24th International Conference on Environmental Indicators

9-12 June 2024, St. Louis, USA

Program

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9-12 June 2024, Southern Illinois University Edwardsville, Illinois, USA

The 24th International Conference on Environmental Indicators will be held on June 9-12, 2024 in St. Louis, USA. This post-pandemic conference will create an interdisciplinary atmosphere that connects researchers, environmental managers and policy makers representing the interdisciplinary nature of environmental indicators throughout the world and expands our multi-faceted perspectives on environmental indicator research, education and application.

Conference Webpage: https://www.environmentalindicators.org/Upcoming-Conference

Conference Theme: Indicators for Environmental and Human Health

Conference Program

The conference welcomes presentations on any topics of Environmental Indicators. The program includes, but is not limited to, the following areas: physical and chemical indicators, bioindicators/biomarkers, emerging contamination, pollution control and remediation, environmental risk assessment, human and animal health, application of environmental indicators for environmental management, regulation policy development, and environmental resilience and sustainability. The conference will include invited plenary lectures, oral and poster presentations.

Conference Venue

The conference will be held at the Conference Center of Southern Illinois University Edwardsville (SIUE), Illinois, United States. SIUE is located in the St. Louis Metropolitan Area, about 25-minute driving to the St. Louis International Airport and the Gateway Arch in downtown St. Louis. There are many tourist attractions in St. Louis and the surrounding areas in the American bottom, such as the iconic Gateway Arch tower, Missouri Botanical Garden, and Cathedral Basilica of St. Louis.

Accommodation

The conference has selected the following two hotels for accommodation that are located within 5-minute driving distance to the Conference Center. Local transportation will be provided.

- Holiday Inn Express & Suites
  Address: 1000 Plummer Dr, Edwardsville, Illinois 62025
  https://www.ihg.com/holidayinnexpress/hotels/us/en/edwardsville/stlex/hoteldetail

- TownePlace Suites by Marriott
  Address: 6101 Center Grove Road, Edwardsville, Illinois 62025
  https://www.marriott.com/en-us/hotels/stlte-towneplace-suites-st-louis-edwardsville-il/

International Advisory Committee

- Dr. Robert Armon, Israel Institute of Technology, Israel
- Dr. Harrison Atagana, University of South Africa, South Africa
- Dr. Nancy D. Denslow, University of Florida, USA
- Dr. Juan Antonio Campos Gallego, University of Castilla-La Mancha, Spain
- Dr. Elias Hakalehto, University of Helsinki & Finnoflag Oy, Finland
- Dr. Diane S. Henshel, Indiana University, USA
- Dr. Zhaojun Li, Chinese Academy of Agricultural Sciences, China
- Dr. Tiequan Zhang, Agriculture and Agri-Food Canada, Canada

Local Organizing Committee

- Dr. Nicholas Guehlstorf, Department of Political Science, SIUE
- Dr. Joseph Kusi, Department of Environmental Sciences, SIUE
- Dr. Zhi-Qing Lin, Department of Biological Sciences, SIUE
- Dr. Kevin Tucker, Department of Chemistry, SIUE
- Dr. Kyong Sup Yoon, Department of Environmental Sciences, SIUE
- Dr. Jianpeng Zhou, Department of Civil Engineering, SIUE

Student Volunteers

- Emily Beiler, Department of Environmental Sciences, SIUE
- Nishi Hiteshkum Joshi, Department of Environmental Sciences, SIUE
- Prakash Joshi, Department of Environmental Sciences, SIUE
- Blake Rentz, Department of Environmental Sciences, SIUE

Conference Secretariat Contact

- Email: 2024-ICEI@siue.edu
- Telephone: 618-560-8302 (Lin) and 413-222-4284 (Yoon)

Conference Zoom Link: https://siue.zoom.us/j/93919513541?pwd=SjExQ2pSaXhGcFRPeDljR1pZclE5dz09

QR code for program and proceedings:

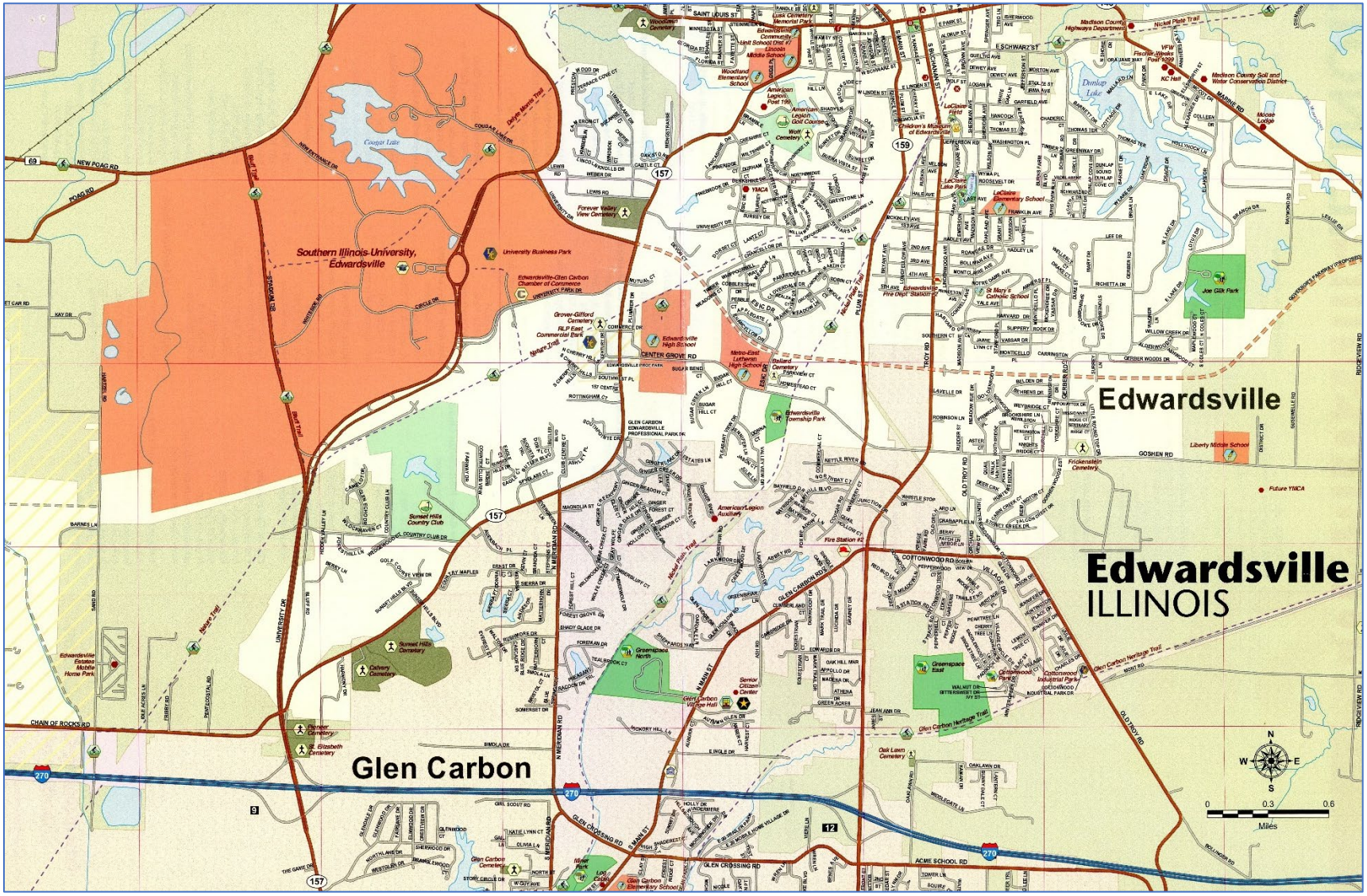
2024 Fellow of International Society of Environmental Indicators

Nancy D. Denslow, PhD

Dr. Nancy Denslow is a Professor in the Department of Physiological Sciences at the University of Florida. She received her BS degree in Chemistry from Mary Washington College, MS in Biochemistry and Molecular Biology from Yale University, and PhD in Biochemistry and Molecular Biology from University of Florida. Dr. Denslow is renowned nationally and internationally for her outstanding research in environmental toxicology and bioindicators. Dr. Denslow's research involves developing and using molecular biomarkers to evaluate changes in gene expression depending on stress or exposure to contaminants. She was a pioneer who introduced microarray technology in the field of molecular ecotoxicology.

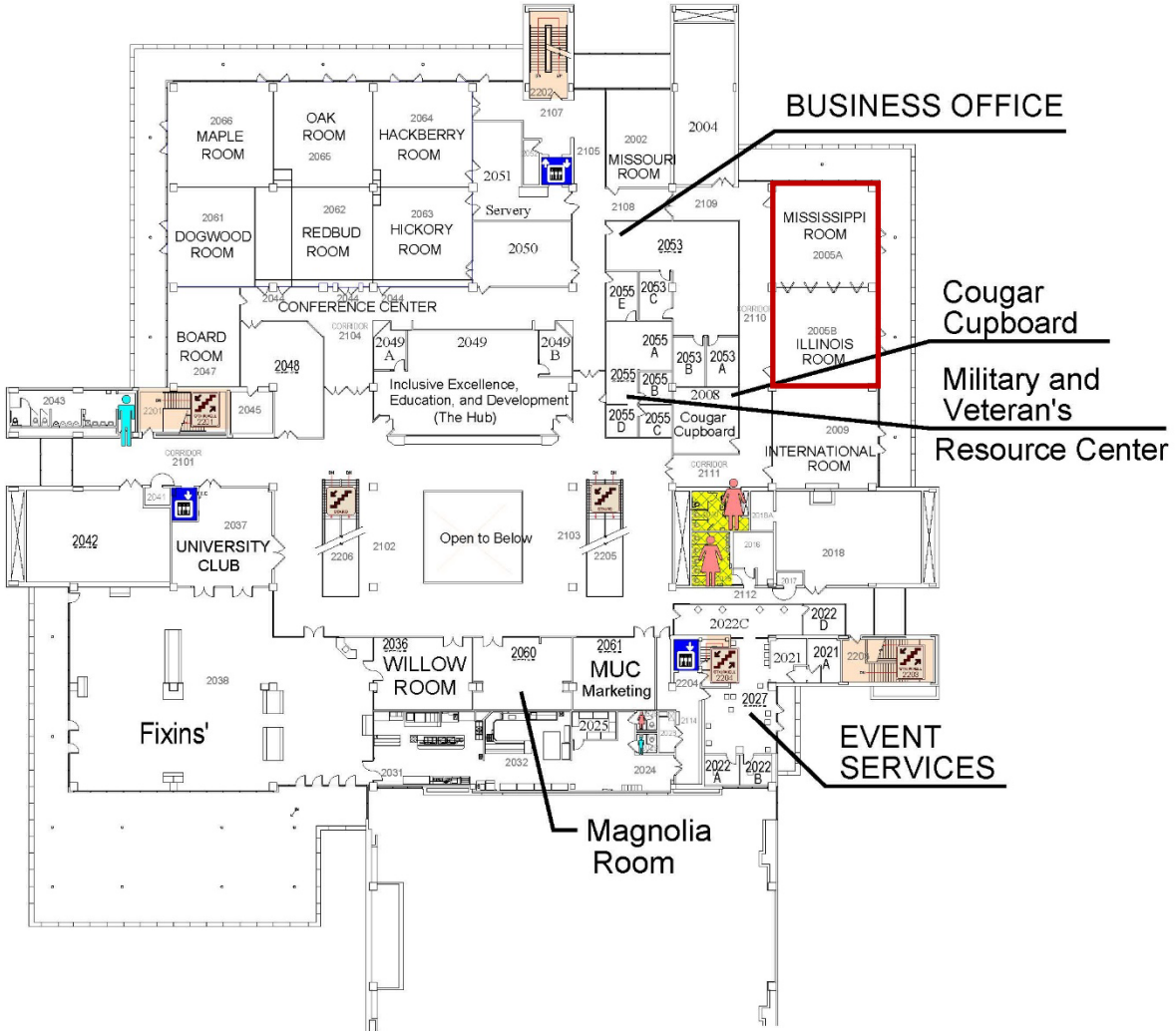
Dr. Denslow has made significant contributions to different environmental research fields, such as understanding the effects of endocrine disruptors, measuring toxicity of nanomaterials in the environment and understanding the effects of organochlorine pesticides with funding from the Superfund Research Program in the United States. She was among the first to identify how nanomaterials interact with aquatic organisms. In collaboration with other researchers Dr. Denslow has developed methods to evaluate changes in protein expression for a large number of different projects from plants to animals and to human disease. She has published over 289 refereed papers, and many in prestigious scientific journals.

Dr. Denslow has made outstanding contributions to the International Society of Environmental Indicators (ISEI). She is a founding member and also a lifetime member of ISEI. Dr. Denslow has served as Secretary and Council member of the Society since 2006.



Southern Illinois University Edwardsville Campus and Cities of Edwardsville and Glen Carbon

The conference will be held at the Morris University Center (MUC) and participants can park their vehicles in Lot B. The space parking code is available at the registration desk. Free parking (Lot E) on Sunday for registration and reception in Science West (Room 2075).



The conference room (Mississippi & Illinois Rooms) is on the 2nd floor of the Morris University Center.

Conference Schedule

9 June 2024 (Sunday)
Location: Science West Conference Room (SW 2075)

4:00-6:00 Registration & Reception
6:00-7:00 ISEI Business Meeting (Zoom)

10 June 2024 (Monday)
Location: Mississippi & Illinois Rooms, The Morris University Center

8:45-9:00 Opening Ceremony (Host: Z.Q. Lin)
Welcome Remarks by SIUE Guests
ISEI & Conference Series by D. Henshel

Session 1
Chair: *Nicholas Guehlstorf*

9:00-10:00 **Keynote Lecture**: Mercury Myths, Mistakes, and Misunderstandings
Nick Ralston, Sage Green NRG & University of North Dakota, Grand Forks, North Dakota, USA

10:00-10:15 **Break**

10:15-10:45 PFAS - Forever Chemicals and Their Effects in the Environment and Health
Nancy Denslow, University of Florida, Gainesville, Florida, USA

10:45-11:00 From Flies to Flatworms: Unveiling PFOS's Toll on Brain and Development
Emily Beiler, Southern Illinois University Edwardsville, Illinois, USA

11:00-11:15 Per- and polyfluoroalkyl substances (PFAS) Degradation in a Bioelectrochemical System
Haoran Yang, Southern Illinois University Carbondale, Illinois, USA

11:15-11:45 The Use of Drosophila melanogaster Allowed Development of an Insecticide Exposure Scenario for Monitoring Negative Impacts of Sublethal Levels of Ivermectin
Kyong Sup Yoon, Southern Illinois University Edwardsville, Illinois, USA

11:45-1:00 **Lunch**

Session 2
Chair: *Kyong Sup Yoon*

13:00-13:30 Assessing and Quantifying Community Climate Risk and Resilience
Diane Henshel, Indiana University, Bloomington, Indiana, USA

13:30-14:00 Environmental Applications and Impacts of Transition Metal-Based Nanomaterials

Jia Liu, Southern Illinois University Carbondale, Illinois, USA

14:00-14:30 Protection and Enrichment: How Different Carbonaceous Substances Improve Methane Yield from Encapsulated Anaerobic Microorganisms
Annesh Borthakur, Saint Louis University, St. Louis, Missouri, USA

14:30-14:45 **Break**

14:45-15:15 Large-scale Project Ideas and Pilot Tests for a Total Circulation of Industrial, Agricultural and Other Side Streams with the Aspect of Ecosystem Engineering (Zoom)
Elias Hakalehto, University of Helsinki & Finnoflag Oy, Kuopio, Finland

15:15-15:45 Predicting Water Quality in Swartspruit River, South Africa by Molecular Characterisation of Diatoms Present in the River (Zoom)
Harrison Atagana, University of South Africa, Roodepoort, South Africa

15:45-16:15 Predicting Harmful Algal Blooms in Otter Lake by Nutrient Quantification and Predictive Analytics
Kevin Tucker, Southern Illinois University Edwardsville, Illinois, USA

16:15-16:45 **Poster Session**

Screening Private Well Water and Tap Water in Rural Missouri and Illinois Communities for PFAS and Heavy Metals
Jimmy Dimpor, Southern Illinois University Edwardsville, Illinois, USA

Chemical Interaction of Selenium and Toxic Metals in Shellfish Commercially Available on the US Market
Prakash Joshi, Southern Illinois University Edwardsville, Illinois, USA

Analysis of Sunscreens and Antibiotics in Groundwater during the COVID-19 Pandemic in the Riviera Maya, Mexico
Noah Hanratty, Jacqueline Cooney, Rosa Marie Leal-Bautista, Melissa Lenczewski, Megan Davis, Jasmine Rodriguez, and Kevin Tucker, Department of Chemistry, Southern Illinois University Edwardsville, Illinois, USA

The Effect of Environmentally Relevant Concentrations of Statins on *Eisenia hortensis*
Kendra G. Selby, Claire E. Korte, Gabriel A. Bressendorff, Lauren H. Phan, and Kevin Tucker, Department of Chemistry, Southern Illinois University Edwardsville, Illinois, USA

Identification of Toxic Algae Species Using MALDI MS
Cheyenne Copling, Milena Di Blasí, Carolyn Butts-Wilmsmeyer, Kevin R. Tucker, Department of Chemistry, Southern Illinois University Edwardsville, Illinois, USA

16:45-18:00 **Dinner**

11 June 2024 (Tuesday)
Location: Mississippi & Illinois Rooms, The Morris University Center

Session 3
Chair: *Kevin Tucker*

9:00-10:00 **Keynote Lecture**: Utilizing Microbes as Biosensors of the Urban Environment with the Help of Data Science
Fangqiong Ling, Washington University in St. Louis, Missouri, USA

10:00-10:15 **Break**

10:15-10:45 Contaminant-Mediated Selection Alters Gene Flow and Genetic Diversity in Mussels from the Strait of Istanbul
Chris Theodorakis, Southern Illinois University Edwardsville, Illinois, USA

10:45-11:15 Fish Physiology Indicators of Environmental Health
Thea Edwards, United States Geological Survey, Columbia, Missouri, USA

11:15-11:45 Assessing Health Risks of Primary Contact Activities in Urban Lakes Using Microbial Quality Indicators
Joseph Kusi, Southern Illinois University Edwardsville, Illinois, USA

11:45-13:00 **Lunch**

Session 4
Chair: *Joseph Kusi*

13:00-13:30 Agriculture & Agri-Food Canada's One Health Portfolio (Zoom)
Sergio Paulo, Agriculture & Agri-Food Canada, London, Ontario, Canada

13:30-14:00 Soil Chemical Property Indicator of Sustainable Paddy Rice Cultivation in Northern Thailand (Zoom)
Rochana Tangkoonboribun, Thailand Institute of Scientific and Technological Research, Phathunthani, Thailand

14:00-14:30 Development of Universal Soil Phosphorus Testing to Indicate Water Quality Risks (Zoom)
Tiequan Zhang, Agriculture & Agri-Food Canada, Harrow, Ontario, Canada

14:30-15:00 A Contextualization of the Unregulated Effects of Industrial Farming, Nutrient Runoff and Costly Surface and Drinking Water Treatments with Some Policy Suggestions
Nicholas Guehlstorf, Southern Illinois University Edwardsville, Illinois, USA

15:00-15:15 **Break**

15:15-15:45 Visualizing the Landscape of Major Chronic Disease Mortality Rates from 2008 to 2020 in Illinois: Spatiotemporal and Statistical Analyses
Shunfu Hu, Southern Illinois University Edwardsville, Illinois, USA

15:45-16:00 Detecting Invasive *Lespedeza cuneata* through 3D Point Cloud Analysis
Owen Luetkemeyer, Southern Illinois University Edwardsville, Illinois, USA

16:00-16:30 Transport and Fate of Selenium in the Soil-Crop Systems with Long-term Swine Manure Treatments
ZQ Lin, Southern Illinois University Edwardsville, Illinois, USA

16:30-18:00 **Conference Dinner & ISEI Fellow Award**

12 June 2024 (Wednesday)
Field Trip & St. Louis City Tour

9:00-11:30 Field trip: Missouri Botanical Garden
(9:00 departure from Science West, Parking Lot E)

11:30-13:00 **Lunch at Anheuser-Busch** (on own)

13:00-14:30 Anheuser-Busch Tour

15:00-16:00 The Gateway Arch Museum

Proceedings of the 24th International Conference on

Environmental Indicators

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Mercury Myths, Mistakes, and Misunderstandings

Nicholas Ralston[1,2,*]

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Formerly one of least understood toxicants, the mechanisms of mercury (Hg) toxicity are now among the best defined. Before the importance of selenium (Se) metabolism was recognized, the biochemistry of Hg's effects on brain physiology had been impossible to explain. This engendered mistaken assumptions and public health advisories which have adversely affected the populations they were intended to protect.

The human genome includes 25 genes for enzymes which employ selenocysteine (Sec), the 21st genetically encoded amino acid in their active sites. As the most potent intracellular nucleophile, Sec enables enzymes (selenoenzymes) to perform elite functions in fetal brain development, control of thyroid hormone and calcium regulatory processes, and to prevent and reverse oxidative damage. Reactive oxygen species that form as byproducts of cellular respiration are counteracted by interactive sulfur and Se metabolic pathways. Selenoenzyme-dependent control of intracellular redox conditions, signaling, and the prevention and/or reversal of oxidative damage involve various thiomolecules. The oxidized cysteine (Cys) residues of glutathione (GSH) and/or thioredoxin (Trx) are acted upon by selenoenzymes as substrates and cofactors. Due to the brain's high metabolic rate, it is particularly vulnerable to oxidative damage and employs highly evolved mechanisms to ensure it is preferentially supplied with Se. Selenoprotein P (SelP) transports Se in plasma and is captured and internalized by receptors selectively expressed on surfaces of brain, endocrine, and placental tissues. Even after multiple generations with low Se-intakes, this unique homeostatic control is able to prevent adverse effects. Other than genetic knockouts of SelP or the SelP receptor, there is only one environmental insult known to impair Se delivery to these tissues. –High exposures to Hg.

Mercury has a very high affinity for sulfur (10^{39}) but its affinity for Se is a million times higher (10^{45}). Because intracellular thiomolecule concentrations are 10^5 higher than Se, Hg in its various forms will initially find and bind Cys residues of GSH and Trx. These function as suicide substrates that deliver Cys-Hg into the selenoenzyme's active site in the correct orientation to transfer Hg to the catalytic Sec moiety. Formation of Sec-Hg irreversibly inhibits selenoenzyme activities and forms inorganic HgSe residues that sequester Se. Attritional losses eventually induce a conditioned Se-deficiency that prevents selenoenzyme synthesis and oxidative damage to brain tissues proceeds unchecked.

Long-lived apex marine predators such as great white sharks or pilot whales accumulate far more Hg than Se in their meats. Maternal consumption of those seafoods is associated with subtle neurodevelopmental impairments in their children. However, virtually all commonly consumed forms of ocean fish contain far more Se than Hg and are also rich in omega-3 fatty acids that are important in brain health and development. Increasing ocean fish consumption during pregnancy has consistently been associated with improved social, scholastic, and IQ performance in their children. Although eating shark and whale meats with high Hg:Se molar ratios was harmful, warnings against eating typical varieties of ocean fish have resulted in generations of children losing neurodevelopmental benefits. Meanwhile, freshwater fish Hg and Se are highly variable and many subsistence consumer populations at accentuated risk may currently remain unrecognized. Gaining a consilient perspective of the pivotal nature of the Hg:Se relationship will enable public health authorities to minimize risks from exposures to sources of disproportionately high Hg while maximizing maternal intakes of Se and other beneficial nutrients which promote fetal health and development.

PFAS, the Forever Chemicals and Their Effects in the Environment and in Health

Nancy D. Denslow*, Kevin J. Kroll, Russell Lewis, and John A. Bowden

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Per- and polyfluoroalkyl substances (PFAS) have been released into the environment through a multitude of industrial and consumer-based products. PFAS have become an important emerging concern worldwide, as these substances are found in biota, water and sediments and constitute potential hazards to environmental and human health. They are known to cause immunotoxicity, hepatotoxicity, impaired development, cancers, and alter lipid metabolism, among other toxicological endpoints. While it is generally thought that PFAS act through activation of the peroxisome proliferator-activated receptor alpha (PPARα), the concentrations required for transactivation are higher (100 μM) than levels normally found in blood. It is possible that alternative biochemical mechanisms are involved at concentrations that appear in the environment. To begin to understand the toxicity mechanisms *in vivo*, we have performed exposures of embryos and adult fathead minnows to several concentrations of PFAS including PFOS, PFOA, and PFBS. PFAS altered proper heart development, heartbeat, and lipid profiles, suggesting activation of several different types of pathways in addition to PPARs. In RNAseq experiments with adults, the main pathways targeted included lipid related pathways, hormone biosynthesis, glucose metabolism and respiratory chain, among others. Follow up studies indicated that the lipidome of fathead minnow embryos and of adult brains are altered by PFAS, importantly for many bioactive lipids. These studies point to a main effect of PFAS on the less studied but fundamental biochemical pathways, including mitochondrial function, respiration, and metabolism. PFAS are persistent environmental hazards and how they perturb the biochemical systems of aquatic organisms is an area of urgent research. Regulatory measures are being undertaken around the world to mitigate the effects from PFAS exposures.

From Flies to Flatworms: Unveiling PFOS's Toll on Brain and Development

Emily Beiler, Carl Namini, Autumn Belt, and Kyong-Sup Yoon*

Southern Illinois University Edwardsville, Edwardsville, Illinois, USA

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Perfluorooctance sulfonic acid (PFOS) is a persistent organic pollutant (POP), found in nearly all trophic levels with negative health impacts on a wide range of organisms including humans. Our study aimed to determine if PFOS is acutely and chronically neurotoxic and affects the nervous system of fruit flies and planaria by altering locomotor behavior and circadian rhythm. Adult males exposed to PFOS (2, 20, 100, 200 μM) exhibited concentration and time dependent mortality responses (χ^2 test, $p<0.05$). A PFOS concentration of 20 μM was determined to be suitable for monitoring altered PFOS toxicity in the presence of target specific ion channel modifiers. Flies co-treated with 20 μM PFOS and one ion channel modulator (verapamil, MK-801, Ryanodine, or imidacloprid) showed significantly decreased PFOS toxicity, indicating that reduced influx of cations led to the protection against the PFOS caused mortality (χ^2 test, $p<0.05$). For example, 10 μM imidacloprid cotreatments displayed significantly decreased PFOS mortality (5.5-fold) at the 48 hr post-treatment marks when compared to the PFOS-only treatment results (t-test, $p<0.05$). Ion channel modulators acting on the gamma-aminobutyric acid receptors (ivermectin, lindane, and carbamazepine) were also used in combination with 20 μM PFOS. Ivermectin (0.1 ppm) cotreatments significantly decreased the fly mortality by 4.4-fold at the 48 hr post-treatment marks (t-test, $p<0.05$). Flies were exposed to sublethal concentrations of PFOS (0.5-200 nM) during the developmental stages. Flies displayed significantly decreased daytime activity at 0.2 nM (1.42-fold reduction) and significantly increased daytime activity at 200 nM (1.26-fold) (ANOVA, $p<0.05$). This suggests that PFOS might interfere with the flies' circadian rhythm. Planaria are currently undergoing 96-hour mortality bioassay studies to determine acute mortality responses. Preliminary findings have shown acute mortality at 34.3, 52.8, and 81.3 μM PFOS, with 81.3 μM displaying 100% mortality by 96 hours. No mortality was observed for 22.3 and 14.5 μM PFOS.

Per- and Polyfluoroalkyl Substances (PFAS) Degradation in a Bioelectrochemical System

Haoran Yang[1], Michelle M. Lorah[2], Chunjie Xia[3], Kelly S. Bender[4], and Jia Liu[1,*]

[1]School of Civil, Environmental and Infrastructure Engineering, Southern Illinois University, Carbondale, Illinois, USA; [2]US Geological Survey, MD-DE-DC Water Science Center, Baltimore, Maryland, USA; [3]Paul H. O'Neill School of Public and Environmental Affairs, Indiana University Bloomington, Bloomington, Indiana, USA; [4]Department of Microbiology, Southern Illinois University, Carbondale, Illinois, USA

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Due to military and civilian applications, groundwater is widely contaminated with per- and polyfluorinated alkyl substances (PFAS). Their degradation is an urgent task and a matter of global concern. In this study, biodegradation and electrochemical reduction were combined for PFAS degradation in the cathode chamber of a bioelectrochemical system (BES). In the experiment, West Branch Consortium (WBC-2) was used as the seed in the cathode chamber to form a biofilm on the carbon fiber brush of the cathode and bioelectrochemically reduce PFAS under constant applied voltage. PFAS-polluted groundwater samples and 100 μg/L of perfluorooctanesulfonic acid (PFOS) solution were respectively treated at the cathode chamber at different applied voltages to verify the conditions for efficient degradation of PFAS in the system. The results showed that PFAS were successfully degraded under the experimental conditions either with WBC-2 alone, or with a mixture of WBC-2 and the native bacteria species in the groundwater. When 100 μg/L PFOS was spiked to the culture media, about 98.0% of PFOS was removed from the solution, and 3.0, 3.6, and 1.3 μg/L of PFOA, PFPrA, and PFBA, respectively, were detected in the culture media after 49 days. In groundwater, 99.6, 98.9, 99.9, and >99.9% of PFOA, PFOS, PFHxA, and L-PFHxS were removed, respectively, after 102 days. Meanwhile, due to degradation, the concentration of PFPeA in the cathode chamber increased by 11.49 times compared to its initial concentration in the groundwater. In addition, 220.7 μg/g PFPeA and 3.6 μg/g PFPrA were detected on the carbon fiber brush after 102 days. Rod-shaped bacteria were detected dominantly on the carbon brushes after BES treatment by SEM obervation. Structure of microbial community shows *Bacillus pseudofirmus* and *Agrobacterium rhizobium radiobacter* were the main bacterial species in the biofilm, accounting for 31% and 36%, respectively, of the total counts. Short-chain PFCAs were detected in both PFOS-spiked water and groundwater, which proved PFAS degradation using WBC-2 in the cathode chamber of BESs. Due to its low cost and easy operation, this technology can potentially be applied to treat groundwater polluted by PFAS.

The Use of *Drosophila melanogaster* Allowed Development of an Insecticide Exposure Scenario for Monitoring Negative Impacts of Sublethal Levels of Ivermectin

M. Yusuf Ali[1], Carl K. Namini[2], John M. Clark[3], Barry R. Pittendrigh[4], Si H. Lee[5], and Kyong S. Yoon[2,*]

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The short-term ivermectin (IVM) exposures were newly established to determine toxic effects on the wild-type female fruit fly, *Drosophila melanogaster*. By utilizing the conventional glass-vial contact approach, exposures to IVM (0.01 to 1000 ppm) for equal to or shorter than 12 hr durations were determined to be the most suitable conditions for downstream investigations to assess impacts of the short-term IVM exposures in female fruit flies. Under these conditions, all female flies produced significantly higher levels of ROS and lipid peroxidation in their ovaries (ANOVA, $p < 0.05$). Additionally, female flies exhibited significantly increased DNA damages in their ovaries in an ivermectin concentration dependent manner (ANOVA, $p < 0.05$). Despite the negative impacts described above, the mean percent hatchability values obtained from the eggs oviposited by the IVM exposed female flies were not statistically different when compared to the respective hatchability obtained from the unexposed female flies (ANOVA, $p > 0.05$). Two concentrations (1 and 10 ppm) of IVM were selected for the transgenerational short-term IVM exposures. F1, F2 and F8 flies exposed to IVM showed significantly delayed developments (2.5-3.2, 2.5-3.0, and 0.9-1.3 days delayed, respectively) when compared to that of unexposed flies (ANOVA, $p < 0.05$). Female flies from F5, F11 and F17 showed significantly delayed IVM-induced sluggish behaviors (χ^2 test, $p < 0.05$).

Quantifying Climate Vulnerability and Climate Resilience at the Community Level

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The changing climate combined with natural cycles is causing increasing extremes of weather and altered weather cycles, resulting in unexpectedly severe impacts and new spatial weather patterns. These altered weather patterns are acting out over a landscape of human municipal and structural development, built and planned for less extremes of weather and weather-caused threats (drought, flooding, winds, wildfires). Together, climate change and human development patterns that don't significantly take into account changed climate factors are creating expensive and hazardous impacts at the microregional level, from individual homes that flood to whole neighborhoods that are lost to mudslides.

Better prediction and planning tools are needed at smaller spatial scales in order to better integrate climate planning into municipal, state and federal community planning and oversight so that people are better prepared for the microregional impacts of climate change. Since extreme weather impacts can be differentially experienced from house to house and neighborhood to neighborhood, assessment tools and decision support indicators need to be available scaled to the microregional level, and best scaled to the street level. Ideally climate related metrics would address both risk (including threats, threat magnitude, threat impacts, vulnerabilities increasing susceptibility to these threats) and resilience potential (including potential to absorb the threat with minimal harm, potential for timely and effective repair and recovery, and potential for adaptation to minimize future harm).

Most assessment approaches are top-down, hierarchically aimed at top-down management of risk and harm reduction for more rapid post-threat recovery managed by municipal, state, federal and NGO emergency aid programs. However, when extreme weather events cause "natural disasters" (flood, drought, wind damage, mudslides), individuals, families and neighborhoods are effectively on their own for hours to days coping with the immediate impacts of the extreme weather event and trying to minimize harm to health and property before such emergency aid arrives. Community-based approaches and community-based indices are needed to help individual residents and their families and neighbors better plan for future unexpected weather extremes and both primary and secondary impacts. We have developed a draft set of decision support tools that are geared to helping individual residents and families assess their homes' climate-related weather vulnerabilities and better plan for individual and family home-oriented adaptation strategies to increase their personal resilience in order to address this climate resilience gap.

Acknowledgements: This work was funded, in part, by the US Coastal Research Program (USCRP) as administered by the US Army Corps of Engineers® (USACE), Department of Defense (W912HZ-19-SOI-0008 to DSH). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The content of the information provided in this publication does not necessarily reflect the position or the policy of the government, and no official endorsement should be inferred. The authors acknowledge the USACE and USCRP's support of their effort to strengthen coastal academic programs and address coastal community needs in the United State

Environmental Applications and Impacts of Transition Metal Nanomaterials

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In recent decades, engineered nanomaterials have found wide applications in the field of environmental engineering. Among these, transition metal nanomaterials have garnered significant attention and research efforts due to their notable reactivity and effectiveness in removing persistent and refractory emerging organic contaminants. In this study, various transition metal nanomaterials were synthesized in the laboratory and employed to remove diverse water contaminants under light exposure. Moreover, the potential environmental impacts arising from the application of these nanomaterials were investigated. In the first project, per- and polyfluoroalkyl substances (PFAS) degradation by nanoscale zero-valent iron under ultraviolet light was studied for water reuse purpose. The result showed that degradation rates increased with an increase in the nanoparticle concentrations in the range of 1-100 mg/L. Shorter-chain PFCAs were detected as main intermediates. The degradation followed first-order reaction kinetics. A higher removal of PFAS was achieved without the presence of O_2 compared to with O_2. Effective removal of PFAS in wastewater effluents was achieved at pH 3.0 in the UV/Fe^0 system. PFAS degradation using the UV/ Fe^0 system is a cost-effective technology owing to the low cost and recyclability of Fe^0 nanomaterials, low energy consumption in the system, and its capability to degrade PFAS both with and without the presence of oxygen. In the second project, an innovative magnetic nanomaterial $\gamma Fe_2O_3/TiO_2$ was used to inactivate microcystin and saxitoxin producing bacteria and adsorb nutrient phosphorus under visible light. The nanoparticle can be used to mitigate harmful algal blooms in surface water to protect public health and surface water resources. In the third project, degradation of 1,4-dioxane was exploited by heterogeneous photocatalysis and a photo-Fenton-like process under fluorescent light. Both TiO_2 and Fe^0 nanoparticles removed >99.9% of 1,4-dioxane in a short period of time. Hydroxyl radicals (·OH), superoxide radicals ($\cdot O_2^-$), and hydrogen peroxide (H_2O_2) were detected in both degradation processes. The cost-effective solutions using commercial nanoparticles under fluorescent light can be potentially applied to treat water contaminated by high concentrations of 1,4-dioxane in large scale. In the fourth project, the impacts of metallic nanoparticles present in treated wastewater on a soil micro-ecosystem was studied. It was found that a combination of TiO_2 and Ag did not show toxic impact on organism growth compared to the control of deionized water irrigation. These results indicate the importance of investigating the effects of different nanomaterials in combination as they are introduced to the environment—with environmentally relevant concentrations and speciation—instead of only selecting a single nanoparticle type or residual ion. Moreover, the results of this study support the safe application of reclaimed water from wastewater treatment plants for use in agricultural lands in regard to limited concentrations of aged nanoparticles if present in combination. In the last project, the impacts of Ag and ZnO nanoparticles on freshwater microbial communities were investigated. The results showed that when ZnO nanoparticles were added in combination with Ag nanoparticles, the adverse impact of ZnO nanoparticles was mitigated. The result will provide information that may aid in the preparation of guidance or regulations related to discharge of mixtures of nanoparticles to surface water.

These studies were sponsored by the National Science Foundation, US Environmental Protection Agency, and Illinois Water Resources Center.

Protection and Enrichment: How Different Carbonaceous Substances Improve Methane Yield from Encapsulated Anaerobic Microorganisms

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The Encapsulating anaerobic microorganisms in capsules allows for an infinite solids retention time without the need for membrane separation during anaerobic wastewater treatment. Encapsulation, however, can lead to lower methane yields, which can prevent its application in practical wastewater treatment applications. Improving biomass growth, especially the growth of methanogens is key to improving methane yield from the encapsulated microorganisms. In this study, we investigated amending encapsulated biomass with carbonaceous materials such as biochar and powdered activated carbon (PAC) to improve biomass growth. Microorganisms were grown in suspension with PAC and biochar, and these media + biofilm mixtures were then encapsulated in polyethylene glycol (PEG) capsules and incubated for 10 days. Results showed that growing the methanogens on biochar and PAC significantly increased the methane generation, although the capsules amended with biochar produced significantly more methane. qPCR analysis showed that biochar enhanced the abundance of methanogens in the capsules. In addition, microorganisms grown in the presence of PAC performed better under stress due to ammonium persulfate (APS) toxicity as PAC was able to remove more than 90% of the APS in the wastewater. However, this limited the amount of PAC that could be amended into the capsules. Comparing the two media, we conclude that biochar is a better amendment that can be added to the PEG capsules to improve methane yield. By increasing the biomethane yield from anaerobic digestion, energy extraction from wastewater will be improved as part of a circular and sustainable economy.

Large-scale Project Ideas and Pilot Tests for a Total Circulation of Industrial, Agricultural and Other Side Streams with the Aspect of Ecosystem Engineering

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Since the micro-organisms constitute the third member of the "tripod of global ecosystems", together with plants and animals, it is straightforward to implement their use in sustainable future industries. Besides the environmental qualities, microbial cultures and communities have numerous times proven to provide feasible grounds for novel production lines in accordance with ecosystem engineering. Therefore, Finnoflag Oy, as an inventor company, has chosen the trade mark "Industry Like Nature®" to represent the concept. Among the tens of piloting experiments, the multinational EU Baltic Sea Region biorefinery pilot 2012-14 was a kick-off as it introduced a movable, satellite-controlled test unit for refining various side streams in three countries: Poland, Sweden, and Finland. Later on, we carried out up to 15 square meter piloting trials in Tampere, Finland, to demonstrate the circulation potential of millions of tons of environmentally deposited cellulosic side stream ("zero fibre") that had accumulated to the lake bottom during a century into valuable chemical goods, energy gases and organic soil improvement in a project "Zero waste from zero fibre." Currently, we focus on the EU CircInWater Blue Economy project "Bioresque" on an enormous Finnish paper mill that is still active. The major goal is to obtain organic fertilization that could boost plant growth with the microbial ecosystem constructed into the regenerated cellulosic biomass for the fertility of fields globally. Moreover, it is possible to regain soil productivity, resilience, and humus layers in areas already spoiled by erosion or other influences. Clean water is also an unavoidable side stream in the Finnoflag projects for bringing closer human production to the ecosystemic balances. In this context, we could demonstrate the huge potential of microbial metabolism for establishing cleaner industries, safer food production and a cleaner global ecosystem.

Predicting Water Quality in Swartspruit River, South Africa by Molecular Characterisation of Diatoms Present in the River

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The study aimed to predict the trophic status of the Swartspruit River by molecular characterisation of diatoms in the river using next-generation sequencing. Environmental samples for water chemistry and diatom material analysis were collected across six selected sampling sites in the river in August, September and November 2014. Diatom materials were characterised using microscopic and molecular approaches. Molecular characterisation was achieved through DNA isolation and amplification of 18S rDNA and V4 sub-region of the same gene employing specific primers and sequencing was achieved by next generation sequencing. The results indicated that the river was slightly eutrophic in August and hyper-eutrophic in September and November 2014. The results also confirmed the prevalence of diatom species belonging to the classes Fragilariaphyceae, Bacillariaphyceae and Mediophyceae in the river. The evolutionary trend revealed that the diversity of diatom species found in slightly polluted trophic levels (slightly eutrophic) belonged to the class Fragilariaphyceae, Bacillariaphyceae and Mediophyceae. Species that persisted at extremely polluted trophic status (hyper-eutrophic) belong to the class Bacillariohpyceae. The study has provided a reliable technique for molecular characterisation of diatoms and further demonstrates the use of diatoms as suitable bio-indicators in determining the trophic status of a freshwater ecosystem.

Predicting Harmful Algal Blooms in Otter Lake by Nutrient Quantification and Predictive Analytics

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Contamination of water supplies stems from various sources, including agricultural, industrial, and domestic activities. We have studied two separate bodies of water for different toxins: algae and antibiotics. Harmful algal blooms (HABs) contaminate lakes, ponds, rivers, and coastal waters due to warming temperatures and increased nutrient loads from farming. HABs have detrimental effects on aquatic life, poisoning shellfish, and causing illness and death in animals and humans. Through the collection of field samples and analysis for pH, RDO, turbidity, conductivity, temperature, nitrate/nitrite, ammonia, TKP, TKN, and chlorophyll counts in addition to geospatial analysis from satellite imagery and remote multispectral analysis, statistical analysis has been performed in order to predict the occurrence of algae blooms for this fresh water body. Antibiotics were studied during the COVID pandemic in a tributary of the Mississippi River to determine the spatial and temporal distribution and dynamic changes that took place over the course of 2020-2022. Several COVID related trends were observed for this body of water lending insight into the use and availability of antibiotics during the pandemic.

Utilizing Microbes as Biosensors of the Urban Environment with the Help of Data Science

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The microbes inhabiting urban environments present long-overlooked sources of information about infrastructure status, human health, and ecosystem health. Advances in NextGen DNA sequencing technology have enabled the rapid acquisition of large volumes of genomic data from urban environments, however, adequate methods for sampling, modeling, and data analysis are required to gain insights useful for to guide actions. In this presentation, we will discuss efforts utilizing genomics, machine learning, and modeling to uncover interactions between microbes and various environments. Specific cases will be discussed about microbes as sensors of sewage and drinking water supply systems to improve public health. Taken together, these studies show that understanding generalizable and system-specific determinants of bacterial communities will create new ways for improving engineering design and urban environments.

Contaminant-Mediated Selection Alters Gene Flow and Genetic Diversity in Mussels from the Strait of Istanbul

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Mediterranean mussels (*Mytilus galloprovincialis*) were collected from various sites along the Strait of Istanbul in Turkey. The sediment concentrations of PAHs, metals, pesticides, and PCBs at these sites have been previously characterized. DNA was extracted from these mussels, and a 562 bp-long segment of the mitochondrial control region was sequenced and subjected to various genetic and phylogenetic analyses. The major findings were that (1) a minimum spanning tree identified 3 clades (Clade 1, Clade 2, Clade 3, Clade 3 contained only a single rare haplotype) separated by the nearest clade at least 15 mutational steps, (2) the amount of genetic diversity and frequency of Clade 1 haplotypes was negatively correlated with degree of sediment contamination, while the frequency of Clade 2 haplotypes was positively correlated with the level of environmental contamination, (3) Tajima's D test indicated that there was balancing selection at the least contaminated site, and purifying selection at the most contaminated site, and (4) ΦST values and genetic structuring among sites corresponded to levels of contamination. It was concluded that (1) a Pleistocene vicariance event produced the clades, which may differ in tolerance to toxicants, (2) strong directional currents and local selection can produce fine-scaled genetic structure in this species, and (3) there was evidence that toxicant susceptibility was associated with D-loop haplotypes, and this affected genetic diversity and gene flow. This study suggests that evolutionary history (e.g. vicariance) may affect differential responses to toxicants among individuals within populations, and this should be taken into consideration in ecotoxicological studies.

Fish Physiology Indicators of Environmental Health

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Diverse environmental stressors increasingly influence aquatic ecosystems and fish health. Stressors include contaminants, hypoxia, nutritional deficiencies, and climate change, each with indicators that measure impacts at multiple levels. In the world of fish health monitoring and management, mortality and declining fish numbers continue to be the main indicators that communicate impacts and motivate management actions. But not all environmental stressors directly cause fish mortality. Instead, they erode fish stocks over time through sublethal mechanisms. These manifest as changes in gene expression, hormone profiles, developmental trajectories, and histology, and influence physiological functions like reproduction, immunity, and behavior. Although sublethal health effects are more difficult to measure than mortality, they can provide early warning of stresses on fish health, and they can detect impacts that degrade fish communities through indirect means. Indirect impacts are common with exposure to endocrine disruptors and pharmaceuticals for example. Examples of how sublethal health measures can be integrated into fish health assessments will be discussed, along with existing benefits and challenges.

Assessing Health Risks of Primary Contact Activities in Urban Lakes Using Microbial Quality Indicators

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Most Americans visit parks for outdoor recreational activities during the summer that connect them to the natural environment. Horseshoe Lake State Park in Madison County, Illinois is one of the popular parks visited by residents in St. Louis Metro East (southwestern Illinois) for recreational activities such as fishing, kayaking, boating, picnicking, camping, birding, and hunting during summer. Primary contact may occur to expose individuals to pathogens while using Horseshoe Lake in the park for recreational activities. Lakes are known as potential reservoirs for pathogens that cause waterborne diseases, but information on pathogen indicators in Horseshoe Lake is limited. Pathogen indicators, such as fecal indicator bacteria (FIB), are used to assess the presence of potentially waterborne disease-causing microorganisms in water bodies. By monitoring these indicators, authorities can identify contamination events, track their sources, ensure water quality compliance, and take appropriate measures to protect public health and the environment. The current study monitored concentrations of FIB and identified factors that influence their distribution in Horseshoe Lake. We collected water samples from six selected sites of Horseshoe Lake based on land use patterns for 12 months. We detected and enumerated FIB (Escherichia coli and enterococci) using the IDEXX method and measured field parameters. We determined temporal and spatial variations in FIB concentrations using the Kruskal-Willis test. Regression models and correlation analysis were performed to determine the relationships between FIB, land use, and water quality parameters. *E. coli* and enterococci were detected in 99 and 100% of the samples. E. coli concentrations ranged from 0 to 816 MPN/100 mL and that of enterococci ranged from 1 to 2,420 MPN/100 mL. Out of 72 samples, 7% exceeded the recommended standards for *E. coli*, and 54% exceeded the standards for enterococci. The numbers of *E. coli* and enterococci were significantly highest in the fall and lowest in the winter. The impact of land use on *E. coli* and enterococci presence followed the same pattern-urban > open space/agriculture > riparian forest. *E. coli* and enterococci showed a moderate positive correlation with water temperature and precipitation. Our results demonstrate that individuals using Horseshoe Lake for recreational activities may be exposed to pathogens, but the overall risk of exposure is low. We recommend that best management practices for the Horseshoe Lake focus on urban and open space/agricultural areas within the watershed.

One Health Approach in Agriculture and Agri-Food Canada (AAFC)

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Globally, One Health is generally referred to as an approach that acknowledges health through the interconnection of human, animal, plant, and the environment. The United Nations Food and Agriculture Organization (2023) projects that Antimicrobial Resistance (AMR) could reduce global annual GDP by up to 3.8% by 2050. Additionally, zoonotic diseases contribute significantly to global protein (33%) and caloric (17%) supply losses. In response to these global challenges, Agriculture and Agri-Food Canada (AAFC) is dedicated to advancing science-based research and innovation, aligning with the One Health principles. AAFC's Strategic Plan for Science presents a fresh vision aimed at tackling future challenges within the sector, emphasizing economic sustainability and addressing key issues. Its four missions lead the advancement and sustainability of the Canadian agriculture and Agri-food sector through competitiveness and innovation.

Domestically, AAFC has committed to the five-year Pan-Canadian Action Plan (PCAP) on AMR and Antimicrobial Use. The PCAP uses a One Health approach to respond to AMR which is spread between humans and animals through the environment, including contaminated water and fertilizer. AAFC and the Canadian Institute of Health Research are co-leading the action to develop a national research strategy for combating AMR across all action plan pillars to mobilize federal, provincial and territorial partners to advance Canada's AMR strategy centered on securing access to new antimicrobials and alternatives to antimicrobials, as well as preserving the effectiveness of our most life-saving antimicrobials.

Global epidemic transmission of diseases has intensified agricultural challenges further contributing to the need to implement a modernized strategic plan for science. Thus proactive, interdisciplinary and systemic action are required to find sustainable solutions to mitigate the major global and regional impacts due to the emergence and re-emergence of infectious diseases, as well as addressing other complex agro-environmental issues at home and abroad.

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Soil Chemical Indicators for Sustainable Paddy Rice Cultivation in Northern Thailand

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The SOILGUARD project funded by EU Horizon 2020 Research & Innovation Program focused on assessing the impact of agricultural practices on soil fertility in different regions of the world. In Thailand, research has been conducted on agricultural soil quality in comparing between continuous organic and conventional rice plantation associated with different levels of soil degradation. Thus, effects of both organic and conventional cultivation practices on soil chemical properties were examined in 2022 to 2023. Five sampling sites of each practice per level of soil degradation (low, medium, and high) were selected in Chiang Rai Province, Thailand. Soil samples were collected after rice harvesting in November 2022, and were analyzed for soil pH, EC (electrical conductivity), total organic carbon (TOC), available phosphorus (P), and total ammonium nitrogen (TAN). Results show that soil pH, EC, TOC, P, and TAN contents in the organic rice farming soil were 4.81, 246.19 μS/cm, 10.98 g C/Kg soil, 10.21 mg/kg, and 26.75 mg/kg, respectively, whereas those properties in the conventional farming soil were 4.95, 279.49 μS/cm, 13.21 g C/Kg soil, 17.92 mg/kg, and 24.74 mg/kg, respectively. The research findings suggest that the organic rice cultivating system has lower soil pH, EC, TOC and P values than the conventional farming soil. Soil EC values were significantly different ($p<0.05$), with the maximum EC value of 493 μS/cm observed in the organic paddy rice field having medium degradation, and the minimum EC of 179 μS/cm observed in the conventional paddy rice field with a high level of degradation. These research findings agree with those conducted in Turkey, which was carried out to examine the effects of the chemical and the application of 3 different organic manures including farmyard manure (FM), chicken manure (CM) and blood meal (BM). Soil EC levels were influenced by the applications to some extent, and the chemical fertilizer results in the highest soil EC level in each season. Mineral soils enriched in organic matter or with chemical fertilizer (e.g. NH_4OH) have higher CEC values than those non-amended soils. Soil organic matter improves soil water holding capacity as well as synthetic fertilizers that may augment the salt content.

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Studies on Managing Phosphorus in Agri-eco-systems of Great Lakes Basin: Towards to Development of Universal Indicators for One Health While Maximizing Agronomic Production profitability

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Phosphorus (P) is an essential nutrient to agricultural production, however, its application excessive to crop needs can harm environmental health. Both chemical fertilizer and animal manure contribute to P loading to the Great Lakes. There are diverse components contained in agri-ecosystems. Universal indicators are needed to optimally manage each of the practices to minimize adverse impacts on the environment and to improve the resource sustainability, while maximizing crop production profitability. Using the systems approach, a series studies have been conducted to understand and predict transformation and transportation of P derived from both chemical fertilizer and animal manure in agri-ecosystems. This can be highlighted as follows: (1) Assessment of the nature of P in animal manures nation-wide and the stocks and availability status of legacy P in soils of Lake Erie basin. The legacy P in soils was estimated with 589 kg/ha, which would supply crops for approximately 40 years without further addition, if fully used; (2) Evaluation of the effects of animal manure addition on soil health of chemical, physical and microbial parameters. Manure application shifted taxonomic profiles of microbial communities and their functional groups, with the effect more prominent in regular free drainage than controlled drainage with sub-irrigation. With continuous utilization of legacy P in soils, soil test P declined at a rate of 3.1 mg/ha/year, with critical values observed at 10.3-17.1 mg/kg for various crops in clay loam soils. In sandy loam soils, however, a booster of fertilizer P addition is required to ensure optimum crop growth even if in soils that are very high in legacy P; and (3) Determination of water quality impacts of typical management practices through P loss in both surface runoff and tile drainage water, including manure application, drainage water management, cover crop, crop rotation, tillage practices, and utilization of legacy P in soils. Phosphorus contained in solid cattle manure was less prone to P loss after land application. Use of legacy P in soils decreased soil P losses in runoff water by 33%, which was further enhanced by winter cover crop combined with controlled drainage and sub-irrigation. Based on all above, we developed environmental soil P testing methods for both mineral and organic soils. Degree of soil P saturation is a practically meaningful procedure for water quality assessment with potential for agronomic calibration.

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A Contextualization of the Unregulated Effects of Industrial Farming, Nutrient Runoff and Costly Surface and Drinking Water Treatments with Some Policy Suggestions

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The Industrial agricultural practices are questioned today by some policy stakeholders as it leads to high amounts of unregulated nutrient runoff, which is correlated with toxic cyanobacterial harmful algal blooms (HABs) which are threatening the security of freshwater with water impairments. Treatment facilities must consider expensive solutions when impairment threatens potable water availability for rural communities. While the Clean Water Act requires states to report impaired waterbodies, local decision-makers have no science-based framework for on-lake monitoring metrics. The case study for this project is a watershed that has experienced HABs and been legally impaired but today encourages precision and conservation farming with best management practices. Since the case study lake is used as a drinking water supply for eight rural towns and two rural water districts, understanding the relationship between unregulated chlorophyll a (Chl a) and levels of phosphorus (P) and nitrogen (N) in surface water is valuable knowledge for the Water Commission. This study uses multiple technical devices and indicators to manage monitoring and treatment. The purpose of this research is to examine water quality of a significant portion of the lake using analytical chemistry. Through monthly sampling at various locations, we show that nutrient concentration and algal bloom occurrence differ within the lake which may provide for better monitoring techniques.

Visualizing the Landscape of Major Chronic Disease Mortality Rates from 2008 to 2020 in Illinois, USA: Spatial, Temporal, and Statistical Analyses

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The Illinois Department of Public Health (IDPH) has collected massive mortality data annually at the county level since 2008. The data included the major mortality rates due to heart disease, cancer, stroke, chronic lower respiratory diseases, Alzheimer's disease, diabetes, kidney disease, and influenza/ pneumonia, respectively. Those data sets were originally stored in text-numeric formats, such as comma-separated values (CSV). Therefore, it was extremely difficult for the public and even health professionals to understand the landscape of the mortality rates across the state. The main objective of this research is to develop an innovative approach to visualizing patterns of those major chronic disease mortality rates in three unique ways: spatially, temporarily, and statistically. There are three main goals: (1) to develop both interactive map and map animation to visualize the spatial patterns of those mortality rates at the county level from 2008 to 2020 across the state; (2) to determine if there are statistically significant spatial clusters/outliers of the mortality rates at the county level in Illinois in 2020. Spatial autocorrelation analysis (Global Moran's I), Cluster and Outlier Analysis (Local Moran's I), and bivariate mapping method from ArcGIS Pro are performed to identify any significant spatial clusters/outliers of the mortality rates. Linear regression analysis between the mortality rates in 2020 and the United States Center for Disease Control and Prevention's Social Vulnerability Index (SVI) in 2020 was carried out to further analyze the spatial correlation between them. The results showed that there exist spatial clusters/outliers of the major chronic disease mortality rates across the state of Illinois; However, there is no statistically significant correlation between the mortality rates and the SVI. By utilizing spatial, temporal, and statistical analyses to make sense of the massive data set of the major chronic disease mortality rates in Illinois, this research aims to provide valuable insights for the state public health professionals and policymakers.

Detecting Invasive *Lespedeza cuneata* through 3D Point Cloud Analysis

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Invasive *Lespedeza cuneata* continues to ravage North American grassland ecosystems by outcompeting native grasses and forbs through aggressive reproductive strategies and strong resistance to removal. Early detection remains the most valuable tool in protecting natural ecosystems from *L. cuneata* invasion. Traditional detection methods involve field surveys to determine the extent of an invasion. Yet such methods consume significant time and human resources, limiting the scope of detection to single fields at a time. Remote sensing techniques provide a useful alternative to field surveys if they can detect both the early signs of invasion and the current progression and distribution of the invasive. Until this work, most remote sensing techniques for *L. cuneata* depend on hyperspectral imagery - an expensive and time-consuming resource - and suffer from errors discriminating from tall grasses with similar spectral profiles. The research presented in this paper instead exploits the unique physical structure of *L. cuneata* by building a 3D point cloud from a structure-from-motion procedure using an unmanned aerial vehicle, reducing confusion between native soft plants and the invasive woody species. The methods used detected 98% of the *L. cuneata*-invaded plots sampled, implying a strong relationship between physical structure of a grassland and invasion status.

Transport and Fate of Selenium in the Soil-Crop Systems with Long-term Swine Manure Treatments

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Selenium (Se) is an essential nutrient for humans and animals. Thus, livestock are oftentimes supplemented with Se in their feedstuff. In practice, swine production generally requires Se addition of 0.2-0.3 mg/kg in diet. Accordingly, previous studies reported that concentrations of Se in solid swine manure are about 1-7 mg/kg, and use of swine manure as organic fertilizer in agricultural soils could result in annual Se input of 0.2-2 g/ha. Therefore, the specific objective of this research was to (1) determine soil Se changes under long-term swine manure application and (2) elucidate the pathways of Se in the soil-crop system with different forms of swine manure treatments. The long-term field study was initiated in 2004 in south-western Ontario, Canada. The soil treatments included (1) liquid swine manure, (2) solid swine manure with wheat straw as bedding material, and (3) liquid swine manure composted with wheat straw. The control soil received no fertilizers. Corn and soybean were annually rotated, and manures/compost were only applied to the soil in the years with corn. Soil and crop (corn and soybean) grain samples were collected from each plot (9 mx25 m), and the flux of Se volatilization from the soil of each treatment was measured using a volatilization chamber system. The average soil Se input from each application of swine manure was 33.6±16.3 g/ha. Concentrations of Se in the top soil varied from 0.260 to 0.344 mg/kg over the 10-year study period with the application of different forms of swine manures. The average Se output through corn or soybean grain harvest from the plots was 0.43 to 1.32 g/ha/year. The flux of biogenic Se volatilization varied from 38 to 95 mg/d/ha, and thus, the biogenic Se loss from the soil to the atmosphere was estimated at 9.1 to 22.8 g/ha during the seasons with non-frozen ground each year. The future study shall quantify the transport pathway of Se in surface runoff and leaching to deep soil depths under field conditions. Concentrations of total Se in top 15-cm soils did not show statistically significant changes over a 10-year period with swine manure application. The Se mass input from hog manure application could compensate the Se mass loss through grain harvest, biogenic volatilization, and inevitably leaching and surface runoff from the soils with manure amendments.

Screening Private Well Water and Tap Water in Rural Missouri and Illinois Communities for PFAS and Heavy Metals

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Per- and Polyfluoroakyl substances (PFAS), contaminants of emerging concern, are a large family of synthetic polymers used in industrial and household products, known for their ubiquitousness, environmental persistence, and toxicity. As of February 2024, 5,021 U.S. locations are contaminated with PFAS, with blood serum levels among Americans ranging from 0.02 to 33.4 μg/L. Individuals are exposed to PFAS through drinking water and the use of consumer products. The Illinois EPA (IEPA) has detected PFAS in community drinking water supply sources above health-based guideline levels in the state including Collinsville, Wood River, and East Alton in Madison County. These Illinois communities are geographically close to St. Charles County in Missouri, where PFAS data are limited. Since 2013 the Missouri Department of Natural Resources has been monitoring PFAS occurrence in drinking water systems within the state. There are more than 400,000 private wells in Missouri, accounting for more than 17 percent of the state's drinking water supply. These wells are used by more than 1.4 million Missourians with over 5000 of these private wells located in St. Charles. This study assessed the presence of PFAS and heavy metals in private well water in Portage, Missouri, a rural community predominantly influenced by agricultural activities with minimal industrial presence. Utilizing survey responses and water sample collections, PFAS concentrations were quantified using Cyclopure test kits, and heavy metals, including Cadmium, Copper, Mercury, Nickel, Lead, Selenium, and Zinc, were analyzed with Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Preliminary findings indicated that while PFAS levels generally remained below health advisory levels, lead concentrations in the six sampled wells exceeded the US EPA maximum contaminant level goal of zero, posing significant health risks, particularly to children. Additionally, analysis of four tap water samples from the nearby cities of Collinsville and Granite City revealed the presence of several PFAS compounds. The detected levels were as follows: PFOA at 19.4 ng/L, PFOS at 7.2 ng/L, PFBA at 2.6 ng/L, PFBS at 10.0 ng/L, PFPeA at 9.3 ng/L, PFHxA at 11.7 ng/L, PFHpA at 8.0 ng/L, PFHxS at 9.4 ng/L, and PFPeS at 1.7 ng/L. These concentrations surpass health advisory thresholds, highlighting broader regional water quality issues. These results underscore the critical need for regular and thorough water quality monitoring within these communities. This study not only sheds light on the contamination status of water sources in rural and peri-urban areas of Missouri and Illinois but also emphasizes the ongoing need for vigilant monitoring and public awareness regarding water quality.

Chemical Interaction of Selenium and Toxic Metals in Shellfish Commercially Available on the US Market

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Seafood has become increasingly prevalent in people's daily lives, and approximately a quarter of the seafood harvested consisted of shellfish. Shellfish provide high dietary intake of protein and other essential nutrients, but there are also concerns about toxic metals accumulated in shellfish tissues because some shellfish such as mussels, oysters, and clams are benthopelagic. Thus, the objectives of this study were to investigate toxic metal concentrations in shellfish of 16 species that are commercially available in the US supermarket. To investigate the spatial variations of metal accumulation in shellfish, shrimp samples of *Litopenaeus vannamei* were collected from four different ocean regions. Preliminary results showed that concentrations of Cd and Hg varied significantly among 16 species, showing relatively high Cd concentrations of 13.1±5.3 mg/kg in snail (*Babylonia lutosa*) and high Hg concentrations of 0.166±0.074 mg/kg in squid (*Dosidicus gigas*). Comparable concentrations of Cd and Hg were observed in the shrimp harvested from four different parts of the world.

Analysis of Sunscreens and Antibiotics in Groundwater during the COVID-19 Pandemic in the Riviera Maya, Mexico

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The COVID-19 pandemic presented a unique opportunity to study the effect of emerging contaminants, such as pharmaceutical and personal care products (PPCP's), on groundwater in the Rivera Maya, Mexico. The sudden drop in tourism allowed for the analysis of tourism's effect on groundwater pollution. The concentrations of antibiotics and sunscreen were analyzed from samples taken at public wells, beaches, and both public and private cenotes. Cenotes are naturally occurring caverns of groundwater and draw many tourists every year. Samples were collected over three years and at different stages of the pandemic: when COVID-19 restricted tourism (2020), when tourism began to increase (July 2021), and when tourism returned to its peak (July 2022). After filtration and pH adjustment, solid phase extraction (SPE) was performed to extract the analytes of interest. The samples were then analyzed with liquid chromatography – tandem mass spectrometry (LC-MS/MS) and statistical analysis was performed. Data collected from March 2020 - July 2021 showed a higher concentration of antibiotic and sunscreen components as tourism began to increase. A residential aspect to the contamination was also seen, which may be related to the improper usage of antibiotics to treat COVID-19.

The Effect of Environmentally Relevant Concentrations of Statins on *Eisenia hortensis*

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The high prevalence of prescription drugs has led to inadvertent contamination of the terrestrial environment, leading to adverse biological effects on its inhabitants. Statins are a class of blood lipid-lowering agents that are among the most widely prescribed drugs, causing them to be found in measurable concentrations in the environment. Earthworms such as *Eisenia hortensis* can function as bio-indicators of soil toxicity to assess the effects of statins on the terrestrial ecosystem. In this study, *E. hortensis* were exposed to either 1000%, 100%, 10%, or a control of the environmentally relevant concentration of atorvastatin (ATO), lovastatin (LOV), simvastatin (SIM), or Type I water. The 100% concentrations were 0.2, 0.1, and 1.5 ppb, respectively. Following exposure, worms were prepared for analysis by either liquid chromatography tandem mass spectrometry (LC-MS/MS) or matrix-assisted laser desorption/ionization mass spectrometry imaging (MALDI MSI). Present LC-MS/MS analysis has shown that there is minimal statin uptake at 1000% exposure for at least two of the statins, prompting an ongoing exposure to 10,000% of the environmentally relevant concentration. Current results also indicate that higher concentrations of SIM are absorbed compared to ATO, which is likely a consequence of their structural differences. MALDI MSI analysis provided visualization of the distribution of the parent pharmaceutical compounds and endogenous lipids. This study exemplifies the utility of complementary analytical approaches by using quantitative LC-MS/MS and qualitative MALDI MSI to obtain a robust metabolic profile of statin-dosed earthworms to assess the effect of environmentally relevant concentrations of pharmaceuticals on the terrestrial environment.

Identification of Toxic Algae Species Using MALDI MS

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Algal toxins are released by harmful algal blooms (HABs) in a variety of fresh and saltwater bodies which pose a threat to human and environmental health. HABs are often the result of warming waters, increased nutrient loads near farming areas, and run-off from pesticides into bodies of water. It is of paramount importance to differentiate between algal species that produce toxins and those that are benign. This goal can be accomplished using matrix-assisted laser desorption/ionization (MALDI) mass spectrometry (MS), which generates a molecular fingerprint for each species. Highly abundant signals within these mass spectral fingerprints can be matched to algae, cyanobacteria, and other microorganism species using statistical modelling to achieve species identification. These fingerprints can be combined to create an extensive database to identify algae down to a genus or species level. A linear benchtop MALDI MS (Shimadzu MALDI-8020) was used to acquire spectra for several matrices including CHCA, MBT, and DHB. MBT (5 mg/mL) was found to be the most successful in ionization of characteristic algae components. Through the generated database, toxic and non-toxic species have been differentiated from one another with 80% accuracy. This study serves as a proof-of-concept experiment for algal speciation, with the intent to construct a database that can be used for speciation of algae and cyanobacteria.