Sarina Ergas’ Research Interests

Ergas research group Fall 2016:

Front row:
- Maraida Balaguer
- Qiaochong He
- Sarina Ergas
- Dhwani Khambhati
- Shuang Tong
- Faith Malay
- Emma Lopez

Back row:
- Lensey Casimir
- Phillip Dixon
- Md Yeasir Rahman
- Arpita Meher
- Nadezhda Zalivina
- Paula Bittencourt
- Justine Stocks
- Michelle Henderson
- Laura Rodriguez-Gonzalez

Missed the party:
- Karl Payne
- Meng Wang
- Madison Rice
- Diarra Thomas
- Andres Garcia Parra
Hybrid Adsorption Biological Treatment Systems (HABiTS) for Decentralized Wastewater Treatment

**PIs:** Sarina J. Ergas, Maya Trotz, James Mihelcic

**Sponsor:** USEPA, Alfred P. Sloan Foundation, McKnight Florida Education Fund

**Students:** Justine Stocks, Amulya Miriyala, Michelle Henderson, Laura Rodríguez-Gonzalez, Madison Rice, Diarra Thomas, Daniel Delgado

**Synopsis:** Onsite Wastewater Treatment Systems (OWTS) treat 30% of household wastewater and are effective in reducing solids, fats, oil and grease from household wastewater before it is released into the environment. However, conventional OWTS are not efficient at removing nitrogen and pathogens, which can lead to harmful environmental and human health impacts. Passive OWTS, such as Hybrid Adsorption and Biological Treatment Systems (HABiTS) with recirculation, have the potential to lessen nutrient and pathogens released into the environment by combining ion exchange, biological nitrogen removal, and recirculation. Increased nitrogen and E. coli removals were observed for the 1:1 recirculation ratio compared to the control system without recirculation. In the system without recirculation, total inorganic nitrogen (TIN) was reduced 59% and E. coli was reduced 0.51 log. In the recirculation system TIN was reduced 81% and E. coli reductions were 1.40 log. The improved performance was attributed to recirculation, pre-denitrification and improved aeration. Further research is being conducted on disinfection of effluent from HABiTS for non-potable reuse.
Examining the use of iron-sulfur minerals for biological nitrate removal from small community water systems

**PIs:** Sarina J. Ergas, Jeffrey A. Cunningham, Laura Rodriguez-Gonzalez

**Sponsor:** Water Innovation Network for Sustainable Small Systems

**Students:** Erica Dasi, John Sutton, Maria Rea,

**Synopsis:** Nitrate (NO$_3^-$) is a common contaminant found in small community water systems (CWS), which serve less than 10,000 people. Conventional physical and chemical methods for removing nitrate from drinking water supplies have high energy and/or chemical cost and produce waste that is difficult to dispose of. This project seeks to develop a biological nitrogen removal process targeted for CWS that uses low cost materials, no chemical feed systems, and eliminates the need to dispose of waste. More specifically, this investigation aims to examine the relative efficacy of iron-sulfur minerals as electron donors for mediating the biological removal of nitrogen (i.e. denitrification). Previous studies in our lab have identified, pyrite and sphalerite, as two promising candidates for drinking water denitrification. These minerals are employed in side-by-side column studies, where water quality measurements and biological nitrogen removal are being monitored.
A novel algal-bacterial shortcut nitrogen removal process for wastewater treatment

PIs: Sarina J. Ergas, Qiong Zhang, Kathleen Scott, Meng Wang
Sponsor: National Science Foundation
Students: Nadezhda Zalivina, Larissa Arashiro, Han Yang, Ryan Keeley, AvaAnne Hogue, Maraida Balaguer-Barbosa

Synopsis: Centrate from anaerobic digesters contains high concentrations of ammonia. Its recirculation back to the head of the plant causes irregular variations in nitrogen loads, which can upset mainstream biological nitrogen removal (BNR) processes and increase costs. Drs. Ergas, Zhang, Scott, and Wang are investigating a novel algal-bacterial shortcut nitrogen removal process that will form the basis of the development of efficient low cost and low energy BNR technologies. The preliminary research showed 93% removal of TN, where over 80% were removed through nitritation/denitritation. Compared to conventional BNR, the new process achieved 85% reduction of energy requirement for aeration and 40% reduction of carbon source requirement. The current research focuses on investigating the effect of varying operating conditions (SRT, light intensity) on system kinetics and performance, analyzing the algal-bacterial consortium using molecular tools and optimizing system design through coupled process-optimization modeling.

![NH₄⁺-N, NO₂⁻-N, and NO₃⁻-N profiles during phase 2a (feeding during dark period) and 2b (feeding during light period)]
Bioenergy Production from MSW by High-Solids Anaerobic Digestion

**PIs:** Sarina J. Ergas, Qiong Zhang, Meng Wang, Eunyoung Lee, Daniel Yeh, Wendy Mussoline

**Sponsor:** Hinkley Center for Solid and Hazardous Waste Management, National Science Foundation

**Students:** Phillip Dixon, Paula Bittencourt, Dhwani Khambhati, Greg Hinds, George Dick, Eduardo Jimenez, Lensey Casimir, Deborah Stolte Bezerra Lisboa Oliveira, Luiza Stolte Bezerra Lisboa Oliveira, Aleem Waris

**Synopsis:** High solids-anaerobic co-digestion (HS-AcD) of biosolids (B) with the organic fraction of municipal solid waste (OFMSW; e.g. food waste [FW] and yard waste [YW]) has a number of benefits over liquid anaerobic digestion (L-AD) systems, including little or no production of liquid side-streams that require treatment and the recovery of nutrients as a stabilized compost that can be used as a soil amendment. Co-digestion of substrates with a range of bioavailability has the potential to improve the methane (CH$_4$) yield and reduce the total digester retention time. Specific objectives of this study were to: 1) investigate the performance of HS-AD of OFMSW and biosolids under varying operating conditions, 2) apply life cycle assessment (LCA) to assess whether HS-AD is environmentally beneficial, and 3) compare the HS-AD with other waste management options (e.g., landfilling, Waste to Energy (WTE), composting) using life cycle cost analysis (LCCA) to ensure economic sustainability.

**Figure 1.** Cumulative CH$_4$ yields for HS-AD with different substrate ratios.
Reducing Nitrogen Loads to Tampa Bay Using Bioretention Systems

**PIs:** Sarina J. Ergas, Maya Trotz, James Mihelcic, Maya Trotz  
**Sponsor:** National Fish and Wildlife Foundation, USEPA  
**Students:** Emma Lopez, Tom Lynn, Ryan Locicero, Laura Rankin, and Mackenzie Peterson

**Synopsis:** Excess nitrogen in stormwater runoff leads to eutrophic areas, negatively impacting aquatic ecosystems. A technology being studied to remove nitrogen, such as NH$_4^+$, NO$_2^-$, and NO$_3^-$, from stormwater are modified bioretention systems, a low impact development technology (LID) that attenuates peak flows, restores watershed hydrology, and improves the quality of stormwater runoff. In addition to a vegetative and a sandy nitrification layer, modified bioretention includes a denitrification layer with an internal water storage zone (IWSZ) containing wood chips as a carbon source and electron donor. In a side-by-side field study of a conventional and modified bioretention, modified bioretention has greater overall nitrogen removal rates for all nitrogen species, likely due to the enhanced denitrifying conditions and increased hydraulic detention time associated with the IWSZ.

**A Modified Bioretention**

![Diagram of modified bioretention system](image)

**Percent of TN Removal**

<table>
<thead>
<tr>
<th>Storm Events</th>
<th>Modified Bioretention</th>
<th>Conventional Bioretention</th>
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<td>11</td>
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![Synthetic Stormwater and Peristaltic Pump](image)

**Left:** Emma and Mackenzie running stormwater effluent samples for nitrogen.  
**Right:** Wood chips included in the IWSZ of the modified bioretention  
**Bottom:** Field Study of conventional and modified bioretention.
Integrated Marine Aquaculture Systems for Sustainable Seafood Production in the Gulf of Mexico Region

**PIs:** Sarina J. Ergas, Kevan Main, Jim Michaels, Maya Trotz, Qiong Zhang, Norma Alcantar, Jeff Cunningham, Fei Zhong

**Sponsors:** National Oceanographic and Atmospheric Administration (NOAA), Florida Sea Grant, Aquaculture Review Council

**Students:** Suzanne Boxman, Brian McCarthy, Alex Kruglick, Youngwoon Kim

**Synopsis:** Farmed fish production has rapidly expanded and intensified due to increased global demand for aquatic animals as a food source and decline of wild fish stocks. However, conventional aquaculture systems are challenged by high water and energy demands and pollutant discharges. We are addressing these issues by focusing on the food (farmed fish, halophytes, sea cucumbers), energy (reduced demands, alternative sources), water (synergistic treatment, resource recovery) nexus. Our central hypothesis is that integrated multi-trophic aquaculture (IMTA) systems, guided by careful consideration of synergies and tradeoffs, can achieve near-zero discharge and be economically viable and environmentally beneficial. Our overall goal is to develop economically and environmentally sustainable land-based marine seafood production systems supported by multidisciplinary systems thinking with diverse partners and communities.

![Nitrite concentration vs. time in Mote IMTA.](image)

Dr. Suzanne Boxman focused on this topic at USF.