

Center for Health Effects of Environmental Contamination (CHEEC)
The University of Iowa
2015 – 2016 Biennial Report

The University of Iowa (UI) Center for Health Effects of Environmental Contamination (CHEEC) is a multidisciplinary environmental research center that supports and conducts research to investigate possible health outcomes related to exposure to environmental toxins. CHEEC activities include 1) developing and maintaining environmental databases used in conducting research, 2) collaborating on environmental health research programs and projects, 3) managing a seed grant program to support environmental research, and 4) providing a variety of education and service programs to the citizens of Iowa and the region. CHEEC is comprised of UI faculty and researchers from the Colleges of Engineering, Public Health, Liberal Arts and Sciences, and the State Hygienic Laboratory. CHEEC cooperates and collaborates with the Iowa Departments of Public Health (IDPH), Natural Resources (IDNR), and Agriculture and Land Stewardship (IDALS). CHEEC's mission, as described in the 1987 Iowa Groundwater Protection Act, is to "*determine the levels of environmental contamination which can be specifically associated with human health effects.*" This report presents an overview of CHEEC research programs and educational activities during 2015–2016.

Environmental Databases

Environmental databases are a central component of CHEEC. CHEEC created and maintains databases on Iowa drinking water quality, including the *Iowa Historical Municipal Water Supply Source and Treatment Database*, the *Municipal Analytical Water Quality Database*, and the *Iowa Private Well Water Database*. Municipal supply databases are used in conducting drinking water and health effects research. Private well databases are used to look at trends in private well water quality, and to collect baseline data on emerging contaminants.

Iowa Municipal Water Systems

The CHEEC Municipal Analytical Water Quality Database contains information from numerous sources including state and federal special surveys, regulatory programs (Safe Drinking Water Act), and various academic studies. This database houses information from the 1950s to the present. The Historical Municipal Water Supply Source and Treatment Database contains information dating back through the early 1900s. This database is updated every 5 years by contacting public water utilities across Iowa about changes to their water treatment process and new water sources. The most recent update was completed in 2012.

Iowa Private Drinking Water Wells

CHEEC maintains data from surveys of Iowa private drinking water wells. The Iowa Statewide Rural Well Water Survey (SWRL, 1988–89) was conducted by CHEEC and the Iowa Geological Survey Bureau as part of the implementation of the Iowa Groundwater Protection Act. SWRL provided a statistically valid assessment of the proportion of private rural wells and rural residents affected by various water contaminants. A total of 686 wells were sampled for coliform bacteria, nitrate, 27 pesticides and major inorganic ions. A second phase of the SWRL study (SWRL2) was conducted in 2006–08, in which 473 private rural drinking water wells were

sampled; 116 of the wells were original SWRL wells; the other wells were randomly selected from the IDNR's Private Well Tracking System. SWRL2 tested for the same contaminants as the original SWRL, with the addition of arsenic and several pesticide degradates. The Iowa Community Private Well Study (2002–03) includes water quality data for 230 private drinking water wells in 50 incorporated Iowa towns not served by a public water supply system.

Research and Data Management

In 2015–2016, CHEEC staff participated in the following projects as Investigators and in providing applications programming.

Exposure assessment method for disinfection byproducts in drinking water

Collaborators: National Birth Defects Prevention Study centers, CHEEC

This project is calculating disinfection byproducts (DBP) exposures in public drinking water systems for participants in the ***National Birth Defects Prevention Study*** (NBDPS). The exposure assessment includes linking geocoded maternal addresses to appropriate drinking water utilities, linking relevant DBP water quality data to those residences, and modeling the DBP data to account for possible spatial and temporal variability.

Water quality data for private wells for the *Agricultural Health Study*

Collaborators: National Cancer Institute, State Hygienic Laboratory at UI, CHEEC

This project provided nitrate, pesticide and other water quality data for private wells and public water utilities across Iowa to use in modeling drinking water exposures for participants in the ***Agricultural Health Study***. Over 89,000 persons are in this Study (Iowa and North Carolina); the goal is to investigate the effects of environmental, occupational, dietary, and genetic factors on the health of the agricultural population.

***Iowa Women's Health Study* Drinking Water Exposures and Cancer Risk**

Collaborators: National Cancer Institute, Univ. of Minnesota School of Public Health, CHEEC

This project involves analyzing drinking water contaminant data (nitrate, pesticides, disinfection byproducts) in Iowa municipal water supplies in communities where over 21,000 participants in the ***Iowa Women's Health Study*** resided during the 1960s through the 1980s. Drinking water exposure data is included with lifestyle, dietary and other data to evaluate risks for thyroid, bladder and ovarian cancer.

Seed Grant Program

CHEEC awards approximately one-third of its annual state allocation to pilot-scale research projects. Since the inception of the CHEEC Seed Grant Program in 1988, 148 projects have been funded. A review of the Program showed that 60 students have received advanced degrees resulting from these research projects, and 110 articles have been published in peer-reviewed journals describing research results. While recently funded seed grant projects are still in progress, 58 project proposals using seed grant project results have been awarded external funding (grants/contracts) with a \$10 return for every \$1 invested by CHEEC. CHEEC awarded the following seed grants in FY 2015 and FY 2016:

Metabolomics characterization of early biomarkers of microcystin exposure in blood

Investigators: W. Rumberiha, P. Imerman, Department of Veterinary Diagnostic and Production Animal Medicine, Iowa State University; A. Perera, WM Keck Metabolomics Research Laboratory, Iowa State University

Summary: Fresh water cyanobacteria harmful algal blooms (HABs) are increasing in frequency and severity in the U.S. Blooms produce potent and lethal cyanotoxins, which poison people and animals. This is a serious emerging “One Health” problem. Among the many cyanotoxins produced by HABs are hepatotoxic and carcinogenic microcystins. Currently, the state-of-the-art diagnostic approach for microcystin intoxications in people is measuring elevated blood serum liver enzymes as biomarkers of effect. Unfortunately, elevated liver enzymes are late biomarkers of microcystin effects. The objective of this study is to identify and characterize early biomarkers of microcystin exposure and effects in humans using the mouse model. These early biomarkers will be used for diagnosis in populations exposed to contaminated water in order to mount early intervention procedures to protect individual and public health.

A low-cost aerosol sensing estimator for assessing aerosol exposure

Investigators: S. Sousan, T. Peters, UI Department of Occupational and Environmental Health, ; G. Thomas, UI Department of Mechanical and Industrial Engineering

Summary: The association of air pollution with adverse cardiopulmonary health outcomes may be underestimated because of misclassification errors introduced by uncertainty in the exposure assessment of aerosols. Until recently, the excessive cost of high-end aerosol measurement devices (>\$10,000) has prevented the regular collection of aerosol data with high spatial and temporal resolution with exposure measurements often being limited to a single site to represent large populations. In some cases, new, low-cost (<\$500) aerosol devices have been found to correlate favorably to high-cost devices. However, these low-cost devices suffer from some limitations, such as an inability to distinguish between fine and coarse particles. The proposed study aims to overcome these limitations by designing and evaluating a customized, aerosol sensor based on low-cost, high-resolution cameras. The low-cost sensor will enable routine aerosol assessment among the general population, providing estimates of aerosol concentrations resolved by size (fine and coarse aerosol) and time (<5 min logging).

Metagenomic analysis and modeling of environmental resistance to agricultural antibiotics

Investigators: M. Soupir, A. Howe, Department of Agricultural and Biosystems Engineering, Iowa State University

Summary: Increasing levels of antibiotic resistance in clinical settings has led to the belief that animal agriculture antibiotic use is contributing to the global resistance problem; however, that connection is unclear given the limited understanding of antibiotic resistant bacteria (ARB) and resistant genes (ARG) in the soil and water environment. Previous work has documented differences in ARG concentrations in drainage when compared to measured concentrations of U.S. EPA recommended indicator bacteria. This study will conduct laboratory experiments in a controlled column environment, representative of an agroecosystem, to (1) identify the diversity and quantify the abundance of ARGs and their hosts in manure, soils with varying management histories, and simulated subsurface drainage; and (2) identify the diversity and quantify the abundance of mobile genetic elements and their linkages to ARGs. Results will

provide valuable insight into i) the microbial community harboring ARGs and ii) horizontal gene transfer processes occurring in agricultural systems.

Exposure to environmental obesogen tributyltin during early pregnancy in association with maternal obesity and gestational weight gain

Investigators: W. Bao, UI Department of Epidemiology; H.J. Lehmler, UI Department of Occupational and Environmental Health; D.A. Santillan, M.K. Santillan, UI Department of Obstetrics and Gynecology; K. Wang, UI Department of Biostatistics.

Summary: Emerging evidence from animal studies has established tributyltin (TBT) as a novel environmental obesogen in the development of obesity and impaired metabolic function, but data on health effects of TBT exposure in humans are lacking, indicating a critical need to translate the findings from animal studies to humans. This project will investigate associations of prenatal TBT exposure during early pregnancy with maternal obesity and gestational weight gain. Investigators will measure TBT concentrations in maternal plasma samples collected from 100 pregnant women at the first prenatal visit (<10 weeks of gestation). These samples have been already collected and archived in the University of Iowa Maternal Fetal Tissue Bank, an ongoing prospective cohort study. Maternal anthropometric measures, along with demographic and clinical data, will be extracted from confidential electronic health records.

Fate of neonicotinoid insecticides in water and wastewater treatment systems

Investigators: D.M. Cwiertny, G.H. LeFevre, UI Department of Civil and Environmental Engineering; D.W. Kolpin, U.S. Geological Survey

Summary: Neonicotinoids represent one of the most heavily used pesticide classes, particularly for corn and soy production. Commonly detected in Midwestern water resources, little is known about their fate in the environment, particularly engineered treatment systems intended to mitigate risks of their exposure. The study hypothesis is that chemical and biological processes used in conventional treatment alter the structure of neonicotinoids so as to remove their specificity to invertebrates, thereby exposing non-target organisms, including humans, to unanticipated risks arising from their bioactive transformation products in finished water and effluent. The research plan integrates laboratory studies simulating conventional water and wastewater treatment processes with monitoring of neonicotinoid removal and transformation at the Univ. of Iowa Water Treatment Plant. Outcomes will provide insights into best practices for neonicotinoid removal during treatment and better understanding of the risks associated with their formation of unintended transformation byproducts.

Environmentally active surface films

Investigators: S.K. Shaw, J.S. Grant, UI Department of Chemistry

Summary: This study will address an emerging avenue for pollutant fate and transport in the active surface film. Surface films are composed of organic (waxy) and inorganic (salty) species which combine in dynamic, heterogeneous matrixes on nearly all impervious surfaces. The films work as 'environmental sponges' by mediating fate and transport of volatile and semi-volatile organic pollutants (OP), ultimately affecting human and environmental health. The goal is to assign culpability of surface films' physical morphology and oxidation state to their participation in OP absorption and release, by developing and exposing proxy films to metered doses of

known environmental maturation agents (i.e. UV radiation and ozone) and quantifying the films' morphology and interaction with OP as a function of film maturity. Study hypothesis: the films' heterogeneous character/dynamic behavior will impact OP adsorption (and absorption), and that this behavior will trend with film hydrophobicity.

Discovering links between environmental contaminant clusters and environmental, geographic and social drivers using network-based data processing

Investigator: A. Sen Gupta, UI Department of Electrical and Computer Engineering

Summary: This project is an interdisciplinary collaboration across the College of Engineering, and College of Public Health that harnesses the power of information science and signal processing towards better understanding of contaminant fingerprints in the environment. The Investigator will study data-driven associations linking contaminant clusters to environmental, geographic and social drivers. The project will develop a data-driven infrastructure towards robust interpretation of raw signal and processed field data, along with prediction models for success of intervention methods. While the focus of the work is chemical contaminants, the methods also apply to biological contaminants (water-borne fecal pathogens in soil and water).

Cooperative Research Projects

The CHEEC Cooperative Research Program seeks to leverage research monies from university, state, and federal entities to conduct research in areas of mutual interest. The collaboration requires matching funds from participating entities; the program seeks to establish innovative lines of environmental health research leading to preliminary results that may be used in seeking larger grant funding from federal and private sources. Since the Program began in 1999, 13 projects have been funded. Over the life of the Cooperative Research Program, there has been an average of a 5 dollar match from Cooperators for every dollar CHEEC has invested. Cooperators have included the U.S. Geological Survey, the U.S. Department of Agriculture, the U.S. Department of Energy, the U.S. Environmental Protection Agency, the National Institutes of Health, the Iowa Department of Natural Resources, the Iowa Department of Public Health, the Leopold Center for Sustainable Agriculture at Iowa State University, Iowa County Health Departments, and Departments in the UI Colleges of Public Health, Engineering, Medicine, and Liberal Arts and Sciences.

CHEEC awarded the following cooperative research grants in FY 2016:

Effect of co-exposure to air pollution and house dust endotoxin on asthma and wheeze

Investigators: A. Mendy, P. Thorne, UI Department of Occupational and Environmental Health; D. Zeldin, P. Salo, Natl Institute of Environmental Health Sciences; R. Cohen, J. Wilkerson, Social and Scientific Systems, Inc.; C. Weir, HHS Office of Emergency Management

Summary: Air pollutants and house dust endotoxin are ubiquitous in the environment. Air pollutants exacerbate pre-existing asthma and evidence is mounting that it may cause the disease through oxidative stress and destruction of the airway mucosa. Endotoxin is also well known to cause bronchial asthma, although research suggests it might be protective against the atopic phenotype, especially with early-life exposure. Animal studies suggest that co-exposure

to both air pollutants and endotoxin may have worse consequences on respiratory health than individual exposures. This study will investigate the effects of co-exposure to environmental pollutants on asthma and wheeze in humans in a representative U.S. sample. The research will lead to an increased understanding of environmental risk factors for asthma and wheeze to enhance prevention of these respiratory conditions.

Naturally-occurring radioactivity in private drinking water in Iowa: Understanding the potential for increased cancer risks to Iowans

Investigators: M. Schultz, UI Department of Radiology; M. Wichman, D. May, State Hygienic Laboratory at the University of Iowa

Summary: Naturally-occurring radioactive material can be a source of radiation exposure to the public, especially in ground-derived drinking water. Two radionuclides (Pb-210 and Po-210) are of concern because their characteristic properties combine to present potential carcinogenic risks to human. These radionuclides are present in subsurface geological deposits in Iowa from which drinking water is derived. While potential carcinogenicities are known, concentrations of Pb-210 and Po-210 are not well characterized in Iowa aquifers. Concentrations of Pb-210 and Po-210 in 50 privately-owned wells in Iowa will be determined to develop an understanding of the potential contribution to increased lifetime cancer risk to Iowans. These studies could result in a more detailed understanding of the biogeochemical relationship of increased levels of Po-210 and Pb-210 to other natural radionuclides found in Iowa's well water, and will provide preliminary data for understanding potential risk of natural radioactivity in Iowa's well water.

Education Programs

CHEEC was involved in a number of educational programs and activities during 2015–2016 focusing on Iowa water quality, both on source water quality and protection and on drinking water quality. General educational outreach activities for both the public and for professional organizations are listed below.

- A “Water Underground” exhibit for the University of Iowa Mobile Museum. The Mobile Museum toured the state in 2015, including a week at the Iowa State Fair
- Gave seminar talks at the UI Explorer’s Seminar “Water Underground”, at the Iowa Governor’s Conference on Public Health: “Private Water Wells in Iowa: Safe Drinking Water?” and “A Summary of Water Monitoring from the Past Decade – Drinking Water: Public Systems and Private Wells”, at the Raccoon River and Beyond stakeholders meeting: “Source Water Quality in Iowa: Drinking Water and Health”, and at a Des Moines Water Works Board of Directors meeting: “Public Health and Drinking Water”
- Co-sponsored a seminar titled “The Flint Michigan Water Crisis: Miracle or Disaster?” featuring Prof. Marc Edwards from Virginia Tech University
- Was featured speaker on a webinar for the Iowa Public Health Association titled “Iowa Water Quality and Public Health”
- Was featured speaker on a podcast for the UI Center for Global and Regional Environmental Research titled “Nitrate in Iowa Water Sources: Public Health Concerns”
- Served on planning committees for Iowa Association of Water Agencies meetings

CHEEC sponsors, co-sponsors and hosts conferences, symposia and workshops on a variety of issues related to environmental health

(<http://www.cheec.uiowa.edu/outreach/conference.html>).

In 2016, a symposium titled “Iowa’s Drinking Water – Could Flint Happen Here?” was cosponsored by CHEEC, the UI Public Policy Center, the UI Center for Global and Regional Environmental Research, and the UI Environmental Health Sciences Research Center.

<https://www.youtube.com/playlist?list=PLUA1IWqFcew7qjXDNsKVUBOZoUnD8CFaZ>

Education grants

CHEEC Education Grants provide funding for educational programs that encompass the broad interdisciplinary nature of environmental health. Proposals for education programs with a public health or an environmental education focus that demonstrate a link to environmental health issues are encouraged. Awards are for **partial support** for public education projects in environmental health related to exposure prevention, assessment and awareness, and improvement of environmental health. . In 2015–2016, CHEEC grants were awarded to the following projects:

Watershed: A Symposium on Dance, Science, Activism and the Future of Water in Iowa

Department of Dance, University of Iowa

Feeding the World: Challenges for Water Quality and Quantity

Public Policy Center, University of Iowa

Who We Are

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