 2020 include: i) understanding PFAS fate and destruction; ii) harnessing genetically modified crops for phosphorus removal of surface runoff; iii) recalcitrant organic nitrogen control for thermal hydrolysis; and iv) molecular mechanism of aerobic granulation. In order to successfully accomplish these demanding research goals, SERL enrolled following three talented young men and are still recruiting more prospective graduate students.

New Grants in 2019 ($484,656)

- Innovative biological and physicochemical removal of Per- and Polyfluoroalkyl Substances (PFAS) from Wastewater – A platform for building long-term partnerships between VT and NC A&T in Water Treatment Technologies, 12/1/2019-6/30/2021
- Continuous flow aerobic granulation in real domestic wastewater – Phase 2 Study, 5/1/2019-7/31/2020
- Molecular biology methods for understanding aerobic granulation in wastewater treatment systems, 7/1/19-6/30/20
- A test of method to maintain the uninterrupted high ammonia removal efficiency during the bioreactor startup for continuous flow aerobic granulation in real municipal wastewater, 6/1/19-5/31/20
- Development of a sustainable treatment system for poultry litter with maximum value recovery, 7/1/19-6/30/22
- A transdisciplinary approach to phosphorus reclamation, 7/1/19 – 6/30/21
- Identification of the source and cause of the biosolids odor emission in western branch water resource recovery facility, 9/1/2019-5/31/2020
- Potential impact of the recalcitrant dissolved organic nitrogen formation as a result of the thermal hydrolysis on the Loudoun Water reclamation plant operation, 5/1/2019 - 12/31/2020
- Effect of thermal hydrolysis pretreatment on high solids anaerobic digestion, 7/1/19-6/30/20
- Effect of Class A biosolids production on the fate and transport of PFAS on farmland, 7/1/19-5/30/20

New students, projects, & sponsors in 2019

Mr. Hao Luo started his Ph.D. candidacy in SERL in Spring 2019.

Mr. Jeffrey Nicholson joined SERL as a PhD student in Summer 2019.

Mr. Jiefu Wang started his Ph.D. candidacy in SERL in Fall 2019.
Recognition in 2019

1. Yewei Sun, Ph.D., Grizzard Fellowship Award - Nov 12, 2019 - $2,500
2. Yewei Sun, Ph.D., WaterJam 1st Place Poster Award - Sep 12, 2019 - $1,000
3. Yewei Sun, Ph.D., VWEA Sonny Roden Graduate Scholarship - Sep 10, 2019 - $2,500
4. Yewei Sun, Ph.D., Featured talk in 2019 WEFTEC conference - Sep 24, 2019
5. Zhaohui An, Ph.D., Sussman Foundation Internship Award - Mar 19, 2019 - $6,825
6. Timothy Robert Kent, M.S., AEESP Master’s Thesis Award - May 16, 2019 - $1,000

Total: $13,825

Yewei Sun is indeed the champion awardee of 2019. He received three awards and one featured talk in a national conference. *Left & Middle*: Yewei was awarded the VWEA Sonny Roden Graduate Scholarship; *Right*: Yewei received a 1st place award in the WaterJam poster competition, which will also cover his travel to AWWA-ACE conference.

Timothy Robert Kent only spent a little bit more than one year in my lab during which he published research papers in two high impact journals, namely *Biotechnology Advances* (12.831) and *Environment International* (7.943). Hence, I was not surprised to see him receiving the AEESP Thesis Award (*left*) even though himself considered it as a long shot. We appreciate HRSD’s support of Tim’s research and study. Notably, VT swept three out of the four best dissertation and thesis awards in 2019 AEESP conference. See Dr. Amy Prudent and Dr. Peter Vikesland’s teams (*right*).

*Left*: Yewei Sun gave his featured talk in 2019 WEFTEC; *Middle*: For Yewei’s contribution to the process intensification research in UOSA for protection of Occoquan Lake, he received 2019 Grizzard Fellowship Award. We all miss Dr. Grizzard so much; *Right*: Zhaohui An received 2019 Sussman Internship Award for his research work with local Utilities.
The performance of biologically active filtration can be mathematically predicted and optimized.

In this study, a modeling framework was developed to simulate biologically active filtration (BAF) headloss buildup in response to organic removal and nitrification. This model was calibrated and validated with data collected from a pilot-scale study used for potable water reuse and a full-scale facility used for potable water treatment. The model prediction provided insights that biofilm growth rather than particle deposition primarily contributes to the headloss buildup. Therefore, biofilm control is essential for managing headloss buildup and reducing the backwash frequency. Model simulation indicated that the BAF performance in terms of pollutant removal per unit headloss can be effectively improved by increasing the media size. Source: Water Research, 167, 115128

The very first continuous flow aerobic granulation bioreactor in the world was demonstrated in UOSA.

This pilot study verified the feasibility of achieving successful aerobic granulation in continuous flow infrastructure of modern wastewater treatment plants fed with primary effluent with seasonal temperature variation between 10 and 22.5 °C. Source: Science of The Total Environment, 688, 762-770

The cerium chloride is cost-effective in controlling struvite scaling and improving sludge dewaterability.

In order to control the nuisance struvite scaling issues, cerium chloride (CeCl₃) was dosed as an effective OP precipitant. The results of this study demonstrated that CeCl₃ dosing showed higher OP removal efficiency than other commonly used OP precipitants. In addition, sludge dewaterability improvement and thus lower polymer and dewatering energy demands were also observed. The seasonal dosing of CeCl₃ at UOSA provided a net annual saving of US $47,000. Source: Water Environment Research, https://doi.org/10.1002/wer.1150

Mass diffusion limitation compromised NOB suppression in aerobic granules.

Those NOB survived free ammonia (FA) inhibition in larger granules were forced to dwell within the granule interior, where the AOB growth slows down due to DO diffusion limitation. This means FA inhibition can be effective only in small granules or thin biofilms. Source: Environment International, 131, 105005

Season and fertilization affect nitrogen turnover microbial community in wetland mesocosms.

Constructed wetlands effectively stored and transformed pollutants. The seasonal effect convolved with fertilization effect and appeared to be the dominant factor influencing the soil microbial community. The effects of plant species richness were more nuanced, with greater richness significantly impacting the abundance of only a subset of bacterial groups. Source: Science of The Total Environment, 689, 269-277
Journal papers

Conference presentations


Conference Posters


