Center for Health Effects of Environmental Contamination

The University of Iowa

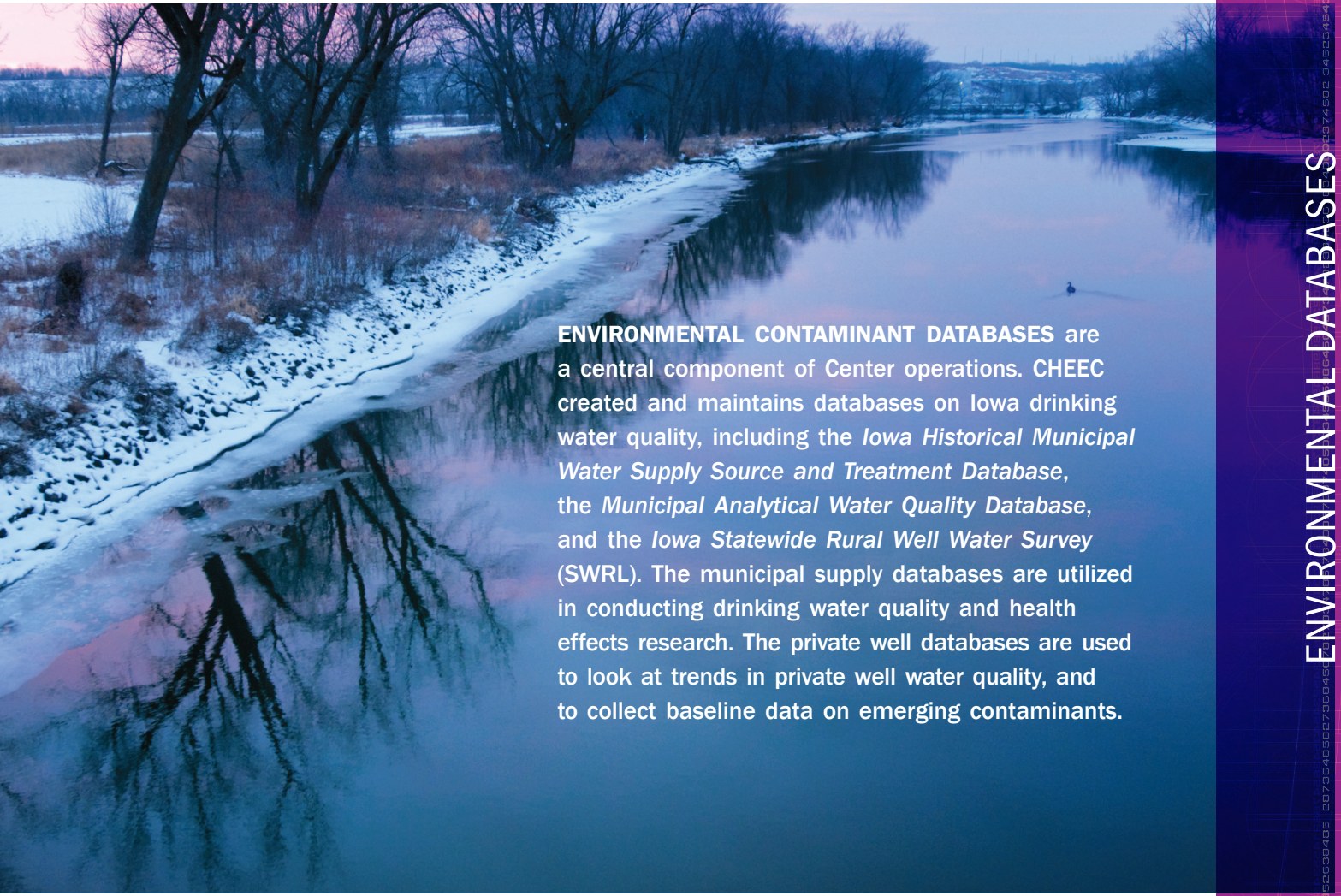
2009-2010 biennial report

The University of Iowa Center for Health Effects of Environmental Contamination (CHEEC)

is a multidisciplinary environmental research center dedicated to supporting and conducting research that investigates possible adverse health outcomes related to exposure to environmental toxins. CHEEC's major activities include 1) developing and maintaining environmental databases to be used in conducting environmental research, 2) cooperating and 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 faculty and researchers located in the University of Iowa Colleges of Engineering, Public Health, and 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 research activities conducted or supported by CHEEC, as well as education programs and service functions CHEEC staff participated in during 2009-2010. A discussion of the emerging environmental health issue of arsenic in Iowa's private drinking water wells is also presented.

“DETERMINE THE LEVELS OF ENVIRONMENTAL CONTAMINATION
WHICH CAN BE SPECIFICALLY ASSOCIATED WITH HUMAN HEALTH EFFECTS”



ENVIRONMENTAL DATABASES

ENVIRONMENTAL CONTAMINANT DATABASES are a central component of Center operations. 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 Statewide Rural Well Water Survey* (SWRL). The municipal supply databases are utilized in conducting drinking water quality and health effects research. The private well databases are used to look at trends in private well water quality, and to collect baseline data on emerging contaminants.

Iowa Municipal (Public) Water Supplies

The CHEEC Municipal Analytical Water Quality Database contains information compiled from numerous sources including state and federal special surveys, regulatory programs (Safe Drinking Water Act), and various academic studies. This database houses information dating from the 1930s, 1960s, and from the early 1970s 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 re: changes to their water treatment process and new water sources.

Iowa Private Drinking Water Wells

CHEEC maintains data from a number of 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 environmental contaminants, and a cross-section of the quality of Iowa groundwater. 686 wells (in all 99 Iowa counties) were sampled for coliform bacteria, nitrate, 27 pesticides (and 5 metabolites) and major inorganic ions. A second phase of the SWRL study (SWRL2) was conducted in 2006–08. In this study, 473 private rural drinking water wells were sampled in 89 Iowa counties. 116 of the wells were original SWRL study wells; the other wells were randomly selected from the IDNR's Private Well Tracking System. 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.

In 2009-2010, CHEEC staff participated in the following projects as Investigators, in developing and maintaining project databases, and in providing applications programming.

Exposure Assessment Method for Disinfection Byproducts in Drinking Water

COLLABORATORS: National Birth Defects Prevention Study centers, U.S. EPA, CHEEC

FUNDING AGENCIES: National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention (CDC)

This project will calculate 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 address 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.

Nitrates, Nitrites and Nitrosatable Drugs and the Risk for Selected Birth Defects

COLLABORATORS: Texas A&M University, the University of Iowa Registry for Congenital and Inherited Disorders, National Birth Defects Prevention Study centers, CHEEC

FUNDING AGENCY: National Institute for Environmental Health Sciences

This study is examining the separate and joint effects of prenatal exposures to nitrates, nitrites and nitrosatable drugs on the risk for selected congenital malformations in children, using data collected by the NBDPS. Texas and Iowa are conducting an exposure assessment for nitrate in public drinking water and in bottled water; Texas is also modeling nitrate exposures in private well water.

Muscular Dystrophy Surveillance, Tracking and Research Network (MDSTARnet)

COLLABORATORS: Centers for Disease Control and Prevention (CDC), Iowa Registry for Congenital and Inherited Disorders, Iowa Department of Public Health, research units in Arizona, Colorado, Georgia, and New York.

FUNDING AGENCY: Centers for Disease Control and Prevention

CDC is working with researchers to set up surveillance/tracking systems for Duchenne/ Becker muscular dystrophy (DBMD), the most common muscular dystrophy in children. The goal is to find all DBMD patients in these states by using information from clinic medical records and hospital records. Information about each child's treatments and medical status will be reviewed to try and answer many questions about DBMD.

National Children's Study

COLLABORATORS: University of Iowa (Pediatrics, Epidemiology, Iowa Registry for Congenital and Inherited Disorders, CHEEC), Polk County hospitals and Public Health agencies, Des Moines University
FUNDING AGENCY: National Institute of Child Health and Human Development

The National Children's Study will examine the effects of the environment, broadly defined to include factors such as air, water, diet, sound, family dynamics, community and cultural influences, and genetics on the growth, development, and health of children across the United States, following them from before birth until age 21 years. In Iowa, 1,000 children in Polk County will be enrolled in the Study.

Water Quality Data for Private Wells for the Agricultural Health Study

COLLABORATORS: CHEEC, State Hygienic Laboratory
FUNDING AGENCY: National Cancer Institute

This project will provide 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.

RESEARCH FOCUS: Arsenic in Iowa's Private Drinking Water Wells

ARSENIC OCCURS NATURALLY in geologic deposits and can become concentrated in groundwater, depending on subsurface chemical conditions and other factors. Epidemiologic studies in the U.S. and elsewhere have reported associations between exposure to high levels of arsenic in drinking water and risks for lung and bladder cancers, skin disease, and cardiovascular disorders. In Iowa, groundwater provides drinking water for about 80% of the population. While public water systems regularly monitor their drinking water supplies for arsenic (under Safe Drinking Water Act regulations), private water wells are not regulated. These private wells may be at risk of contamination by arsenic or other compounds, due to the proximate location of pollutant sources and because they tend to utilize vulnerable aquifer systems.

Recent surveys have shown that arsenic is commonly found in Iowa's groundwater sources. A 2002–03 sampling of 230 private wells in 50 incorporated communities (the Iowa Community Private Well Study) analyzed water samples for a variety of contaminants including arsenic. Arsenic was detected in 24% of the wells tested. SWRL2 (2006–08) sampled 473 wells located in 89 counties. Arsenic was detected in 47% of the wells sampled; about 8% of those wells (located in 31 counties) had total arsenic concentrations ≥.01 mg/L (EPA's drinking water standard for public water supplies). An estimated 450,000 Iowans rely on private wells for drinking water; a sizeable population may be at risk of exposure to high arsenic levels in their drinking water.

Following SWRL2, recommendations were made to the IDNR regarding arsenic in private well water, including regular testing for arsenic through the Iowa Grants to Counties (GTC) Program. The GTC Program provides free annual sampling and testing of private well water for nitrate and bacteria. Additional testing for other compounds (herbicides, metals) is provided if a well tests positive for bacteria or high nitrate. CHEEC recommended that arsenic be added to the initial analyses for nitrate and bacteria. The design and implementation of an Iowa Arsenic Groundwater Monitoring Network was also recommended. The Network would coordinate ongoing testing of private wells for arsenic, disseminate information to the public, and serve as an umbrella organization for education, research and demonstration projects focusing on arsenic. Efforts are underway to identify funding for the proposed Network.

SEED GRANTS

CHEEC awards approximately one-third of its annual state allocation to pilot scale research. Since the inception of the Seed Grant Program in 1988, the return from federal, state and private sector grants and contracts on CHEEC's investment has been almost 12 to 1. More importantly, Seed Grant projects create a valuable learning environment for undergraduate and graduate level students. CHEEC awarded the following seed grants in FY 2009 and 2010.

Effects of Nanoparticle Physicochemical Properties on Lung Surfactant Function

INVESTIGATOR: J. Fiegel, Division of Pharmaceutics and Department of Chemical and Biochemical Engineering, University of Iowa

The lung fluid interface plays a major role in stabilizing the lung during physiological processes such as breathing. Inhaled nanomaterials deposited on the lung fluid surfaces can adversely affect the stability and function of the fluid. This project will study how nanoparticles alter the function of complex lung fluid interfaces; the goal is to be able to predict loss of surfactant function based on nanoparticle physicochemical properties.

Effect of In Utero Exposure to PCB 136 (2,2',3,3',6,6'-Hexachlorobiphenyl) Enantiomers on Neurodevelopmental Outcomes in Adult Offspring

INVESTIGATORS: I. Kania-Korwel, and HJ Lehmler, Department of Occupational and Environmental Health, University of Iowa

Polychlorinated biphenyls (PCBs) are industrial chemicals that persist in the environment and cause adverse neurodevelopmental effects in laboratory animals and in humans. This study will look at exposure to one PCB congener (PCB 136) during gestation and lactation and the effect on long-term neurodevelopmental outcomes in mice.

Monitoring Contaminant Impact on Biofilm Adaptation with Raman Spectroscopy

INVESTIGATORS: T. Peeples and J. Jessop, Department of Chemical and Biochemical Engineering, University of Iowa

Biofilm flow devices with Raman scattering can provide information on complex mixtures of microbes and their adaptive mechanisms that facilitate contaminant biodegradation. This project will investigate 1) whether Raman scattering can be used to identify and quantify members of biofilm communities, and 2) whether that biofilm formation leads to enhanced levels of atrazine degradation.

Effects of Environmentally–Induced Oxidative Stress on Regulator of G Protein Signaling (RGS) Proteins

INVESTIGATOR: D. Roman, Division of Medicinal and Natural Products Chemistry, College of Pharmacy, University of Iowa

Environmental toxins can cause damage to cells by inducing oxidative stress. 4HNE is a lipid peroxidation product of oxidative stress. RGS proteins are signaling checkpoints downstream of G protein coupled receptor (GPCR) activation and are critical for regulating GPCR-mediated cell signaling events. Alterations in GPCR signaling and RGS protein function are seen in neurodegenerative diseases such as Parkinson's; this project will study the role of oxidative stress and 4HNE in RGS4 inhibition and subsequent cellular signaling dysfunction.

Iron–Induced Alveolar Epithelial Cell Death Via Increased Ferritin Expression and p53 Activation

INVESTIGATORS: A. Comellas, Department of Internal Medicine; V. Grassian, Departments of Chemistry and Chemical and Biochemical Engineering, University of Iowa

Particulate matter (PM) is associated with many respiratory diseases. PM is a complex mixture composed of a core of ash or carbon, coated with organic molecules and transition metals. As a transition metal, iron can generate reactive oxygen species and contribute to oxidative stress. Oxidative damage and cell death in the alveolar epithelium are related to PM induced lung injury. This project will study how iron content increases the expression of ferritin in alveolar epithelial cells, which in turn activates p53–dependent cell death pathway.

Toxic Effects of Photolytic Transformations of Polybrominated Diphenyl Ethers (PBDEs) and their Hydroxylated Compounds (OH-PBDEs)

INVESTIGATORS: Y. Suh and G. Ludewig, Department of Occupational and Environmental Health, University of Iowa

PBDEs (flame retardants) and their hydroxylated compounds (OH-PBDEs) are common in the environment; human exposure occurs primarily via contaminated house dust. OH-PBDEs may be converted to PBDDs by solar or artificial UV light; light irradiation of PBDEs and OH-PBDEs may generate cytotoxic, genotoxic and cancer-initiating reactive products. This project will study

the cytotoxicity, oxidative stress, genotoxicity, and cytochrome P450 enzyme induction in human HaCaT keratinocytes after exposure to irradiated OH-PBDEs.

Analysis of the Non–Target Growth Effects of Metolachlor on Human HepG2 Cells

INVESTIGATOR: K. Dhanwada, Department of Biology, University of Northern Iowa

Metolachlor, a commonly used herbicide in the Midwest corn-belt, functions by inhibiting chlorophyll and protein synthesis in target plants. Herbicide exposure can affect the growth and behavior of organisms; studies report increasing metolachlor concentrations and time of exposure results in decreased growth of liver cells. This study will look for a mechanism for decreased HepG2 cell growth after metolachlor exposure, including assessing toxicity effects leading to necrosis, effects of apoptosis induction and alterations in cell cycle progression.

Siloxanes in Chicago Air

INVESTIGATORS: K. Hornbuckle, Department of Civil and Environmental Engineering; C. Stanier, Department of Chemical and Biochemical Engineering, University of Iowa

Siloxanes are organo-silicon compounds found in products like cosmetics, deodorants and water repellants; more than one million tons of siloxanes are produced or imported in the US every year. Because of widespread use they are found in wastewater and solid waste, entering the environment through volatilization, wastewater discharge, and emission of landfill gases. This project will develop analytical methods for three siloxanes: octamethylcyclotetrasiloxane (D4), decamethylcyclopentasiloxane (D5); and dodecamethylcyclohexasiloxane (D6) in air samples.

CHEEC supports and hosts seminars, conferences, and other educational programming. The following seminars were given on the University of Iowa (UI) campus in 2009–2010:

Arsenic and herbicide degradates in Iowa private drinking water wells, Department of Occupational and Environmental Health Seminar

The Iowa Statewide Rural Well Water Survey Phase 2: Emerging Water Quality Concerns, Department of Civil and Environmental Engineering Seminar

Staff gave presentations on CHEEC research at a number of state and national meetings, including the 2009 American Public Health Association Annual Meeting, the 2010 Iowa Water Conference, the 9th Annual IDNR Water Monitoring Conference, and the 2010 Iowa Environmental Health Association Annual Meeting. In addition to lecturing on water quality issues in UI Geography and Epidemiology classes, staff gave presentations at State Hygienic Laboratory training sessions for newly hired county environmental health specialists and at IDNR source water protection workshops. Center staff served on the IDNR Ambient Water Quality Monitoring Technical Advisory Committee and on the newly formed IDPH Advisory Committee for the Environmental Public Health Tracking Program.

WHO WE ARE

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