TEXAS TECH UNIVERSITY

1) Anthony F Cozzolino

https://www.depts.ttu.edu/chemistry/Faculty/Cozzolino/

Research category: Methodologies to help remediate current and future contamination threats

The Cozzolino Group develops water stable molecules for anion recognition. The anion recognition occurs through pnictogen bonding, an emerging interaction that competes with hydrogen bonding. Careful design of molecules containing two pnictogen bonding sites leads to the binding of carboxylates more tightly (up to three orders of magnitude) than systems designed to use hydrogen bonding. These anion recognition sites can be used bind carboxylates in the form of many common drugs. Incorporating of these systems into solid supports (metal-organic frameworks, covalent organic frameworks or porous polymers), they could be used for the remediation of water of these pharmaceutical pollutants. The reversibility of the interactions would allow for the solid support to be flushed with a high concentration of a non-toxic anion, such as chloride, to allow for regeneration of the remediation material.

Remote sensing applications for monitoring water quantity and quality: The Cozzolino Group develops water stable molecules for anion recognition. The anion recognition occurs through pnictogen bonding. The use of pnictogen bonding (similar to hydrogen bonding) results in a specific change in electronic structure upon binding of analytes. In the current design, this electronic structure change manifests in a color change. This color change is therefore diagnostic of the presence of specific anions. Pnictogen bonding systems that contain fluorophores can be developed in order to allow sensing through changes to fluorescence upon binding of anions. Either of these changes can be monitored remotely. The target anions can range from toxic cyanide anions to carboxylate containing anions. Importantly, carboxylate anions are found in many drugs that find their way into the waste stream. Careful design of these pnictogen bonding molecules could allow for specific anion binding and sensing.

2) Michael Findlater

https://www.depts.ttu.edu/chemistry/Faculty/findlater/

Research category: Methodologies to help remediate current and future contamination threats; wastewater quality and management

In collaboration with researchers in Civil Engineering and Chemistry & Biochemistry, we study the selective targeting and removal of problematic ions in aqueous environments. Our focus has been remediation of wastewater from the oil and gas industry (hydraulic fracking) to allow the water to be reused. However, we have recently begun to explore targeted applications with relevance to the electronics industry and human health by targeting rare-earth elements and toxic heavy metals, respectively.

3) Kristin Hutchins

https://www.depts.ttu.edu/chemistry/Faculty/hutchins/index.php

Research category: Laboratory methods to support water-related research; Methodologies to help remediate current and future contamination threats

Research in the Hutchins Group focuses on developing new functional materials that can act as environmental and water decontaminants. Our group is interested in the design and synthesis of small organic molecules and polymers that will interact with and remove contaminants in a targeted, specific way. We investigate the bonding behavior of pharmaceuticals and metal-organic complexes in the solid state by synthesizing multi-component crystals. These crystals include a compound of interest (e.g. pharmaceutical) and a small molecule receptor that interacts with the compound of interest via non-covalent bonds, such as hydrogen bonds or metal coordination. We utilize X-ray crystallography to characterize the bonding between the two components and conduct solution-state binding studies. Once we identify receptors that bind with the contaminants (e.g. pharmaceuticals), we design and synthesize polymer-based materials. The polymers incorporate functional groups that will form bonds with the contaminant. We study how well the contaminant is removed from sample solutions, and refine our design as needed.

4) Dimitri Pappas

https://www.depts.ttu.edu/chemistry/Faculty/pappas/index.php

Research category: Water pollution; water supply and sanitation; Methodologies to help remediate current and future contamination threats

Microbial contamination of water remains a challenging problem to address worldwide. The Pappas group has developed sensors for microfluidic detection of cells in complex samples. This work has focused on cell separations in microfluidic systems, which are capable of low power and label free isolation and detection. We propose to develop novel sensors based on microfluidic capture of bacterial and/or algal cells that serve as contamination sources. The system will integrate cell isolation strategies that can be used both for detection and to determine the optimal separation medium for scaled-up remediation. Isolation using lectin binding, aptamers, or other capture molecules can be contained in a single device for multi-parameter detection of biological contaminants without a priori knowledge of the contamination source. Using multi-stage sensors, bacterial/algal cells in a water sample can be separated from particulate matter using Dean flow, and then captured contaminant cells can be electrically detected in the device. The system can be pass-through for continuous monitoring, can be low-cost and field deployable in the future.

5) Deborah Carr

https://www.depts.ttu.edu/biology/people/faculty/carrdeborah/

Research category: Water quality; Methods for measuring water quality; ecological and human health impacts of pollutants and emerging contaminants

My broad research interests involve the response of soil and sediment microbial communities to pollutants and environmental stressors, and the impact of the microbial response to ecosystem parameters such as microbial diversity, nutrient cycling, and organic carbon utilization. Other interests include the microbial community role in degradation of pollutants and restoration of soils and wetlands from urban brownfield site remediation toward ecosystem sustainability.

Current projects include:

- The effects of pharmaceuticals on soil communities when applied through waste water effluent, and general water reuse strategies.
- Natural attenuation by microbial processing, of Pharmaceuticals and Personal Care Products (PPCPs), including estrogens and antibiotics.
- Response of the microbial community to PPCPs soils of high-water contents.
- Shifts in microbial diversity and function as a result of perturbation by pollutants
- Enzymatic degradation of polyethylene, polystyrene, and polyurethane
- Microbial communities and community dynamics inside concrete
- Bioremediation strategies for produced water in drilling operations
- Natural attenuation and soil toxicity of crude oil in beach sands, diesel, and drilling fluids.
- Natural attenuation and soil toxicity of drilling fluids in arid soils.
- Degradation of natural fiber sorbents in remediation of petroleum spills.
- Nitrogen and carbon cycling in arid soils in response to climate stress

I study the microbial processes in soils and sediments and the effects pollutants have on those processes. I examine how these processes contribute to ecosystem services and how we could take advantage of them in reaching environmental sustainability. I also take that information and apply it to bioremediation of pollutants and environmental restoration.

Currently, we are looking at pharmaceuticals and personal care products in waste water effluent and their processes and effects in soil both individually and in mixtures. Another project is identifying relevant proteins responsible for the enteric degradation of polystyrene, and polyethylene but insect larva. And also, characterizing the microbial communities endemic to poured concrete, and their contribution to carbon and nitrogen flux in urban environments. We have recent research with oil, diesel and drilling fluids for the oil industry and their effects in the soil community. Besides degradation, we are also looking at microbial substrate utilization, germination and plant growth on aged soil exposed to the products, and the proteomic and metagenomics changes associated with the products. We are also looking at the same kinds of things with I am interested in why some soils “heal” themselves just fine after a perturbation and why some remain polluted over long periods of time and need big remediation strategies. I believe recovery potential may lie in the proteins present in each soil, not only would this information increase our basic knowledge of the natural world, but it would have enormous potential going forward in allocating money and effort for successful remediation strategies and product design that is less harmful, more easily disposed of in a sustainable world view.

6) Seshadri Ramkumar

http://www.tiehh.ttu.edu/dr.-s.s.-ramkumar.html

Research cateogry: Water supply and sanitation; Methodologies to help remediate current and future contamination threats

The project is aimed at developing filter technologies using sustainable materials involving natural materials like cotton, functionalized with inorganic particles that can act as catalytic particles to cleave toxins. Nano technologies may not be suitable for large scale adaption in India due to the cost as well as large scale requirement. Nonwovens laboratory at TTU has come-up with “Adsorptive-Absorption Filter,” technology (Ref: 1), which can be tried in India rural settings. The PI will interact with an engineering institute by inviting a research fellow to: 1) Optimize the technology using sustainable materials (low grade cotton; 2) Functionalize the cost-effective cotton substrate and 3) Have field study in India.

India is the world's second highest populated country with 1.2 billion population. Most of the population still live is rural area, where agriculture is the basis of employment. India is dependent of monsoon and most of the farming is rain fed. Even in urban areas, due to increased population and heavy migration from rural areas, water scarcity has become a serious issue. There is a need for the development of sustainable and cost-effective technologies to provide safe potable drinking water. Water scarcity and safety have occupied the center stage in recent national debates, showcasing how serious the water situation is in the country.

India and United States are the two leading cotton producers. More importantly, there is a need to develop value-added applications for discounted cotton. The project will strengthen the collaboration between the two countries in two important areas: a) water safety and b) cotton. Since 2006, the PI has been maintaining active collaborations with Indian engineering institutes in Coimbatore area, which is a prominent area for engineering and cotton research activities.

7) Venki Uddameri

https://www.depts.ttu.edu/waterresources/administration/vitae-uddameri.pdf

Research category: TBD

The Texas Tech University Water Resources Center (WRC) was established in 1965 to conduct research and coordinate water related activities on campus and housed with the Ed Whitacre Jr. College of Engineering (WCOE). The center has a 50+ year history of conducting basic and applied research activities that are not only relevant to the Southern High Plains region but also of national and international significance (see https://www.depts.ttu.edu/waterresources/)

The TTU WRC is led by Dr. Venki Uddameri whose research interests span broadly over sustainable water resources with an emphasis on climate impacts on groundwater dependent regions. There are nearly 40 faculty across WCOE who have either a primary or secondary interest in water issues and 17 full time faculty in civil, environmental, petroleum and chemical engineering whose primary focus is on water. Faculty affiliated with the center have a wide-ranging expertise in both water availability and water quality issues in surface water, groundwater, soil and contaminated sediments.

Water is one of the four major priority areas for WCOE and the center has been on a fast growth trajectory and has hired several new faculty in recent years including one National Academy of Engineering (NAE) member, Dr. Danny Reible. Recent research activities are focused on emerging areas of food-energy-water nexus, water reuse in hydraulic fracturing, emerging contaminants and environmental applications of nano-materials. Research projects carried out by the center are funded by federal, state and local entities including the NSF, SERDP, NASA and private industry. The center has high-end computational facilities including several computer workstations with modern analysis and modeling software, GIS and Remote Sensing tools and programming languages. State-of-the-Art analytical facilities, including but not limited to GC-MS-MS, LC-MS-MS, ICP-MS, GC-MS, LC-MS and other chemical specific analyzers were acquired recently and are housed in the Maddox Engineering Research Center (MERC), which includes nearly 80,000 sq. ft of modern laboratory space including clean rooms and advanced material characterization laboratories.

The areas identified under the Water Advanced Research Innovation (WARI) program match the research activities carried out by the Water Resources Center.