The Future Health of Taiwanese Children

26 September 2017
Conference Room, 4F, Front United Medical Building, Taipei Medical University(TMU)

臺北醫學大學
TAIPEI MEDICAL UNIVERSITY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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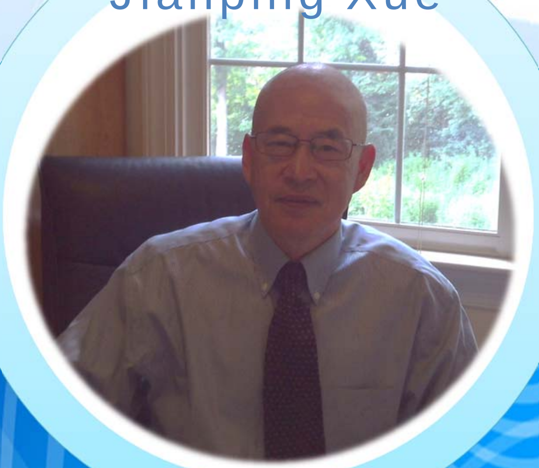
臺北醫學大學醫學綜合大樓前棟4樓誠樸廳

Karen Bradham

Senior Research Physical Scientist
U.S. Environmental Protection Agency

Jianping Xue



Physical Scientist
U.S. Environmental Protection Agency

Paloma Beamer

Associate Professor
University of Arizona

Time	Speakers	Topic
09:00- 09:30	Registration	
09:30- 09:40	Opening Remarks	
09:40- 09:45	Moderator: Janice Chien	
09:45- 10:30	Karen Bradham (Senior Research Physical Scientist, USEPA)	Soil Contamination – Health Risks and Risk Management Decisions
10:30- 11:15	Jianping Xue (Physical Scientist, USEPA)	Multi-media assessment of lead for USA children with SHEDS-multimedia
11:15- 12:00	Paloma Beamer (Associate Professor, University of Arizona)	Quantification of Diné activity patterns with the San Juan river in the wake of the gold king mine spill

環境及學童健康風險研討會
將於 2017/11/8-9 假張榮發基金會國際會議中心舉行

Karen D. Bradham

EDUCATION

Dec. 2002	**Ph.D. Environmental Toxicology** Oklahoma State University, Stillwater, OK
May 1999	**M.S. Chemistry,** Western Carolina University, Cullowhee, NC
May 1997	**B.S. Chemistry,** St. Andrews Presbyterian College, Laurinburg, NC

BRIEF CHRONOLOGY OF EMPLOYMENT

2011-present

Senior Research Physical Scientist
US Environmental Protection Agency
National Exposure Research Laboratory (NERL)

Current description of research activities

Senior scientist, principal investigator, and technical expert for developing, planning, and implementing bioavailability methods to characterize human exposures to toxic elements from various sources and pathways. Serves as the EPA's Office of Research and Development (ORD) Bioavailability Research team lead and primary point of contact for the Agency and internationally. The team currently consists of expert agency toxicologists and soil scientists, students, technicians, and post-docs located in multiple laboratories across ORD. The bioavailability methods and data are being used to fill critical data gaps identified in the human exposure and risk research of the EPA's ORD Safe and Healthy Communities and Chemical Safety and Sustainability research plans. This research directly supports the Agency's effort to improve the human health program and the scientific basis of human health risk assessments and risk management. Bioavailability research efforts have resulted in 1) development of an inexpensive in vivo model for obtaining arsenic and lead relative bioavailability data; 2) validation of low-cost in vitro methods designed to mimic human gastric conditions and correlate with the in vivo model to reduce reliance on animal testing; 3) identification of mechanisms controlling arsenic bioavailability and arsenic speciation; 4) application of in vivo and in vitro methods development for evaluating nano-materials; 5) the transformation of soil arsenic exposed to in vitro cultured human colon microbiota. This research includes peer reviewed publications, reports, symposia proceedings, data, and methods that have been delivered to USEPA collaborators, including the Department of Housing and Urban Development, USGS, USDA, USEPA Office of Solid Waste and

Emergency Response, Office of Superfund Remediation and Technology Innovation, foreign governments, international collaborators, and USEPA Regional Offices.

Technical Lead Activities:

Co-chair of EPA's Technical Review Workgroup for Metals and Asbestos, Bioavailability Committee (2007-2012 and 2017-current). Invited member of committee from 2003-present. EPA's Technical Review Workgroup for Metals and Asbestos (TRW) Bioavailability Committee was formed to provide technical support to those conducting human health risk assessments at contaminated sites. The Bioavailability Committee serves as primary point of contact, information archive, and repository of outreach materials for the methods recommended in the guidance document. This committee develops new guidance and policy concerning site assessment and cleanup at hazardous waste sites, provides site consultation in support of regional requests, and identifies research needs to address data gaps relevant to contaminant bioavailability in soil site assessment activities. The EPA TRW's Bioavailability Committee website: http://www.epa.gov/superfund/health/contaminants/bioavailability/trw.htm

Technical lead and principal investigator for The American Healthy Homes Survey (AHHS) I and II, a national survey of housing related hazards in U.S. residences. The U.S. Department of Housing and Urban Development (HUD and the National Exposure Research Laboratory (NERL) conducted the first nationwide survey of housing related hazards besides lead and allergens in 2005. This national survey assessed potential housing related exposure to analytes of interest to both agencies (e.g., pesticides, mold, and arsenic concentrations). The AHHS collected environmental and questionnaire data using a stratified nationally representative sampling approach that incorporated 1,131 U.S. residences. Results from this study are being used to generate high quality data filling critical data gaps, reducing the Agency risk assessor's reliance on default assumptions, and providing improved science understandings regarding human exposures to selected pesticides and other persistent pollutants for the U.S. population. This research directly supports the Agency's effort to improve the human health program and the scientific basis of human health and risk management. This research includes peer reviewed publications, reports, symposia, and methods that have been delivered to EPA collaborators, including the U.S. Department of Housing and Urban Development and the Office of Pesticide Programs. AHHS II is currently in review and the start date will be determined soon.

2006-2011 **Physical Scientist (GS-13)**

- US Environmental Protection Agency
- National Exposure Research Laboratory (NERL)

2002-2005 **Postdoctoral Physical Scientist (GS-12)**

- US Environmental Protection Agency

  - National Exposure Research Laboratory (NERL)

PROFESSIONAL SOCIETIES & MEMBERSHIPS

- Associate Editor for the Journal of Environmental Quality
- Co-chair of EPA's Technical Review Workgroup for Metals and Asbestos, Bioavailability Committee
- Member of the Society for Environmental Geochemistry and Health
- Member of the International Society for Exposure Science
- Member of EPA Human Health Assessment workgroup
- Society for Environmental Toxicology and Chemistry (SETAC), Contaminated Soil Advisory Group
- Member of the Bioavailability Research Group of Europe (BARGE)
- Member of the Bioavailability Research Group of Canada (BARC)

AWARDS AND HONORS (select examples)

- 2016 Science and Technology Achievement Award Level II for Development of Cost Effective Models to Accurately Predict Arsenic Bioavailability in Human Health Risk Assessment
- 2015 Office of Research and Development, National Exposure Research Laboratory, Exposure Science Award "For stressing the importance of exposure science in risk assessments by reducing the uncertainty of exposure estimates used by Regional and Program offices in decision making".
- 2014 Science and Technology Achievement Award Level III: Karen Bradham, Clay Nelson, et al., Relative Bioavailability and Bioaccessibility and Speciation of Arsenic in Contaminated Soils. Environmental Health Perspectives/Peer-reviewed, 119(11):1629-1634 (2011).
- 2013 ORD Honor award- Bronze medal- Toxic Elements Team: In recognition for successfully developing a method that has been applied at Superfund sites and included into the SW-846 Compendium of Agency approved methods.
- 2013 ORD Honor Award- ORD Diversity Awards-Non Supervisor; MDAB Analytical Methods for Human Exposure Characterization Team: To an exceptional team that practices the principles of diversity and inclusiveness resulting in a highly efficient and successful research organization.
- USEPA, Promotion to Senior Scientist, Technical Qualification Board, 2012
- 2012 ORD Environmental Justice Award: Community Cumulative Risk Research-Working for Environmental Justice: For incorporating ORD science into community-based tools for environmental justice.
- 2011 ORD Honor Award, Exceptional/Outstanding ORD Technical Assistance to the Regions or Program Offices, ORD West Oakland Research Support Team, for providing integrated transdisciplinary scientific leadership to the sustainable remediation of residential yards to reduce the impact of lead in soils on children's health.
- 2011 ORD Honor Award, Impact Award, ORD's Bioavailability Research Team, for successfully implementing transdisciplinary research and effectively communicating the impact of ORD science within and outside EPA
- 2011 ORD Honor Award for Exceptional/Outstanding ORD Technical Assistance to the Regions or Programs Offices: Federal Equivalent Method (FEM) and Federal Reference Method (FRM) Development for National Ambient Air Quality Standards (NAAQS)
- 2010 Honorable Mention Scientific and Technological Achievement Award (STAA) for research publication: American Healthy Homes Survey: A National Study of Residential Pesticides Measured from Floor Wipes
- US EPA Special Accomplishment Recognition Award, 2009

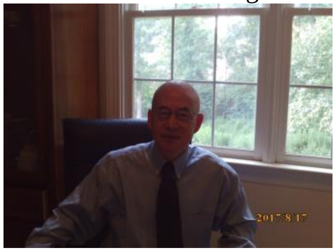
- US EPA Superior Accomplishment Recognition Award, 2009 for contributions to the Tire Crumb Rubber Team
- 2007 US EPA, National Exposure Research Laboratory Special Achievement Award,
  Leader in the Environmental Research Community for "Developing a new in-house research program in the area of Bioavailability"
- 2006 US EPA, ORD Bronze Medal Honor Award for the American Healthy Homes Survey Team in recognition of the outstanding collaborationn between HUD and EPA in pursuing the first nationwide survey of additional residential hazards

RESEARCH INTERESTS

- Research interests include method and model development for use in assessing exposure to soil contaminants for use in risk assessment guidance;
- Development/improvement of risk based environmental chemistry methods for assessing bioavailability to better characterize human and ecological exposure from various sources and pathways;
- Development of techniques to evaluate soil chemical processes and soil components that control bioavailability and/or risk of chemical species ;
- Development of innovative in vitro chemical methods and in vivo models to evaluate the bioavailability and risk of contaminated media;
- Development and evaluation of methods for assessing human exposures to environmental media, including housing related contaminants and mold;
- Investigation of housing related health hazards and human exposures to indoor environments by conducting methods development, measurements, and relating this information to questionnaire data.

COMMITTEE APPOINTMENTS, ADJUNCT FACULTY APPOINTMENTS

- Associate Editor for Journal of Environmental Quality
- Adjunct Assistant Professor, The Ohio State University School of Environment and Natural Resources
- Co-chair EPA's Technical Review Workgroup for Metals and Asbestos, Bioavailability Committee
- Invited external advisor for Taipei Medical University (TMU) studies on children's soil and dust ingestion exposure factors program in Taiwan
- National Institutes of Health scientific planning committee for arsenic
- Advisor for National Ambient Air Quality Standards (NAAQS)
- National Center for Environmental Assessment planning committee for exposure science
- Member of the Bioavailability Research Group of Europe (BARGE)
- Member of the Bioavailability Research Group of Canada (BARC)



Jianping Xue

EDUCATION

M.S., School of Public Health, Harvard University, Boston, USA, 1989-1990
M.S., Department of Public Health, Tongji Medical University, Wuhan, P.R.China, 1983-1986
M.D., Nanjing Medical School, Nanjing, P.R. China, 1978-1983

PROFESSIONAL EXPERIENCE

Physical Scientist, NEAL, ORD, EPA 2000-present
Embassy Science Fellows, Consulate General of the United States of America, August to November 2008,
Senior Programmer, Genetics Institutes, American Home Product, 1998-2000
Research Specialist, Research Associate, Dept. Environmental Health, Harvard School of Public Health, 1991-1998
Research Specialist, Energy & Environmental Policy Center, JFK School of Government, Harvard University, 1990-1991
Senior Researcher, Jiangsu Disease Prevention and Control Center, P.R of China, 1986-1989

CERTIFICATIONS

ECFMG Certificate, May, 1996

AWARDS

2014 Honorable mention: Scientific and Technological Achievement Awards (STAA award)
2012 Level II STAA award
2012 Bronze medal for commendable service: PCBs in schools needed for reducing risks to children and staff
2011 1 Level III STAA award
2011 2 Level III STAA award
2011 Special achievement award NERL
2010 Level I STAA awards
2010 Bronze medal for commendable service: SHEDS-multimedia human exposure modeling team
2010 Special achievement award NERL
2009 NERL Teamwork award

2009 Special achievement award NERL
2009 NERL goal 1 award, support the agency's mission
2009 teamwork award, pyrethroids research team
2008 Level III STAA award

RESEARCH EXPERIENCE

Principal investigator: EPA ORD Multimedia Exposure Analysis to Inform a Public Health-Based Value for Lead in Drinking Water

Principal investigator: EPA NERL Flint water lead contamination analyses

Principal investigator: Tire Crumb research study (TCRS)

Principal investigator: Assessing Environmental Health Disparities in Vulnerable Groups (SHC project 2.63.4)

Principal investigator: Assessing Environmental Health Disparities in Vulnerable Groups (SHC project 2.63.6)

Principal investigator for SHEDS-Multimedia (linked with PK or PBPK models) applied to support higher tier assessments (CSS 2.3.2)

Principal investigator: Linked SHEDS and PBPK modeling system for supporting FQPA cumulative risk (CSS 4.1.1)

Principal investigator: a refined meta-analysis of near-road air pollutants for developing traffic indicators for exposure assessment (ACE 055)

Environmental expert in Consulate General of the United States of America in Guangzhou of P. R. of China to coordinate environment scientists and personals in the Consulate General on the China environmental pollutions focusing water, soil, food. I submitted 3 cables to US state department on the seriousness of water, soil and food pollution and its potential effect on US imports from China.

Principal investigator for EPA/ORD/NERL's Stochastic Human Exposure and Dose Simulation Model (SHEDS-multi-media), a population-based model for estimating aggregate exposure and dose of children to pesticides in response to the Food Quality Protection Act of 1996

Principal investigator for Pyrethroid project: assessing aggregate and cumulative exposure of children to pyrethroids, collaborating with EPA Office of Pesticide Programs (OPP) and Office of Research and Development (ORD) scientists as part of ORD's Safe Foods Research project to develop the SHEDS component of a source to risk assessment for pyrethroids.

Principal investigator for Organophosphates project: assisting OPP on the OP cumulative risk assessment from dietary and water.

Principal investigator for N-methyl Carbamates project: assisting OPP on the N-methyl Carbamates cumulative risk assessment from dietary and water.

Principal investigator for CCA project: Assessing Children's Exposure to Arsenic and Chromium from CCA-Treated, at request of EPA's Office of Pesticide Programs (OPP), Antimicrobials Division (AD)

Principal contributor to a multi-year project sponsored by the US EPA, entitled "The National Human Exposure Assessment Survey (NHEXAS)." The goal of this comprehensive study is to pilot and implement methods to assess the frequency, magnitude, duration, distribution, and determinants of human exposures to multiple environmental contaminants in the US.

Principal contributor to an HEI sponsored study on respiratory effects of chronic ozone exposure in children being conducted in Nashville, TN.

Principal contributor to an ongoing Superfund Exposure and Risk Assessment project sponsored by Argonne National Laboratory with U.S. Dept. of Energy funding. This project involves developing probabilistic exposure assessment models to characterize the distribution of population exposures and risks from exposures to a large number of pollutants (metals, VOCs, and PAHs, uranium, thorium, radium, DNT, TNT, etc).

Principal contributor to an NIEHS-sponsored study on Acid Aerosol Exposure Assessment and Health Effects. Retrospective evaluation of cross-sectional mortality data associations with estimated levels of acid aerosol concentrations over a three-year period.

Principal contributor to epidemiologic study sponsored by Health and Welfare, Canada. This study examined the association between daily pollution and mortality in greater Toronto, Canada using 20 years of data.

Principal contributor to the Harvard component of a multi-year research program between 1988 and 1993 on Particle Exposure Assessment sponsored by the US EPA and performed under subcontract to RTI, Inc. The project was entitled, "The Particle Total Exposure Assessment Methodology Study" (PTEAMS), and was conducted near Los Angeles, CA. The study involved the design, installation, and operation of personal air monitoring equipment for particles, nicotine and trace metals as well as multivariate data analysis. The objective of these assessments was to quantify the nature of population exposures to various sources of particles.

Data manager and analyst for a completed project designed to evaluate air pollutant exposures and health effects in children residing in the Kanawha Valley of WV. Ongoing field study sponsored by the National Institute for Chemical Studies, Inc. with EPA funding. Questionnaires and time-activity diaries were developed and administered to a large cohort of children. Indoor, outdoor, and personal monitoring for VOCs, acids, particles, and other pollutants was also conducted.

Principal investigator of a study on indoor air pollution effects on respiratory function in children residing in Nanjing, P. R of China, 1987-1988.

Project manager, risk assessment of Yizheng Chemical Fiber Company, P.R. of China 1986-1989

Principal investigator of a study of lead pollution from the Gaoyou Smelter and impacts on children's health, 1988-1989.

Paloma I. Beamer

Curriculum Vitae

Community, Environment and Policy
Mel and Enid Zuckerman College of Public Health
University of Arizona
1295 N. Martin Ave.
P.O. Box 245210
Tucson, AZ 85724
(520) 626-0006
pbeamer@email.arizona.edu

CHRONOLOGY OF EDUCATION

2000 B.S., Civil and Environmental Engineering, University of California, Berkeley

2002 M.S., Civil and Environmental Engineering, Stanford University

2007 Ph.D., Civil and Environmental Engineering, Stanford University
Research Advisor: James O. Leckie
Dissertation: "Development of a Model to Estimate Aggregate and Cumulative Exposure and Dose in Young Children"

2014 Graduate Certificate, Clinical & Translational Research, University of Arizona

CHRONOLOGY OF EMPLOYMENT

1997-1999 *Instructor, Tutor,* Mathematics, Engineering, and Science Achievement (MESA), University of California, Berkeley

1997 *Intern*, US-Mexico Border Team, US Environmental Protection Agency, Region 9, San Francisco, CA

1999 *Intern*, Lawrence Livermore National Laboratory, Livermore, CA

1999-2000 *Intern*, Eisenberg, Olivieri & Associates, Oakland, CA

2000-2007 **Stanford University**

- 2000-2007 *Research Assistant*, Exposure Research Group, Department of Civil and Environmental Engineering
- 2001-2003 *Instructor, Coordinator, Mentor,* NASA Research in Science and Engineering Program
- 2001-2004 *Teaching Assistant*, Department of Civil and Environmental Engineering
- 2005 *Lecturer,* Civil and Environmental Engineering, Stanford University

2004 *Intern*, ALZA Corporation, Menlo Park, CA

2007-present **University of Arizona**

- 2007-2014 *Assistant Professor*, Division of Community, Environment and Policy, College of Public Health

2007-present	*Associate Investigator*, Cancer Prevention and Control, Arizona Cancer Center
2009-present	*Full Member*, Southwest Center for Environmental Health Sciences
2009-2014	*Assistant Professor,* Chemical and Environmental Engineering (NTE)
2010-present	*Affiliated Faculty*, Mexican American & Raza Studies Department
2014-present	*Associate Professor,* Division of Community, Environment and Policy, College of Public Health
2014-present	*Associate Professor*, BIO5 Institute (NTE)
2014-present	*Associate Professor,* Chemical and Environmental Engineering (NTE)
2015-present	*Associate Scientist*, Asthma and Airways Disease Research Center

HONORS AND AWARDS

At previous rank:

1995-2000	*Regent Scholar*, University of California, Berkeley
1996	*Outstanding Freshman*, Hispanic Engineers and Scientists (SHPE), University of California, Berkeley
2000	*Kennedy Interdisciplinary Award*, Latin American Studies, University of California, Berkeley
2000	*Lifetime Achievement Award*, Hispanic Engineers and Scientists (SHPE), University of California, Berkeley
2000	*Engineer-In-Training (EIT) Certification*, State of California, Department of Consumer Affairs, Board for Professional Engineers, Land Surveyors and Geologists
2000-2002	*Dean's Doctoral Diversity Fellowship*, Stanford University
2000-2002	*Alfred P. Sloan Scholar*, Stanford University
2002-2004	*Fellow*, National Institute of Health Graduate Training Program in Biotechnology, Stanford University
2004	Student Research Poster Competition, 1st Place, International Society of Exposure Analysis (ISEA) Conference, Philadelphia, PA
2005	Student Research Poster Competition, 2nd Place, Engineering Opportunity Job Fair, Stanford University
2005	*Graduate Student of the Year Award*, Stanford Society of Chicano/Latino Engineers and Scientists (SHPE)
2006	Selected for Graduate Institute at the National Technical Career Conference for Society of Hispanic Engineers (SHPE), Orlando, FA
2006	Selected as one of 55 attendees from a group of over 730 applicants to attend the NSF ADVANCE Workshop on Negotiating the Ideal Faculty Position at Rice University

<u>*At current rank*</u>:

2010	*Travel Award*, Hispanic/Latino Immigrant Health and Faculty Development Workshop, Hispanic-Serving Health Professions Schools
2010	*Young Investigator Research Award*, Yuma Friends of Arizona Health Sciences Center, University of Arizona.
2011	*Mentored Quantitative Research Development Award (K25)*, National Heart, Lung and Blood Institute, National Institutes of Health
2011	*2010 Scientific Technological Achievement Award*, Level I, United States Environmental Protection Agency
2012	*Award for Excellence in Research*, Mel and Enid Zuckerman College of Public Health, University of Arizona
2012	*"40 under 40" Award Recipient*, Arizona Daily Star (newspaper) and Tucson Hispanic Chamber of Commerce
2013	Nominee for *Award for Excellence in Teaching*, Mel and Enid Zuckerman College of Public Health, University of Arizona
2014	*Emerging Investigator*, Themed Issue, Environmental Science: Processes & Impacts, Volume 16, Issue 6.
2015	*Public Voices Fellow*, The OpEd Project, Women's Foundation of Southern Arizona

SERVICE/ OUTREACH (limited to period in rank)

<u>Local/State Outreach</u>

Local/State Service Contributions:

2015	Peer Review, Arizona Cooperative Extension publication
2015 – present	Member, Environmental Quality Advisory Council, Pima County Department of Environmental Quality
2016	Consult to Dr. Francisco Garcia, Director of Pima County Health Department, regarding use of recycled asphalt pavement.

Community Presentations:

2011	Speaker, Green Valley Respiratory Rally, American Lung Association, "Tools for Understanding Air Quality and COPD"
2011	Participant, A Community Health Talk, Presented by Garden Roots, Dewey-Humboldt, AZ
2011	Speaker, "Beyond the Curves" Community Seminar Series, "Is it Toxic?: Trials and Tribulations of Risk Assessment."
2011	Speaker, Pima Association of Governments, Air Quality Subcommittee Meeting, "Children's Health Problems and Proximity to Roadway Diesel Emissions."
2013	Speaker, Pima Association of Governments, Southwest Air Quality Forum, "Lower Respiratory Illnesses and Diesel Exposure in Tucson."
2014	Speaker and Lab Tour for students from the Western Institute for Leadership Development, charter high school, Tucson, Arizona.

2016 Speaker, Weekly Brown Bag Series, Arizona Department of Environmental Quality, Office of Border Environmental Protection.

Local Media Interviews:

2010 Article in *Arizona Daily Star*, written by Elena Acoba, Arizona Daily Star, “Crop gardeners shift to spring planting,” January 31, 2010.

2011 Front page lead article in *Arizona Daily Star*, written by Tony Davis, “UA Study: Diesel exhaust here linked to childhood wheezing,” September 27, 2011

2011 KOLD News 13 interview with Barbara Grijalva, “UA scientist’s work aimed at reducing childhood asthma,” November, 2, 2011.

2011 Featured in *Inside Tucson Business*, “People in Action” for US EPA Award, November 11, 2011.

2011 KOLD News 13 interview with Chris Holmstrom, “Bottled water over tap for Latino community in Nogales,” November 22, 2011.

2012 KOLD News 13 interview with Barbara Grijalva, “UA testing breast milk for cancer-causing solvent,” July 30, 2012.

2012 Featured in *Arizona Daily Star*, “Honorees named for 40 Under 40”, December 10, 2012 and “2012 Class Includes Business, Non-Profit Leaders,” December 14, 2012.

2013 Featured in *Green Valley News* article by Kitty Bottemiller, “Poor Air Quality Kicks up Loads of Problems,” May 30, 2013.

2014 Article in *Arizona Daily Star*, written by Stephanie Innes, “Cavities again? Blame the Tucson water system ...,” November 2, 2014.

2015 Included in “UA Experts Can Offer Expertise on Issues Related to Mining Spills”, published by University Relations, August 13, 2015.

2015 Article in *The Voice* published by the Arizona Farm Bureau and written by Julie Murphee, “Arizona Agriculture asks, is EPA Really Competent to Keep Our Water Clean?,” August 19, 2015.

2015 Project featured in *Navajo Times* article by Sunnie Clahchischiligi and Cindy Yurth, “Shiprock approves university study on San Juan,” August 30, 2015.

2016 Featured in article written by Alondra Harris and other UA EHS-TRUE undergraduates that participated in sampling on the Navajo Nation, “Water, Hogans and Rocks,” https://ubrp.arizona.edu/water-hogans-and-rocks/.

2016 Featured in *Arizona Daily Wildcat* article written by Lena Naser, “Navajo find the Gold King mine spill to be both environmentally and spiritually damaging,” April 1, 2016.

2016 Interview with Donovan Quintero for “Researchers measuring effects of mine spill,” in *Navajo Times*, August 18, 2016.

2016 Featured in article written by Karen Francis Begay, Assistant Vice President for Tribal Relations, “Research Team Partners with Navajo Nation to Address Impacts of the Gold King Mine Spill,” in *Tribal Relations E-News*. University of Arizona, Office of Government and Community Relations.

Bioavailability: Human Health and Risk Management Decisions

Karen Bradham, Ph.D.

U.S. Environmental Protection Agency
Office of Research and Development
Public Health Chemistry Branch

Importance of assessing soil contamination

- Assessing the oral ingestion of soil contaminants
- Presence of metals and metalloids in soils
- Risk associated with oral ingestion of metal-contaminated soil
- Presents a challenge for regulators due to widespread soil metal contamination

2011 U.S. Priority list of hazardous substances

1 ARSENIC
2 LEAD
3 MERCURY
4 VINYL CHLORIDE
5 POLYCHLORINATED BIPHENYLS
6 BENZENE
7 CADMIUM
8 POLYCYCLIC AROMATIC HYDROCARBONS
9 PBENZO(A)PYRENE
10 BENZO(B)FLUORANTHENE

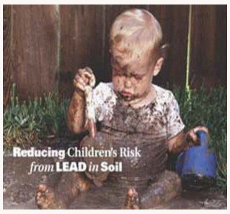
FREQUENTLY OCCURRING AT NPL SITES
TOXICITY POTENTIAL FOR HUMAN EXPOSURE

Soil contamination and bioavailability

- Oral ingestion of soil and dust – "risk driver" for human exposure to metal and other site-specific contaminants
- Bioavailability - critical factor in determining the uptake of contaminants and potential health impacts
- Conventional methods using hot acid digests– do not adequately address metal bioavailability under site conditions
- Bioavailability of metals in soils vary depending on the soil's physical and chemical properties

Definition of bioavailability

- Bioavailability: Fraction of an ingested dose of lead that is absorbed from the gastrointestinal tract and enters the blood and tissues - *can only be measured in living organisms*
- In vitro bioaccessibility (IVBA) – the physiological solubility of the metal that may be available for absorption into the body
- Poorly soluble forms of metals with low bioaccessibility have low bioavailability



http://www.epa.gov/superfund/bioavailability/guidance.htm

Why is biological availability from soil important?

- Absorbed dose (bioavailability) cannot be measured using chemical analytical techniques alone (measured in vivo or estimated using validated in vitro bioaccessibility method)
- Absorbed dose directly relates to contaminant bioavailability
  - contaminant concentration (conventional total)
  - chemical forms of contaminant
  - particle size (fraction that adheres to children's hands)
  - soil properties (pH, cation exchange capacity, amorphous iron and aluminum oxides etc.)
  - exposure duration
  - geochemical matrix incorporating metal species

Site remediation

- Normally, when total concentrations of contaminants are above human health screening levels, the top 12 inches of soil is removed and transported to a hazardous materials landfill
- Cost of soil removal is approximately $1M per acre and the process is time consuming
- Accurate bioavailability-based risk assessment may prevent unnecessary remediation


Importance of bioavailability in risk assessment

- Oral reference doses (RfDs) and cancer slope factors (CSFs) are expressed in terms of ingested dose (rather than absorbed dose)
- Accounting for potential differences in absorption between different exposure media (soil, water, food) is important for site risk assessments
- Metals can exist in a variety of chemical and physical forms and not all forms of a given metal are absorbed to the same extent
- Metal in contaminated soil may be absorbed to a greater or lesser extent than when ingested in drinking water or food
- If the oral RfD or CSF for a metal is based on studies using the metal administered in water or food, risks from ingestion of the metal in soil might be underestimated or overestimated

For more information visit: https://semspub.epa.gov/work/11/175333.pdf

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Using Bioavailability to Assess Human Health Risk of the Soil Ingestion Pathway

For a site specific bioavailability adjustment, the exposure estimate is adjusted when calculating the hazard quotient:	**Exposure estimate can also be adjusted when estimating cancer risk:**
$HQ = \frac{DI \times RBA}{RfD}$ HQ=Hazard quotient DI=Daily oral intake (mg/kg-day) RfD=reference dose RBA=relative bioavailability	CR= (DI x RBA) x CSF CR=cancer risk DI=Daily oral intake (mg/kg-day) CSF= cancer slope factor

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Bioavailable concentration informs clean-up

Contaminant of concern			
Total concentration (example)	**Bioavailability**	**Target concentration for soil clean-up**	**Formula for target concentration**
300 ppm	100% (default assumption)	40 ppm (state specific target)	-
300 ppm	50%	80 ppm	If 50% bioavailable then site can be cleaned to 80 ppm (40 ÷50%)
300 ppm	30%	133 ppm	If 30% bioavailability then site can be cleaned to 133 ppm (40 ÷30%)

Adjusted soil cleanup level still protective of human health

Contaminant of concern			
Arsenic total concentration (example)	**Arsenic Bioavailability**	**Target concentration for soil cleanup**	**Estimated excess lifetime cancer risk**
300 ppm	100% (default assumption)	40 ppm (state specific target)	1 out of 10,000
300 ppm	50%	80 ppm	same
300 ppm	30%	133 ppm	same

Goals of ORD bioavailability research

- Develop bioavailability tools for EPA's Office of Land and Emergency Management (OLEM) and Regional offices
- Develop a less expensive in vivo assay for assessing the bioavailability of arsenic and lead in soil
- Verify in vitro results with in vivo results
- Improve accuracy of human exposure estimates and potentially reduce remediation costs at USEPA contaminated sites

USEPA methods and tools for assessing bioavailability

Mineralogical/characterization/speciation studies
  - Advanced spectroscopic analysis
  - Speciation of the metals at Argonne National Laboratory

In vivo methodologies
  - Quantification of metal present in various tissues and excrement
  - Development of less expensive in vivo model

In vitro methodologies
  - Physiologically-based extraction tests
  - Quick and inexpensive
  - Goal: to avoid or greatly reduce the number of animals needed

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USEPA bioavailability research

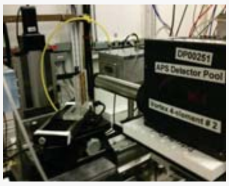
- Evaluate arsenic and lead bioavailability and bioaccessibility
- Soils affected by urban and historical land use activities and NIST standard reference materials
- Total arsenic and lead in soil and biological samples measured by INAA
- Speciation at Argonne National Laboratory, Argonne, IL

USEPA in vivo bioavailability assays

- Mouse as animal model
- Well characterized physiologically
- Large body of data on the absorption, metabolism, distribution, and excretion of lead and inorganic and methylated arsenicals in this species (large amount of EPA research)

USEPA speciation of soils

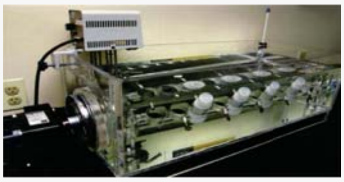
- Materials Research Collaborative Access Team's (MRCAT) beamline 10-ID at the Advanced Photon Source (APS), Argonne National Laboratory (ANL), Argonne, IL
- Principal component analysis coupled with linear combination fitting (LCF)
  - Identify arsenic and lead species in soils
  - Determine if naturally occurring or other source



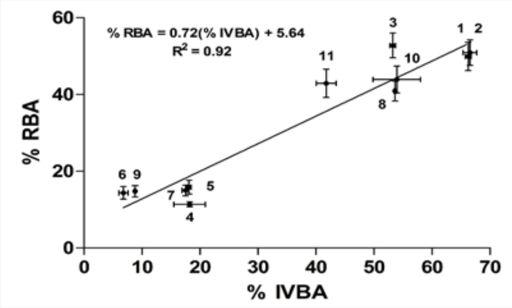
USEPA in vitro testing

- In vitro testing side-by-side comparison with in vivo development
- Soil size fraction < 150 µm
- In vitro extractions conducted using simulated gastric fluid at 37° C for 1 hour

%IVBA = extractable [As or Pb]/soil [As or Pb] x 100



USEPA in vitro/in vivo correlations

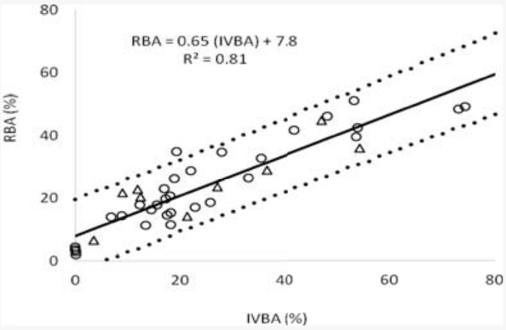


Bradham et al. 2011. Environ. Health Perspectives

Independent data validation for bioaccessibility method

- Validation of model performance using data independent to those used to construct the model
- Predictive capability of the model may be overestimated
- Study conducted to predict arsenic bioavailability
- Validate the predictive capability of this model using an independent set of As-contaminated soils from Australia

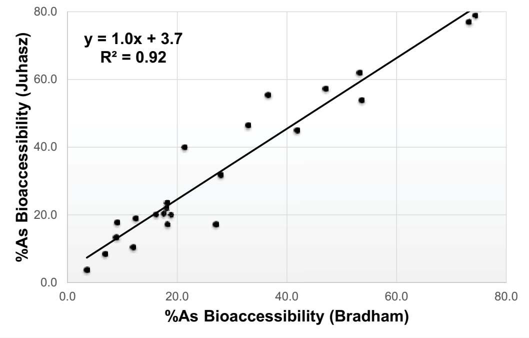
USEPA in vitro/in vivo correlation



Δ Australia soil
O USA soils

Bradham, Juhasz et al 2015 Environ Sci and Technol.

Bioaccessibility reproducibility



Bradham, Juhasz et al 2015 Environ Sci and Technol.

Meta-analysis study

- Several independent investigations of soil As IVBA assays have found that the pH 1.5, 0.4 M glycine IVBA assay yields a strong correlation with *in vivo* RBA measured in mouse and swine (Bradham et al, 2011, 2013, 2015; Brattin et al., 2013; Juhasz et al., 2011, 2014).
- Developed meta-regression model relating soil As RBA and IVBA that is based upon data combined from previous investigations
- Data used to develop the model included paired IVBA and RBA estimates for 83 soils from various types of sites such as mining, smelting, cattle dip, geogenic, and pesticide or herbicide application
- Goal of this analysis was to derive a robust regression function relating IVBA and RBA from an analysis of data from these studies

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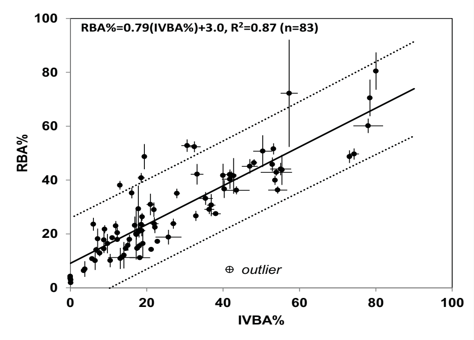
Linear regression model of RBA and IVBA based on pooled data (n=83)



Diamond, Bradham et al, JTEH Part A, 2016

Results of meta-analysis

- Linear regression model accounted for 87% of the observed variance in RBA (R2 = .87): RBA(%) = 0.79 × IVBA(%) + 3.0
- Regression model is robust including large number of soil samples
- Model accounts for variability in RBA and IVBA measurements made on samples collected from sites contaminated with different As sources and research conducted in different labs that have utilized different experimental models for estimating RBA

USEPA guidance and committee

- EPA's Guidance for Evaluating the Bioavailability of Metals in Soils for Use in Human Health Risk Assessment http://www.epa.gov/superfund/bioavailability/guidance.htm
- Recommends collecting site-specific bioavailability data
- Guidance: Pb and As in vivo and in vitro methods accepted for site-specific adjustments
- Lays out a decision framework for incorporating bioavailability information and data collection in human health risk assessments
- Specifies criteria that must be satisfied for validating methods for regulatory use

USEPA Validation Assessment for As IVBA

- Based on the meta-analysis, independent data validation, and other previously published manuscripts, the USEPA recently released the report "Validation Assessment of In Vitro Arsenic Bioaccessibility Assay for Predicting Relative Bioavailability of Arsenic in Soils and Soil-like Materials at Superfund Sites", April 20, 2017, https://semspub.epa.gov/work/HQ/196751.pdf
- The scientific and regulatory rationale for the validation of the arsenic IVBA method are listed in the following reports:
  1) USEPA 2007 Guidance for Evaluating the Bioavailability of Metals in Soils for Use in Human Health Risk Assessment
  2) USEPA's 2012 Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil

EPA Solid Waste Method 1340 Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead in Soil

- Defines analytical procedure for the validated in vitro bioaccessibility assay for lead in soil (method is being updated to include arsenic)
- Estimates of lead RBA are used to adjust bioavailability parameters in lead risk assessment models used in site risk assessment (e.g., Integrated Exposure Uptake Biokinetics [IEUBK] model for Lead)
- Site specific bioavailability data can be entered into the model using the GI bioavailability option allows the user to adjust the GI absorption coefficient to adjust for site specific bioavailability data of lead in the specific media
- EPA has released guidance on incorporating site specific bioavailability data for lead and arsenic: https://www.epa.gov/superfund/lead-superfund-sites-guidance

SW Method 1340 – IVBA for Lead in Soil

- In Vitro Bioaccessibility Assay for Lead in Soil (currently being modified to include arsenic)
- SW-846 *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*: official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with the RCRA regulations
- Methods function as a guidance document setting forth acceptable, methods for the regulated and regulatory communities

Guidance for sample collection for bioaccessibility assay for lead and arsenic in soil

- Provides information on soil screening and selection of soil samples for evaluation using in vitro bioaccessibility assay
- Describes field sampling:
- Number of samples for collection to meet data quality objectives
- Sampling depth
- Sample mass
- Necessary sampling equipment

http://www.epa.gov/superfund/bioavailability/pdfs/IVBA%20Sampling%20Guidance_03-12-15.pdf

Communicating bioavailability of arsenic and lead in soil at contaminated sites

- Not all of the arsenic and/or lead present in the soil is present in a form that can cause harm to human health
- Only bioavailable forms of arsenic and/or lead will be absorbed into the body following exposure
- Understanding bioavailability of contaminants at a site can result in an adjusted soil cleanup level that is equally protective of human health
- There are things people can do to limit exposures to these contaminants

Take simple steps to reduce exposure to contaminated soils or dust

Conclusions

- Bioavailability of metals in soils are <100%
- Importance of bioavailability to improve accuracy of human exposure estimates to inform risk assessments
- Use of bioavailability results in more scientifically sound and economically efficient decisions at contaminated sites
- Risk assessment allows replacement of total concentration data with bioavailability data – resulting in savings

For additional information on USEPA methods and bioavailability, visit the following websites:

Bioavailability Guidance
http://www.epa.gov/superfund/bioavailability/guidance.htm

USEPA Bioavailability Committee
http://www.epa.gov/superfund/bioavailability/trw.htm

USEPA Solid Waste Method 1340
http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/1340.pdf

USEPA Bioavailability Research/Methods and Bioavailability Committee Co-chair: Contact Bradham.karen@epa.gov

Multi-media assessment of lead exposure for USA children with SHEDS-

U.S. EPA Office of Research and Development
Drs. Jianping Xue (NERL), Valerie Zartarian (NERL)

Background

Outbreak of serious Pb exposure from drinking water in Flint, Michigan and from superfund site in East Chicago

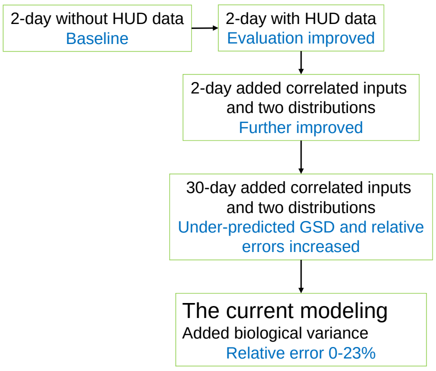
EPA/Office of Water (OW) requested Office of Research and Development (ORD) technical assistance in 2016 with exposure modeling to inform a “health-based benchmark” for lead in drinking water, in response to a NDWAC (National Drinking Water Advisory Council) recommendation regarding the revised Lead and Copper Rule.

Modeling Objectives

- ❖ To determine drinking water Pb concentrations that could keep specified percentiles of simulated national BLL distributions of different aged children below a defined benchmark BLL
    - *using a probabilistic modeling methodology for a multimedia exposure analysis considering Pb in water, soil, dust, food, and air.*
- ❖ In addition, to evaluate the modeled predictions using CDC NHANES and other BLL data; to quantify relative contributions by each media/exposure pathway; and to identify key inputs.

Overview

Blood Pb modeling process



2-day without HUD data
Baseline

2-day with HUD data
Evaluation improved

2-day added correlated inputs and two distributions
Further improved

30-day added correlated inputs and two distributions
Under-predicted GSD and relative errors increased

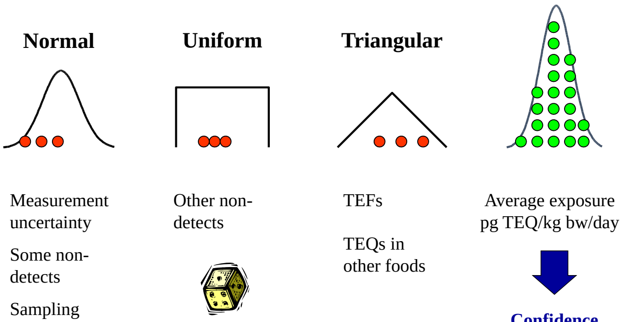
The current modeling
Added biological variance
Relative error 0-23%

Structure of SHEDS

Overview of SHEDS-Multimedia

- **ORD's high-tier Monte Carlo model that considers human exposures probabilistically**
  - Accounts for variability in aggregate (multimedia) population exposures based on realistic activity patterns, concentration distributions, and exposure factors (e.g. intakes)
  - Identifies key factors and relative contribution by exposure pathway for different ages/life stages & population percentiles
- **Scientifically defensible and transparent**
  - Comprehensive model evaluation with different chemicals
  - Multiple external peer reviews through OPP SAPs
  - >30 peer reviewed journal articles
  - Informed OPP decisions for CCA, pyrethroids, OPs, carbamates
  - Code, documentation, & SAP materials on public website

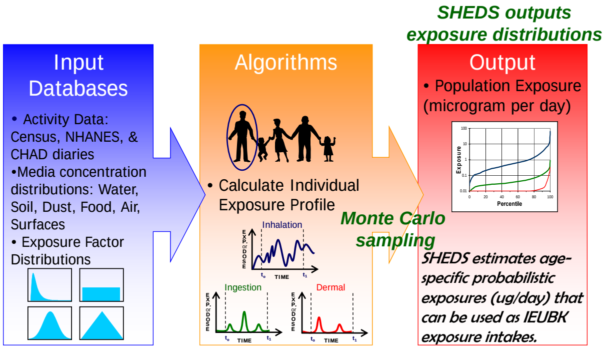
Monte Carlo simulation



Normal	Uniform	Triangular	
Measurement uncertainty Some non-detects Sampling variation (*t*) Consumption	Other non-detects	TEFs TEQs in other foods	Average exposure pg TEQ/kg bw/day

Confidence limits for exposure

SHEDS-Multimedia Model Structure
(provides [ug Pb exposure/day] for IEUBK Coupling)



SHEDS outputs exposure distributions

Input Databases

- Activity Data: Census, NHANES, & CHAD diaries
- Media concentration distributions: Water, Soil, Dust, Food, Air, Surfaces
- Exposure Factor Distributions

Algorithms

- Calculate Individual Exposure Profile

Monte Carlo sampling

Output

- Population Exposure (microgram per day)

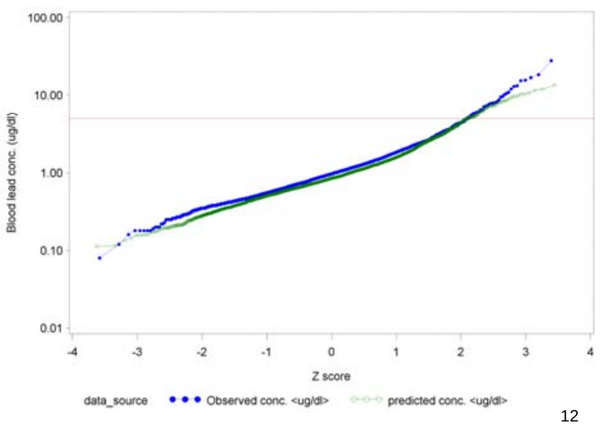
SHEDS estimates age-specific probabilistic exposures (ug/day) that can be used as IEUBK exposure intakes.

Model inputs

Summary of Main Model Inputs

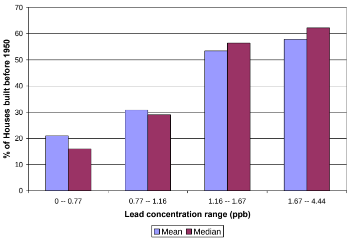
<table>
<tr><th>Variable</th><th>Source</th><th>Values/Distribution Used</th></tr>
<tr><td>Dietary Pb Intake (ug/day)</td><td>Data from FDA Total Diet Study 2007-13 (TDS) & J Spungen, FDA-CSFAN unpublished data for recipe mapping; Method from Xue et al., 2010 <i>EHP</i></td><td>
<table>
<tr><th>Age</th><th>N</th><th>Mean</th><th>Std</th><th>50th</th><th>GM</th><th>GSD</th><th>75th</th><th>95th</th><th>99th</th></tr>
<tr><td>0-6 Month</td><td>1072</td><td>0.70</td><td>0.98</td><td>0.30</td><td>0.27</td><td>4.75</td><td>0.91</td><td>2.71</td><td>3.47</td></tr>
<tr><td>1 Year</td><td>2226</td><td>2.58</td><td>1.84</td><td>2.17</td><td>2.00</td><td>2.16</td><td>3.41</td><td>5.83</td><td>7.63</td></tr>
<tr><td>2 Year</td><td>1788</td><td>3.44</td><td>2.03</td><td>3.06</td><td>2.85</td><td>1.94</td><td>4.49</td><td>7.23</td><td>8.46</td></tr>
<tr><td>3 Year</td><td>1160</td><td>3.54</td><td>2.06</td><td>3.18</td><td>2.98</td><td>1.89</td><td>4.63</td><td>7.26</td><td>8.43</td></tr>
<tr><td>4 Year</td><td>1240</td><td>3.57</td><td>2.16</td><td>3.18</td><td>3.00</td><td>1.87</td><td>4.55</td><td>7.25</td><td>8.63</td></tr>
<tr><td>5 Year</td><td>1066</td><td>3.85</td><td>2.18</td><td>3.43</td><td>3.31</td><td>1.77</td><td>4.83</td><td>7.86</td><td>9.52</td></tr>
<tr><td>6 Year</td><td>1086</td><td>3.80</td><td>2.02</td><td>3.51</td><td>3.29</td><td>1.76</td><td>4.84</td><td>7.55</td><td>8.30</td></tr>
</table>
</td></tr>
<tr><td>Soil and Dust Pb Concs. (ppm)</td><td>Empirical distribution from HUD AHHS 2005-2006 data
http://portal.hud.gov/hudportal/documents/huddoc?id=AHHS_Report.pdf</td><td>
<table>
<tr><th>Media</th><th>House age</th><th>N</th><th>Mean</th><th>Std</th><th>Median</th><th>GM</th><th>GSD</th><th>fited log mean</th><th>fitted log Std</th><th>75th</th><th>95th</th><th>99th</th></tr>
<tr><td>dust</td><td>before 1950</td><td>223</td><td>207.7</td><td>238.2</td><td>113.3</td><td>133.9</td><td>2.47</td><td>4.89</td><td>0.88</td><td>238.6</td><td>706.6</td><td>1108.9</td></tr>
<tr><td>dust</td><td>after 1950</td><td>908</td><td>79.0</td><td>77.2</td><td>64.5</td><td>61.3</td><td>2.00</td><td>4.12</td><td>0.63</td><td>87.1</td><td>195.3</td><td>353.1</td></tr>
<tr><td>soil</td><td>before 1950</td><td>193</td><td>532.2</td><td>912.6</td><td>203.2</td><td>221.1</td><td>3.89</td><td>5.38</td><td>1.30</td><td>574.5</td><td>1841.3</td><td>5792.7</td></tr>
<tr><td>soil</td><td>after 1950</td><td>749</td><td>63.7</td><td>202.0</td><td>19.2</td><td>23.0</td><td>3.37</td><td>3.18</td><td>1.05</td><td>39.9</td><td>207.7</td><td>933.3</td></tr>
</table>
</td></tr>
<tr><td>Soil/Dust Ingestion (mg/day)</td><td>Ozkaynak et al., 2011, <i>Risk Analysis</i></td><td>
<table>
<tr><th>Age</th><th>soil/dust</th><th>mean</th><th>Std</th><th>50th</th><th>GM</th><th>GSD</th><th>95th</th><th>97.5th</th><th>99th</th></tr>
<tr><td>1</td><td>mg_total</td><td>43.9</td><td>54.8</td><td>27.8</td><td>26.6</td><td>2.8</td><td>135</td><td>188</td><td>262</td></tr>
<tr><td>2</td><td>mg_total</td><td>45.2</td><td>58.8</td><td>25.8</td><td>25.9</td><td>3.0</td><td>146</td><td>201</td><td>276</td></tr>
<tr><td>3</td><td>mg_total</td><td>51.7</td><td>64.2</td><td>31.1</td><td>28.9</td><td>3.2</td><td>168</td><td>220</td><td>304</td></tr>
<tr><td>4</td><td>mg_total</td><td>57.8</td><td>75.5</td><td>34.0</td><td>31.6</td><td>3.2</td><td>197</td><td>268</td><td>364</td></tr>
<tr><td>5</td><td>mg_total</td><td>62.6</td><td>79.8</td><td>37.9</td><td>34.4</td><td>3.2</td><td>204</td><td>270</td><td>380</td></tr>
<tr><td>6</td><td>mg_total</td><td>54.3</td><td>76.1</td><td>30.4</td><td>29.2</td><td>3.2</td><td>183</td><td>252</td><td>357</td></tr>
</table>
</td></tr>
<tr><td>Water Consumption (ml/day)</td><td>NHANES 2005-20012</td><td>
<table>
<tr><th>age (years)</th><th>N</th><th>mean</th><th>std</th><th>p50</th><th>GM</th><th>GSD</th><th>p75</th><th>p95</th><th>p99</th></tr>
<tr><td>0-6 months</td><td>1246</td><td>662</td><td>320</td><td>630</td><td>526</td><td>2.5</td><td>854</td><td>1216</td><td>1481</td></tr>
<tr><td>0</td><td>2618</td><td>581</td><td>349</td><td>532</td><td>410</td><td>3.0</td><td>806</td><td>1172</td><td>1489</td></tr>
<tr><td>1</td><td>1792</td><td>247</td><td>247</td><td>219</td><td>151</td><td>3.3</td><td>306</td><td>690</td><td>1148</td></tr>
<tr><td>2</td><td>1948</td><td>300</td><td>312</td><td>251</td><td>176</td><td>3.4</td><td>360</td><td>909</td><td>1424</td></tr>
<tr><td>3</td><td>1272</td><td>316</td><td>313</td><td>257</td><td>193</td><td>3.1</td><td>398</td><td>917</td><td>1640</td></tr>
<tr><td>4</td><td>1358</td><td>320</td><td>333</td><td>261</td><td>197</td><td>3.2</td><td>404</td><td>874</td><td>1434</td></tr>
<tr><td>5</td><td>1196</td><td>364</td><td>366</td><td>303</td><td>213</td><td>3.5</td><td>447</td><td>1037</td><td>1802</td></tr>
<tr><td>6</td><td>1306</td><td>377</td><td>353</td><td>332</td><td>228</td><td>3.5</td><td>480</td><td>1067</td><td>1601</td></tr>
</table>
</td></tr>
<tr><td>Bioavailability</td><td>IEUBK Default</td><td>30% for soil&dust; 50% for water&food</td></tr>
</table>

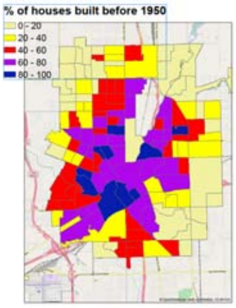
SHEDS-IEUBK Predicted BLL Evaluation with 2009-2014 NHANES blood data



% Flint houses built before 1950 related to Pb in drinking water levels

(regression analysis shows pre-1950 better predictor than pre-1960)





MDEQ data 11/1/15-4/21/16

Impact of House Age on Soil and Dust Pb Concentrations

Media	House age	N	Mean	Std	Median	GM	GSD	fited log mean	fitted log Std	75th	95th	99th
dust	before 1950	223	207.7	238.2	113.3	133.9	2.47	4.89	0.88	238.6	706.6	1108.9
dust	after 1950	908	79.0	77.2	64.5	61.3	2.00	4.12	0.63	87.1	195.3	353.1
soil	before 1950	193	532.2	912.6	203.2	221.1	3.89	5.38	1.30	574.5	1841.3	5792.7
soil	after 1950	749	63.7	202.0	19.2	23.0	3.37	3.18	1.05	39.9	207.7	933.3

Dust and soil Pb conc in ppm. Dust Pb generated from HUD surface residues by method from Appendix G of the EPA Pb NAAQS REA.

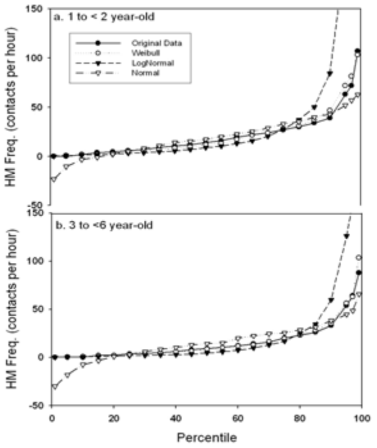
Dust & soil Pb concentrations in houses built before 1950 are ~2.5 & 9 times higher, respectively, than of those built after 1950. ORD is now collaborating with HUD on design of the American Healthy Homes Survey II.

U.S. Department of Housing and Urban Development, (HUD) 2011, American Healthy Homes Survey, American Healthy Homes Survey Lead and Arsenic Findings. Lead concentration data provided by HUD to EPA in 2016 via P. Ashley, Director, Policy and Standards Division, Office of Lead Hazard Control and Healthy Homes, U.S. Department of Housing and Urban Development (2016).

Correlation coefficients inputs for lead exposure assessment

	Dust	Soil	Water
Dust Pb	1	0.48	0.2
Soil Pb	0.48	1	0.2
Water Pb	0.2	0.2	1

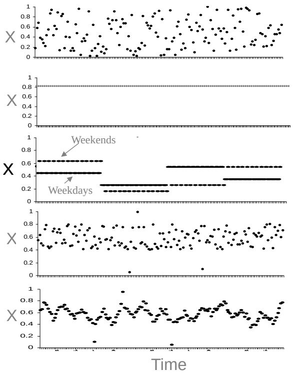
Figure 1. Fits of Alternative Variability Distributions for the Indoor Hand-to-Mouth Frequency Variable



Examples of SHEDS key components

Longitudinal data assemble

Longitudinal Diary Assembly – Overview



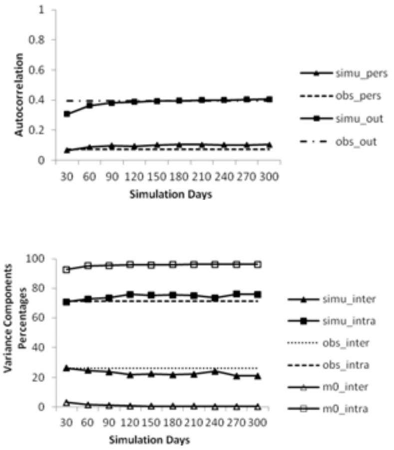
Pick new diary every day

Always use same diary

Option 1 method

Option 2 method
(before autocorrelation between days)

Option 2 method
(diaries reordered to target autocorrelation)



Variance structure adjustment

Calculation of Bio-variability

$(Q_{total})^2=(Q_e)^2+(Q_b)^2$

$Q_{total:}$ total variance
$Q_{e:}$ exposure variance
$Q_{b:}$ biological variance

exposure and biological variances are independent and the distribution is lognormal

$Q_b = [(\ln(GSD_{NHANES\_blood}))^2 - (\ln(GSD_{SHEDS\_prediction}))^2]$

$= [(\ln(1.92))^2 - (\ln(1.64))^2] = 0.185$ (1 years old)

Q_b for 1 to <2 year and 2 to <6 years old are 0.185 and 0.176, respectively

0.22, specified by IEUBK (GSD =1.6 and $(\ln(1.6))^2$=0.22)

SHEDS-MM blood lead conc. Evaluation with 2009-2014 NHANES blood data*
(1-2 years old)

source	N	mean	Std	50th	GM	GSD	95th	97.5th	99th	% higher than 3 ug/dl
Observed	475	1.47	1.30	1.12	1.16	1.92	3.60	5.54	7.90	6.95
Predicted										
*	3000	1.33	0.88	1.11	1.16	1.64	2.95	3.75	4.88	4.87
**	3000	1.46	1.27	1.13	1.16	1.92	3.58	4.60	6.41	7.70
relative error										
*		9%		1%	0%	15%	18%	32%	38%	
**		0%		1%	0%	0%	1%	17%	19%	

longitidunal (3 0days) with correlated key inputs * and ** without and with adding bio-variability

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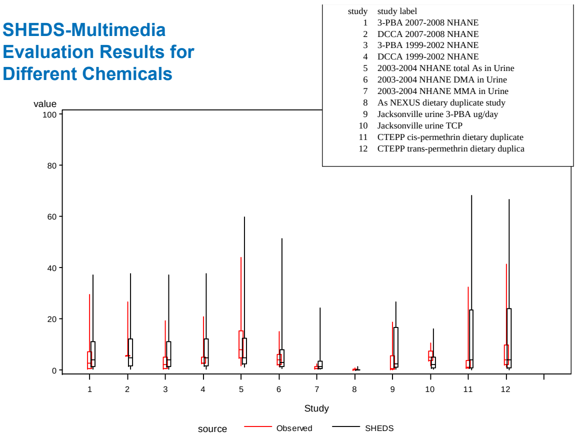
Results

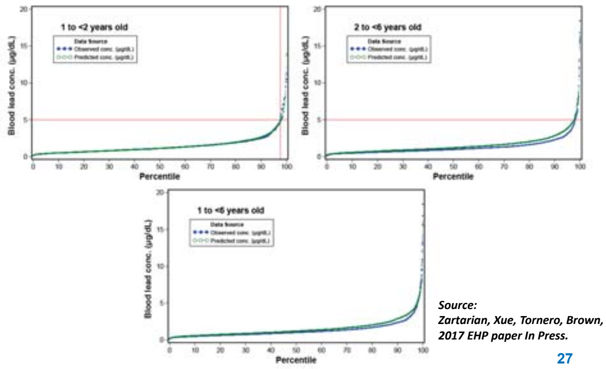
SHEDS-Multimedia Evaluation Results for Different Chemicals



Draft Preliminary Internal

	Ratio of SHEDS over Observed				Relative Error (%)			
Study	Mean	P5	P95	p99	Mean	P5	P95	p99
3-PBA 2007-2008 NHANES	1.24	0.43	1.09	0.93	21	80	8	7
DCCA 2007-2008 NHANES	1.11	0.06	1.36	0.86	11	177	31	15
3-PBA 1999-2002 NHANES	1.14	0.43	1.85	0.98	13	80	60	2
DCCA 1999-2002 NHANES	1.22	0.14	1.78	1.06	20	152	56	6
2003-2004 NHANES total As in Urine	0.99	0.60	1.27	0.96	1	50	24	4
2003-2004 NHANES DMA in Urine	2.11	0.41	3.94	4.73	71	83	119	130
2003-2004 NHANES MMA in Urine	4.53	0.34	10.33	13.29	128	99	165	172
As NHEXAS dietary duplicate study	0.82	0.05	2.14	1.04	19	180	73	4
Jacksonville urine 3-PBA ug/day	2.21	1.65	1.42	1.42	75	49	34	34
Jacksonville urine TCP	0.75	0.13	1.52	1.52	28	155	41	41
CTEPP cis-permethrin dietary duplicate	1.35	0.00	2.16	0.40	30	199	73	86
CTEPP trans-permethrin dietary duplicate	0.80	0.00	1.27	0.47	22	199	24	73

Evaluation of SHEDS-IEUBK Modeled BLL vs. 2009-2014 NHANES BLL data
30-day averaging time; results after addressing biological variability
(0-~23% relative error)



Source:
Zartarian, Xue, Tornero, Brown, 2017 EHP paper In Press.

Evaluation of SHEDS-IEUBK Modeled BLL vs. 2009-2014 NHANES BLL data
30-day averaging time; results after addressing biological variability
(0-~23% relative error)

Age Group	Source	N	Mean	Std	50th	GM	GSD	95th	97.5th	99th	%>3 μg/dl
1 to <2 years old	Observed	475	1.47	1.30	1.12	1.16	1.92	3.60	5.54	7.90	6.95
	Predicted	3000	1.46	1.27	1.13	1.16	1.92**	3.58	4.60	6.41	7.70
	Relative Error		0%		1%	0%		1%	17%	19%	
2 to <6 years old	Observed	1892	1.33	1.60	0.98	1.03	1.89	3.13	4.39	7.15	5.44
	Predicted	3000	1.55	1.28	1.20	1.25	1.88**	3.84	4.94	6.67	8.60
	Relative Error		17%		23%	21%		23%	12%	7%	

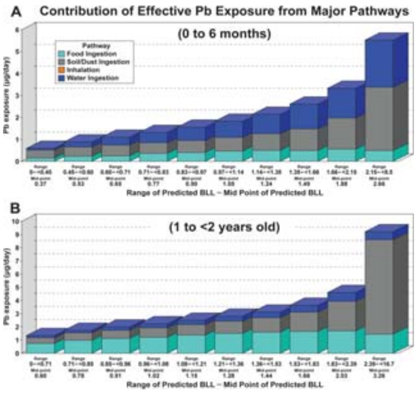
N= sample size. GM = geometric mean. GSD = geometric standard deviation. Relative error is predicted minus observed, divided by observed.

***Longitudinal (30 days) with correlated key inputs.**

****This GSD reflects the effect of exposure and biological variability on BLL**

Source:
Zartarian, Xue, Tornero, Brown, 2017 EHP paper In Press.

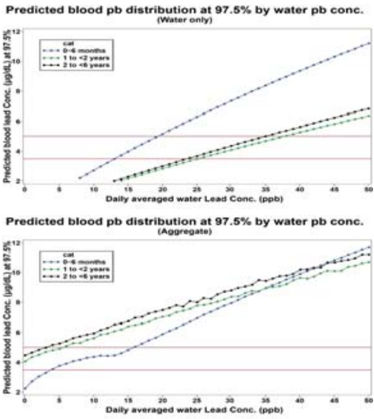
Modeled Contribution of Multimedia Exposure Pathways to BLL
30-day averaging time; results after addressing biological variability



- For higher percentiles, soil/dust ingestion is the major pathway.
- Water ingestion is also an important contributor, especially for infants.
- Food Pb is a background contributor.
- Inhalation pathway contribution is small.

Source:
Zartarian, Xue, Tornero, Brown, 2017 EHP paper In Press.

Example Graphs to Determine Drinking Water Pb Concentrations that Could Keep Children's BLL Below Specified Targets



Source:
Zartarian, Xue, Tornero, Brown, 2017 EHP paper In Press.

SHEDS-IEUBK results for Max. Daily Average* Household Tap Water Pb Concentrations that could keep BLL below specified values

(30-day averaging time; accounting for correlations, biological variability, and other external peer consult and review comments)

Age Group	Exposure Scenario	BBL 3.5 µg/dL @ 97.5th %ile	BBL 5 µg/dL @ 97.5th %ile	BBL 3.5 µg/dL @ 95th %ile	BBL 5 µg/dL @ 95th %ile
0 to 6 months old	Water Only	13.1 ppb	19.3 ppb	14.1 ppb	20.8 ppb
	Aggregate	3.7 ppb	15.8 ppb	6.9 ppb	17.4 ppb
1 to <2 years old	Water Only	25.1 ppb	37.7 ppb	30.9 ppb	46.0 ppb
	Aggregate	-	5.4 ppb	2.5 ppb	14.2 ppb
2 to <6 years old	Water Only	23.6 ppb	35.0 ppb	29.4 ppb	43.6 ppb
	Aggregate	-	2.8 ppb	1.1 ppb	12.1 ppb
0 to 7 years old	Water Only	20.1 ppb	29.5 ppb	27.3 ppb	41.0 ppb
	Aggregate	-	4.7 ppb	2.2 ppb	12.9 ppb

- **Daily avg. of a distribution reflecting real-world monitoring scheme TBD*
- *"-" means BLL will not be below targets even with 0 Pb in water*

Source: Zartarian, Xue, Tornero, Brown, 2017 EHP paper In Press.

Sensitivity analysis

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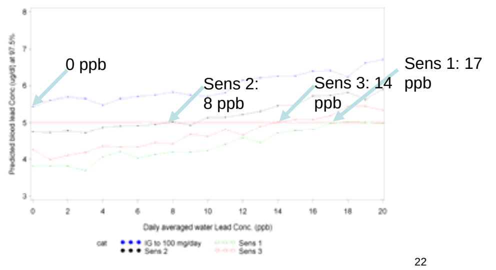
dietary detection value

Sensitivity analyses on Dietary Pb Intake and factors

Secenario	Source	Method	detail
sens 1	FDA	J Spungen, FDA-CSFAN unpublished data	fill in zero for non-detects, 2007-2012 NHANES data
sens 2	FDA	J Spungen, FDA-CSFAN unpublished data	fill in half LOD for non-detects, 2007-2012 NHANES data
sens 3	EPA/ORD/NERL	SHEDS-MM with IEUBK	fill in half LOD for non-detects with food item with any detects and emperical distributions are used and with 942 original soil Pb data
Scenario 2	EPA/ORD/NERL	SHEDS-MM with IEUBK	Fixed dietary inputs and mutiple uniform distributions for soil Pb conc per table 7-5 HUD report
IG to 100 mg/day	EPA/ORD/NERL	SHEDS-MM with IEUBK	Only scale soil and dust ingestion rate into 100 mg/day and other same with Sens 3

Sensitivity Analysis for Soil/Dust Ingestion Rate & Dietary Food Pb Intake

Predicted BLL @ 97.5%ile as a function of Daily Average Household Tap Water Pb Concentration; U.S. Population of 1 to <2 year-olds (AGGREGATE)



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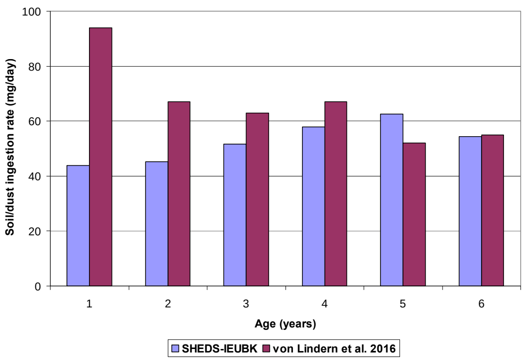
Draft Preliminary Internal

Comparisons of Pb exposure assessments with soil/dust ingestion rate from von Lindern et al. for 1 year olds

Averaged soil/dust ingestion rate comparison



SHEDS-MM blood lead conc. Evaluation with 2009-2014 NHANES blood data*

(1-<2 years old)

source	N	mean	Std	50th	GM	GSD	95th	97.5th	99th	% high than ug/
Observed	475	1.47	1.30	1.12	1.16	1.92	3.60	5.54	7.90	6.
Predicted										
*	3000	1.46	1.27	1.13	1.16	1.92	3.58	4.60	6.41	7.
**	3000	2.19	1.69	1.59	1.81	1.76	5.95	6.99	8.74	18.
relative error										
*		0%		1%	0%	0%	1%	17%	19%	
**		49%		42%	57%	8%	65%	26%	11%	

longitidunal (3 0days) with correlated key inputs *Ozaynak et al. **von Lindern et al. soil/dust ingestion

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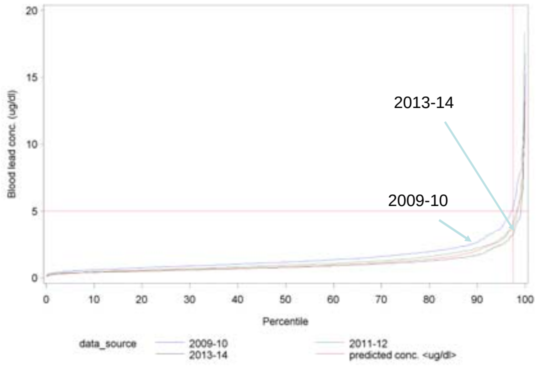
SHEDS-IEUBK BLL Evaluation with 2009-2014 NHANES BLL data for Different NHANES Sampling Periods



Global exposure model inputs

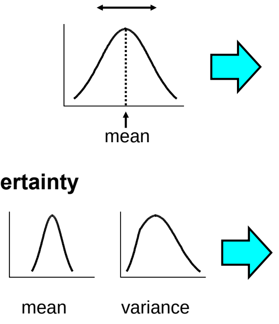
Senstivity analysis by change input individual by 50% (0 to 6 months old)

	Blood Pb Mean (ug/dl)		Blood Pb 97.5th (ug/dl)		Ratio of Upper and Lower	
Inputs	Upper 50%	Lower 50%	Upper 50%	Lower 50%	Mean	97.5th
water intake	1.27	0.86	3.58	2.39	1.47	1.50
water absorption rate	1.28	0.88	3.62	2.46	1.46	1.47
water Pb concentration	1.27	0.87	3.63	2.50	1.46	1.45
soil ingestion rate	1.16	0.98	3.21	2.44	1.18	1.32
soil absorption rate	1.14	0.98	3.31	2.52	1.16	1.31
soil Pb concentration	1.14	0.99	3.21	2.59	1.15	1.24
dust ingestion rate	1.17	0.96	3.19	2.69	1.22	1.19
dust Pb concentration	1.16	0.96	3.12	2.63	1.21	1.19
dust absorption rate	1.17	0.95	3.10	2.70	1.24	1.15
food absorption rate	1.18	0.96	3.11	2.71	1.23	1.15
food Pb intake	1.19	0.98	3.19	3.03	1.21	1.05
air inhalation rate	1.09	1.07	3.05	2.96	1.02	1.03
indoor air Pb concentration	1.07	1.09	2.96	3.00	0.98	0.99
outdoor air Pb concentration	1.08	1.07	2.86	2.92	1.00	0.98

Senstivity analysis by change input individual by 50% (1 -< 2 years old)

	Blood Pb Mean (ug/dl)		Blood Pb 97.5th (ug/dl)		Ratio of Upper and Lower	
Inputs	Upper 50%	Lower 50%	Upper 50%	Lower 50%	Mean	97.5th
soil Pb concentration	1.45	1.20	4.37	2.84	1.20	1.54
soil ingestion rate	1.44	1.20	4.30	2.94	1.20	1.46
soil absorption rate	1.45	1.20	4.22	2.90	1.21	1.46
dust ingestion rate	1.48	1.18	4.44	3.35	1.26	1.33
dust absorption rate	1.48	1.17	4.22	3.20	1.26	1.32
dust Pb concentration	1.46	1.16	4.09	3.14	1.26	1.30
food absorption rate	1.60	1.02	3.84	3.25	1.57	1.18
food Pb intake	1.60	1.06	4.03	3.45	1.52	1.17
water intake	1.39	1.23	3.88	3.43	1.13	1.13
water absorption rate	1.41	1.23	3.75	3.40	1.14	1.10
air inhalation rate	1.33	1.29	3.70	3.43	1.03	1.08
water Pb concentration	1.42	1.24	3.85	3.62	1.15	1.07
outdoor air Pb concentration	1.36	1.32	3.75	3.57	1.03	1.05
indoor air Pb concentration	1.33	1.32	3.55	3.56	1.00	1.00

Uncertainty analysis



Variability

Real natural variation

Determines magnitude & frequency of expected effects

Uncertainty

Limitations in human knowledge

Determines confidence limits for expected effects

e.g.
- **measurement uncertainty**
- **sampling uncertainty**
- **expert judgement**

Figure 2. Uncertainty Bootstrap Distributions for Indoor Hand-to-Mouth Frequency (contacts per hour)

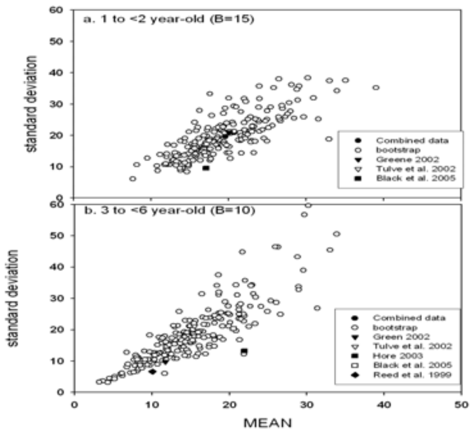
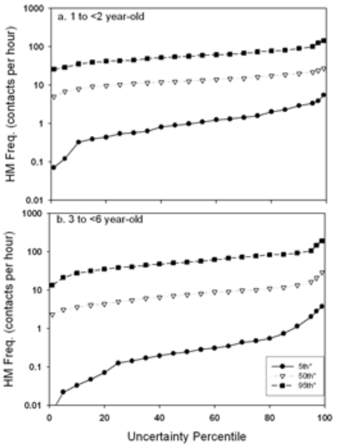
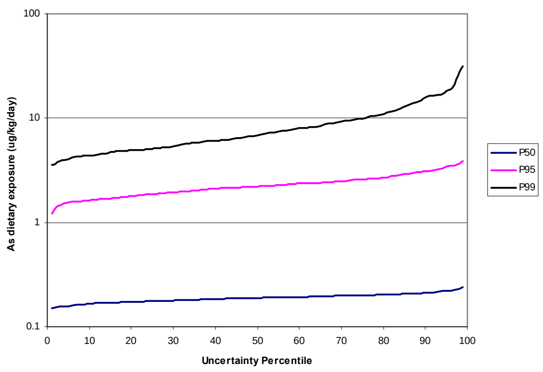


Figure 3. CDFs for 3 selected variability percentiles



Uncertainty of daily dietary exposure of As with 1/8 for As residue and 1/30 CSFII bootstrap



Strengths and Limitations of SHEDS-IEUBK Pb Modeling Approach

Strengths

- ❖ Represents an advance in science
  - SHEDS-Multimedia & IEUBK are published, evaluated models
  - Population-based, probabilistic, multimedia approach enhances understanding of relationship between Pb in drinking water and BLLs
  - Uniquely reports percent contribution to children's BLL by exposure pathway, population percentile, and age group
  - Allows for contribution and sensitivity analyses, and identification of key factors, media, and exposure pathways
  - SHEDS-IEUBK estimates compare well against CDC NHANES BLL data
  - Approach can be applied to other environmental media to inform decision-making considering exposures aggregated from multiple media
- ❖ Reflects scientific input from external peer reviewers

Limitations

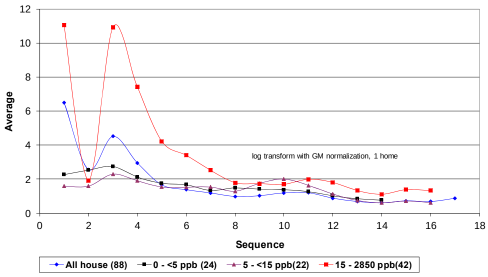
- ❖ Requires selecting a BLL benchmark; CDC reference level may change
- ❖ Requires detailed input data (e.g., distributions rather than point estimates)
  - Uncertainties and limitations in data for key variables
- ❖ Currently intended for national scale analyses

Acknowledgments

- EPA/ORD Managers for providing guidance and review
- EPA/OGWDW and other EPA Program Office staff (e.g., OLEM, OAR) and ORD staff for technical input
- ORD contractors for assistance with model inputs
- Versar and external peer consult reviewers

Supplemental

Sequential water sampling in 88 home measurements

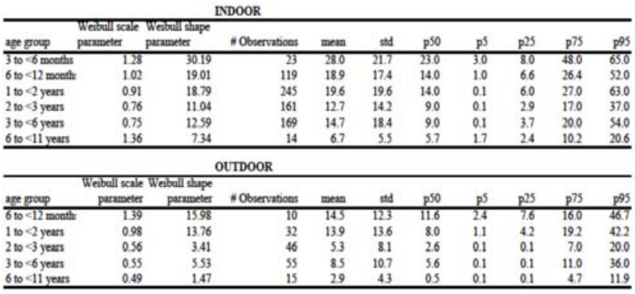


Simple statistics of squential test

Squence	n	detection rate	% higher than 15 ppb	mean	GM
1-5	440	90.0	20.2	28.8	4.4
5-10	440	80.0	18.4	9.7	2.7
10+	406	77.1	12.8	6.9	1.9

Generate longitudinal activity pattern for simulated individual.

- SHEDS constructs activity diaries covering simulation period
- Longitudinal diaries constructed from 1-day CHAD diaries
- Issue: reusing diaries to represent individual's behavior
- Option 1 in SHEDS v.4 uses 8 one-day diaries (Xue et al., 2004)
  - 1 weekend, 1 weekday from 4 seasons; reviewed by 12/03 SAP
  - assumes eight days per year spread evenly across seasons is a reasonable number to use in that it captures most of the relationship between intra- and inter-personal variability with respect to daily time spent outdoors, based on a Southern California study of 160 children.
- Option 2 in SHEDS v.4 uses D&A population statistics (Glen et al., 2007)
  - based on making a new diary selection each day, but altering the selection probabilities to induce set targets for the within-person variance, between-person variance, and day-to-day autocorrelation in a selected key variable from the diaries
  - method presented at 8/07 SAP review of SHEDS-Multimedia v.3



INDOOR

age group	Weibull scale parameter	Weibull shape parameter	# Observations	mean	std	p50	p5	p25	p75	p95
3 to <6 months	1.28	30.19	23	28.0	21.7	23.0	3.0	8.0	48.0	65.0
6 to <12 month	1.02	19.01	119	18.9	17.4	14.0	1.0	6.6	26.4	52.0
1 to <2 years	0.91	18.79	245	19.6	19.6	14.0	0.1	6.0	27.0	63.0
2 to <3 years	0.76	11.04	161	12.7	14.2	9.0	0.1	2.9	17.0	37.0
3 to <6 years	0.75	12.59	169	14.7	18.4	9.0	0.1	3.7	20.0	54.0
6 to <11 years	1.36	7.34	14	6.7	5.5	5.7	1.7	2.4	10.2	20.6

OUTDOOR

age group	Weibull scale parameter	Weibull shape parameter	# Observations	mean	std	p50	p5	p25	p75	p95
6 to <12 month	1.39	15.98	10	14.5	12.3	11.6	2.4	7.6	16.0	46.7
1 to <2 years	0.98	13.76	32	13.9	13.6	8.0	1.1	4.2	19.2	42.2
2 to <3 years	0.56	3.41	46	5.3	8.1	2.6	0.1	0.1	7.0	20.0
3 to <6 years	0.55	5.53	55	8.5	10.7	5.6	0.1	0.1	11.0	36.0
6 to <11 years	0.49	1.47	15	2.9	4.3	0.5	0.1	0.1	4.7	11.9

Table 6. Indoor and Outdoor Hand-to-Mouth Frequency (# contacts/hour) Weibull Distributions from Available Studies

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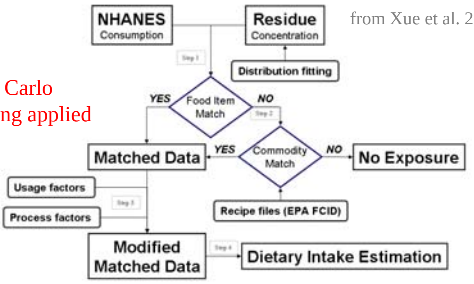
Figure 1 SHEDS Dietary Module Overview

Monte Carlo sampling applied



from Xue et al. 2010, *EHP*

NHANES Consumption:	Food consumption data from NHANES
Residue Concentration:	Residue concentration data by food item or commodity from NYC
Distribution fitting:	fittings of residue data into suitable statistical distribution
Food Item:	food products people in the survey consumed such pizza, raw apple
Commodity:	raw agriculture commodity (RAC)
Usage factors:	Pesticide usage percentages by RAC from USDA.
Process factors:	concentration or dilution factors due to processes of food from RAC into food products.
Recipe files (EPA FCID):	data base for percents of various RACs for the food products.

ORD Multimedia Exposure Modeling Approach to Inform a Health Based Benchmark for Lead

Applied EPA's SHEDS-Multimedia & IEUBK models to simulate real-world aggregate Pb exposures & doses for different scenarios, to determine household tap water Pb concentrations that could keep BLLs below specified values.

- Developed 2 methods to "couple" the models
- Compiled available data for model inputs
- Evaluated model estimates vs. real-world BLLs (e.g., CDC NHANES)
- Identified key exposure pathways and factors via sensitivity analyses
- Addressed comments from a work-in-progress external peer consult
- Submitted paper to *EHP* journal; addressed external reviewer comments

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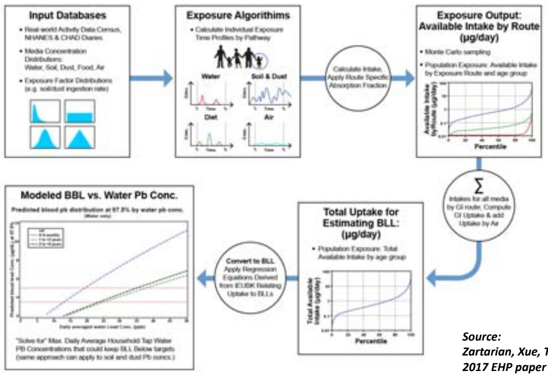
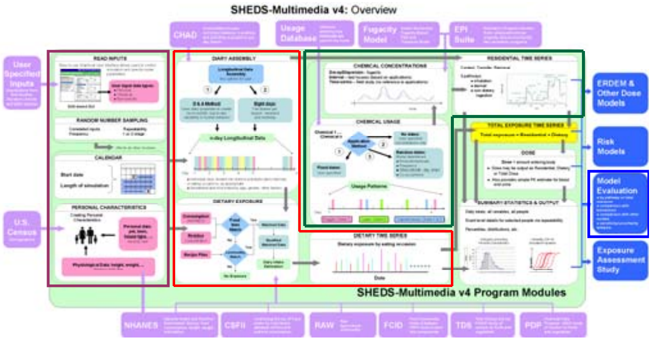
Illustration of ORD SHEDS-IEUBK Modeling to Inform Decisions



Source:
Zartarian, Xue, Tornero, Browi
2017 EHP paper In Press.



Dust & soil ingestion rate (mg/day) by age group and location

type	age group (months)	sample N	mean	Std	p50	GM	GSD	p75
Control location	06-12	2000	29.05	88.8	5.79	5.48	6.50	18.96
Control location	12-24	2000	47.02	129.8	9.15	8.69	6.93	34.81
Control location	24-36	2000	43.40	115.6	8.93	8.61	6.81	34.61
Control location	36-72	2000	35.37	96.4	6.19	6.37	7.02	26.04
near road location	06-12	2000	27.29	77.4	5.92	5.53	6.47	20.24
near road location	12-24	2000	42.10	103.9	9.07	9.11	6.25	32.35
near road location	24-36	2000	45.83	120.7	8.97	9.39	6.42	36.50
near road location	36-72	2000	34.11	89.6	7.37	7.42	6.13	27.18

Dust & soil ingestion rate (mg/day) by soil and activity types

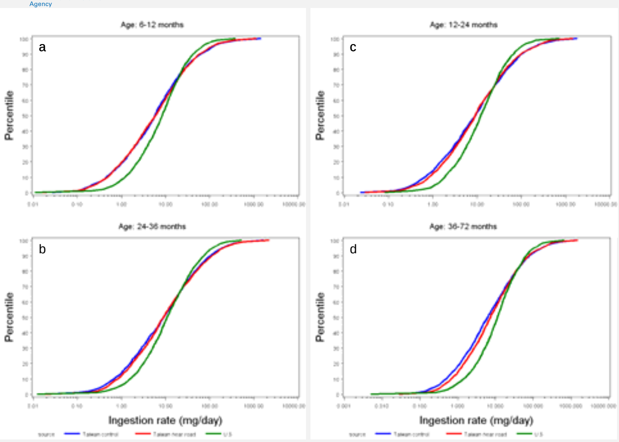
Soil type	Activity	sample N	mean	Std	p50	GM	GSD	p75	p95
Clay	Pre-act	2000	1.92888	3.41301	0.89	0.91	3.38	1.97	7.20
Clay	Indirect	2000	4.36249	11.1893	1.46	1.49	4.20	3.95	17.53
Clay	Direct	2000	25.6589	56.593	8.84	8.14	5.14	24.91	103.13
Sand	Pre-act	2000	1.9193	4.06601	0.95	0.96	3.32	2.19	6.62
Sand	Indirect	2000	9.5321	19.0358	3.39	3.22	4.65	9.49	39.03
Sand	Direct	2000	58.5326	125.229	11.93	10.81	8.05	49.79	290.53

GLM analyses on key factors for soil ingestion rates

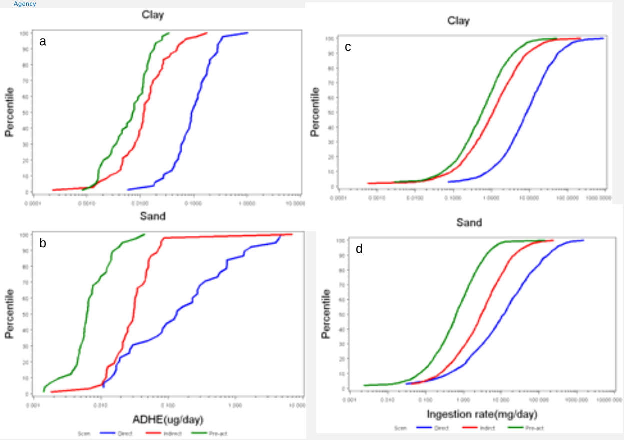
Factors	GLM SS	P value	Statstical significance
Soil aderence factor	9.1E+06	0.000	***
Bath remove rate	1.5E+03	0.467	
Hand to mouth remove rate	7.6E+02	0.604	
Hand soil transfer	1.8E+00	0.980	
Object to mouth transfer	6.3E+01	0.881	
Hand contact ratio	3.8E+05	0.000	***
Hand to mouth freq	1.4E+05	0.000	***
Hand to mouth fraction	1.6E+05	0.000	***
Object in mouth area	3.1E+02	0.741	
Object to mouth freq	1.6E+03	0.454	

GLM SS: sum square statistics from general linear model
*** p value less than 0.001

Total soil ingestion rates by age groups



ADHE and Soil ingestion rate with activity type



Summary of 2016 Work-in-Progress Peer Consult Comments & EHP Journal External Peer Review Comments Addressed

- ✓ Accounted for correlation of Pb in soil/dust & water
- ✓ Considered effects of exposure/dose averaging times and biological variability on estimates of population variability in blood lead
- ✓ Re-analyzed NHANES BLL data with 2 lognormal distributions to examine upper tail; stratified soil and dust Pb data by house age
- ✓ Conducted additional sensitivity analysis for soil/dust ingestion rate
- ✓ Considered incremental risk approach
- ✓ Clarified focus on national scale analysis for general U.S. population

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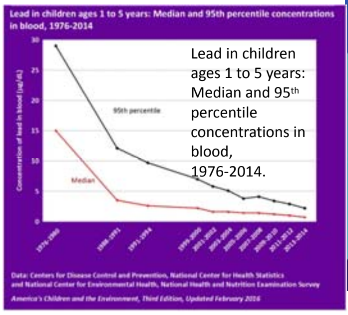
Uncertainty Analyses on CSFII and As residue data

	Uncertainty Ratio (95th vs 5 th)		
Bootstrap	50th	95th	99th
CSFII 1/20 bootstrap	1.19	1.93	3.28
As 1/4 and CSFII 1/10 bootstrap	1.20	1.66	2.43
As 1/4 and CSFII 1/20 bootstrap	1.24	2.03	3.40
CSFII 1/8 bootstrap	1.14	1.51	2.14
As 1/8 bootstrap	1.20	1.31	1.73
As 1/8 and CSFII 1/10 bootstrap	1.26	1.69	2.52
As 1/8 and CSFII 1/20 bootstrap	1.30	1.99	3.87
As 1/8 and CSFII 1/30 bootstrap	1.39	2.22	4.47

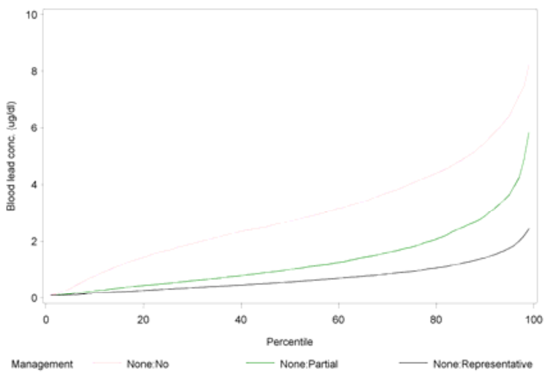
The Need

- Pb is a toxic legacy contaminant which remains a public health priority.
- Multimedia issue requiring a coordinated EPA science-based strategy. (https://www.epa.gov/lead/public-health-approach-addressing-lead)

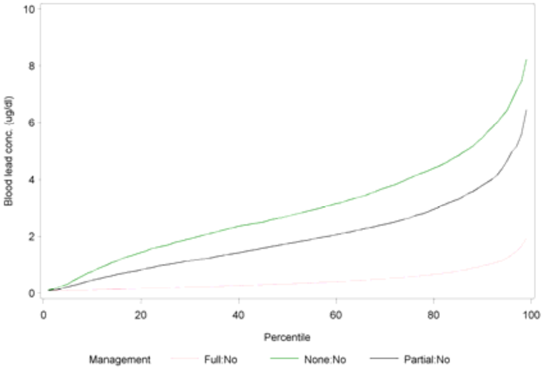


Lead in children ages 1 to 5 years: Median and 95th percentile concentrations in blood, 1976-2014.

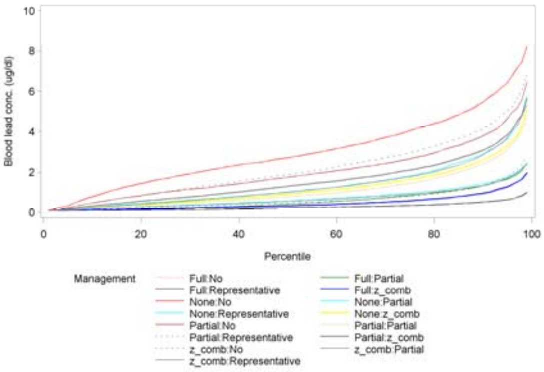
Predicted Blood Lead Conc. (ug/L) for 0 year old



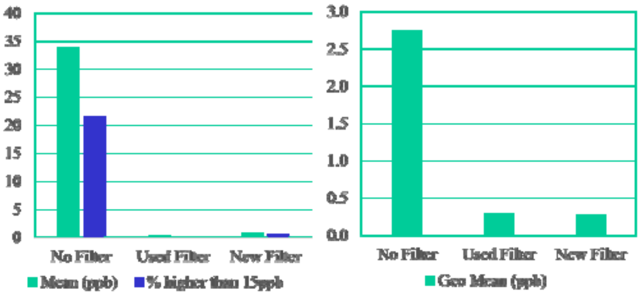
Predicted Blood Lead Conc. (ug/L) for 0 year old



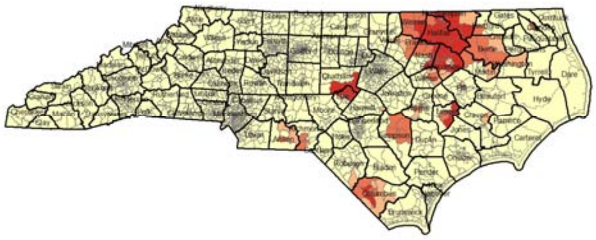
Predicted Blood Lead Conc. (ug/L) for 0 year old



Effect of Filters on
Drinking Water Lead Concentrations in 180 Flint Houses



INTERNAL – DRAFT PRELIMINARY

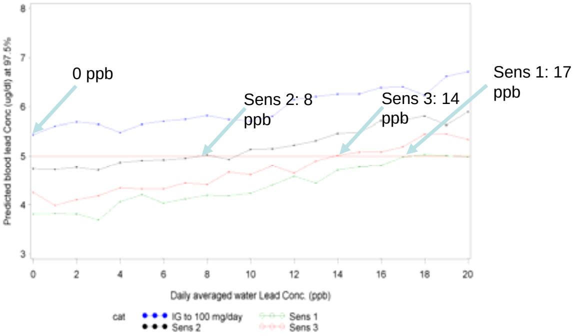


```
                                      Parameter     Standard
Variable      Label         DF       Estimate        Error    t Value    Pr > |t|

Intercept     Intercept      1       -0.00709      0.00393      -1.80      0.0715
LOWINCPCT     LOWINCPCT      1        0.03036      0.00883       3.44      0.0006
MINORPCT      MINORPCT       1        0.02172      0.00483       4.50      <.0001
LESSHSPCT     LESSHSPCT      1        0.01718      0.01456       1.18      0.2380
LINGISOPCT    LINGISOPCT     1       -0.07862      0.02598      -3.03      0.0025
UNDER5PCT     UNDER5PCT      1       -0.10372      0.03504      -2.96      0.0031
OVER64PCT     OVER64PCT      1        0.06791      0.01533       4.43      <.0001
h1950_pct     h1950_pct      1     0.00050419   0.00005771       8.74      <.0001
```

Sensitivity Analysis for Soil/Dust Ingestion Rate & Dietary Food Pb Intake

Predicted BLL @ 97.5%ile as a function of Daily Average Household Tap Water Pb Concentration; U.S. Population of 1 to <2 year-olds (AGGREGATE)



Gold King Mine Spill
Diné Exposure Project

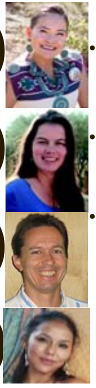
QUANTIFICATION OF DINÉ ACTIVITY PATTERNS WITH THE SAN JUAN RIVER IN THE WAKE OF THE GOLD KING MINE SPILL

YOSHIRA ORNELAS VAN HORNE*, KARLETTA CHIEF, MAE-GILENE BEGAY, NICOLETTE TEUFEL-SHONE, MANLEY BEGAY, NATHAN LOTHROP, PALOMA I. BEAMER

Partnerships:

Funded By: NIH National Institute of Environmental Health Sciences
Agnese Nelms Haury Program in Environment and Social Justice

WHO WE ARE



UNIVERSITY OF AZ

- Karletta Chief
  - Hydrology Professor
- Paloma Beamer
  - Environmental Health Professor
- Dean Billheimer
  - Biostatistics Professor

T BEE NIHI DZIIL

- Janene Yazzie
  - Community Organizer

NORTHERN ARIZONA

- Jani Ingram
  - Chemistry Professor
- Manley Begay
  - Indigenous Studies Professor
- Nicolette Teufel-Shone
  - Health Promotion Professor

NAVAJO CHR

- Mae-Gilene Begay
  - CHR Director

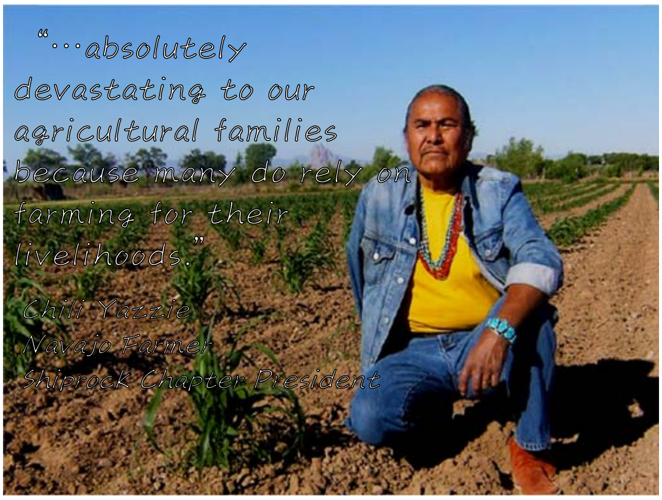
DIN COLLEGE

- Perry Charley
  - Director, Din Environmental Institute

FORT LEWIS COLLEGE

- Becky Clausen
  - Sociology Professor

ct

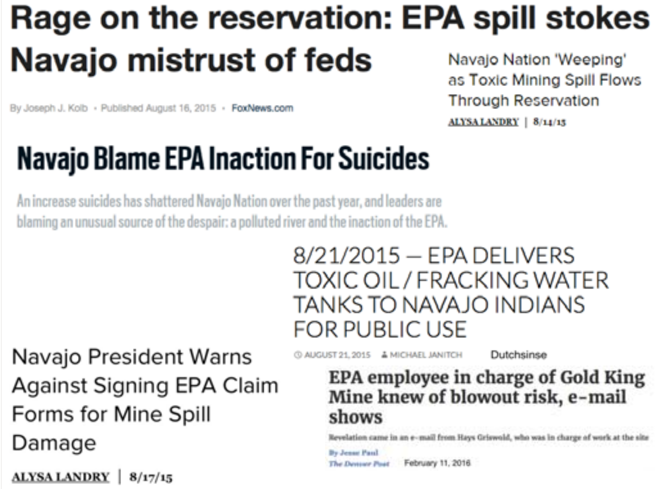


"…absolutely devastating to our agricultural families because many do rely on farming for their livelihoods."

Chili Yazzie
Navajo Farmer
Shiprock Chapter President

“We use the term ‘water is life,’ it’s the lifeline of the people.”

Russell Begaye
Navajo Nation
President



Rage on the reservation: EPA spill stokes Navajo mistrust of feds

By Joseph J. Kolb • Published August 16, 2015 • FoxNews.com

Navajo Nation 'Weeping' as Toxic Mining Spill Flows Through Reservation

ALYSA LANDRY | 8/14/15

Navajo Blame EPA Inaction For Suicides

An increase suicides has shattered Navajo Nation over the past year, and leaders are blaming an unusual source of the despair: a polluted river and the inaction of the EPA.

8/21/2015 — EPA DELIVERS TOXIC OIL / FRACKING WATER TANKS TO NAVAJO INDIANS FOR PUBLIC USE

AUGUST 21, 2015 MICHAEL JANITCH Dutchsinse

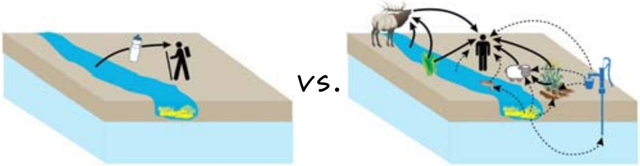
Navajo President Warns Against Signing EPA Claim Forms for Mine Spill Damage

ALYSA LANDRY | 8/17/15

EPA employee in charge of Gold King Mine knew of blowout risk, e-mail shows

Revelation came in an e-mail from Hays Griswold, who was in charge of work at the site

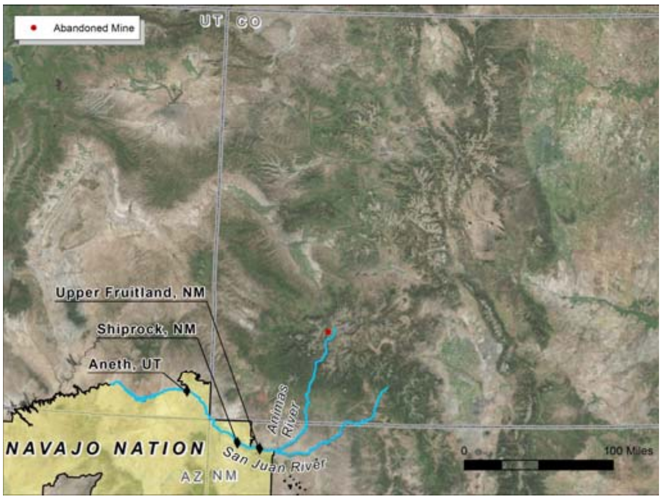
By Jesse Paul
The Denver Post February 11, 2016



EPA Perception

vs.

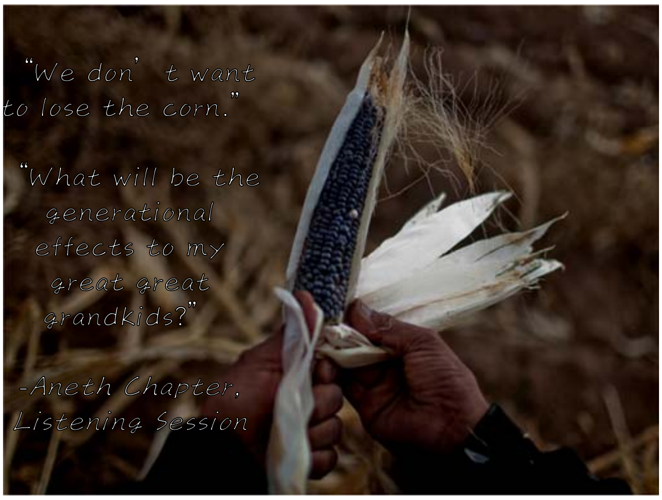
Din Reality



What to Do About 500,000 Abandoned Mines Around the US?

Saturday, 05 September 2015 00:00

By Judy Molland, Care2 | Op-Ed



“We don’t want to lose the corn.”

“What will be the generational effects to my great great grandkids?”

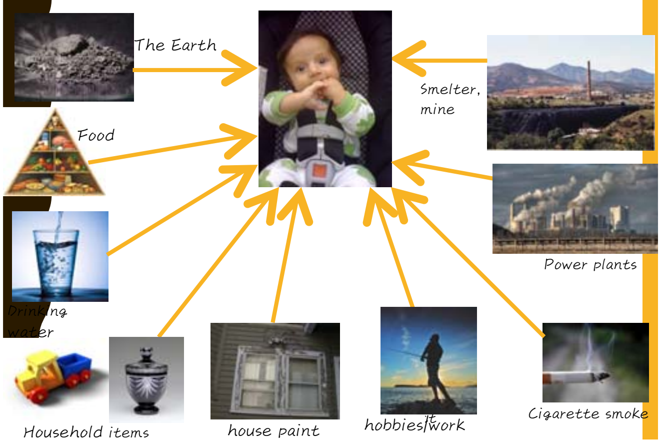
-Aneth Chapter, Listening Session

"We need our own data to communicate to the world our own perspective on our own crises and trauma."
- Teach-In

THE PROBLEM

- EPA contractors released 3 million gallons of acid mine drainage into the Animas and San Juan Rivers, which flow through the Navajo Nation
- EPA hauled in water contaminated with oil for crop irrigation and live stock
- The result?
  - Very high community concern about human exposures, but also their crops, livestock and the wildlife for which there is a strong connection
  - Much community debate about using the river water again. Many are still without water and have lost their crops.
  - Very high perception of risk
  - Very high lack of trust in outside entities

OTHER POTENTIAL SOURCES OF EXPOSURE



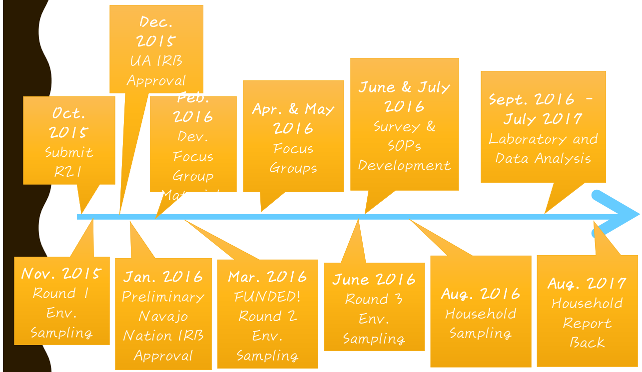
PROJECT GOALS

1. Understand Human Exposure to the Spill
   - Household Environmental Samples for Arsenic and Lead
   - Personal Samples of Urine for Arsenic and Blood Lead tests
   - Survey on activities involving the River
2. Find out levels of Arsenic, Lead, and Manganese in Environmental Samples from 3 Chapters for one year
3. Survey what people think about risk from the Spill and report back measured risks

---

PROJECT AREA

TIMELINE & ACCOMPLISHMENTS



Oct. 2015 Submit R21

Nov. 2015 Round 1 Env. Sampling

Dec. 2015 UA IRB Approval

Jan. 2016 Preliminary Navajo Nation IRB Approval

Feb. 2016 Dev. Focus Group Ma

Mar. 2016 FUNDED! Round 2 Env. Sampling

Apr. & May 2016 Focus Groups

June 2016 Round 3 Env. Sampling

June & July 2016 Survey & SOPs Development

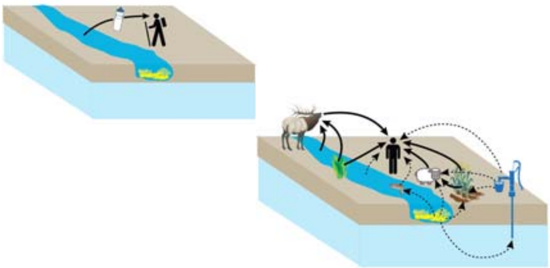
Aug. 2016 Household Sampling

Sept. 2016 - July 2017 Laboratory and Data Analysis

Aug. 2017 Household Report Back

GOAL

- To identify activities between the Diné and the River, and to assess changed in activity pattern as a result of the Gold King Mine Spill.



Gold King Mine Spill
Diné Exposure Project

METHODS

BUILDING TRUST IN THE COMMUNITIES

> *"I need to know people are taking action to do something together for the water because we need to …"*
>
> *- Teach-In*

FOCUS GROUPS

- May 13-22; June 15 & 17, 2016
- 12 Focus groups
  - Upper Fruitland, NM……4
  - Shiprock, NM……………6
  - Aneth, UT………....……..2
- 123 Total Participants
- Transcription
  - All English transcribed
  - Translating from Navajo (4.5 hou total; 43% translated)
- 42 activities identified by consensus panel

GOLD KING MINE SPILL
EXPOSURE AND RISK PERCEPTION STUDY

SEEKING FOCUS GROUP PARTICIPANTS

Upper Fruitland
Wed. June 15
@ 6 PM

Aneth
Fri. June 17
@ 10 AM

FOR MORE INFORMATION CONTACT
Dr. Karletta Chief
1 (520) 222-8801

Janene Yazzie
1 (917) 636-2392

THE UNIVERSITY OF ARIZONA.

METHODS: QUESTIONNAIRE DEVELOPMENT

- Focus groups were attended by community members
- Consensus amongst investigators and facilitators

GOLD KING MINE SPILL
EXPOSURE AND RISK PERCEPTION STUDY

SEEKING FOCUS GROUP PARTICIPANTS

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THE UNIVERSITY OF ARIZONA.

MULTIPLE CATEGORIES FOR WATER USE ACTIVITIES

- Use of the San Juan River water for livelihood purposes
  - *Eating local crops irrigated with water from the San Juan River*
- Recreational use of the San Juan River water
  - *Played in the San Juan River*
- Cultural, ceremonial, or spiritual uses of San Juan River water
  - *Spent time in Taachee (sweats) with steam made from the San Juan River water*
- Use of the San Juan River for arts and craft activities
  - *Made jewelry with natural materials gathered along the San Juan River*

ACTIVITIES IDENTIFIED

Activity Categories	Number
Livelihood	9
Recreational	12
Cultural and Spiritual	14
Arts and Crafts	7
Total	42

EXAMPLE OF PRE-SPILL QUESTIONS

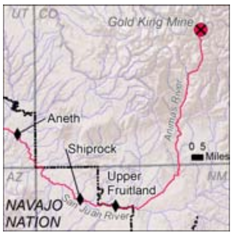
	ENGAGED IN ACTIVITY BEFORE SPILL			SEASON				Frequency of Activity					Duration of Activity			
	YES	NO	DID NOT KNOW	SPRING	SUMMER	FALL	WINTER	1 x Day	4-6 x a week	1-3 x a week	Special occasion	Never	>60 MINUTES	60 MINUTES	30 MINUTES	LESS THAN 30 MINUTES
Played in the San Juan River (e.g., swimming, diving)																
Played in or contacted mud, soil or sediment along the San Juan River																

EXAMPLE OF POST-SPILL QUESTIONS

	LEVEL OF ENGAGEMET IN ACTIVITY AFTER SPILL COMPARED TO BEFORE			SEASON				Frequency of Activity					Duration of Activity			
	LESS	SAME	MORE	SPRING	SUMMER	FALL	WINTER	1 x Day	4-6 x a week	1-3 x a week	Special occasion	Never	>60 MINUTES	60 MINUTES	30 MINUTES	LESS THAN 30 MINUTES
Played in the San Juan River (e.g., swimming, diving)																
Played in or contacted mud, soil or sediment along the San Juan River																

QUESTIONNAIRE ADMINISTRATION

- Partnership with Community Health Representatives from the Navajo Nation
- Administered to participants in 3 chapters of the Navajo Nation



DATA ANALYSIS

❖The frequency of activities was converted into events per week

❖The duration of activities was converted into minutes per day

❖A Wilcoxon signed-rank test was used to determine differences in the number, frequency, and duration of activities before and after the GKMS

❖A Kruskal- Wallis was used to determine if there are differences by age of participants (adults vs child) or chapter

Gold King Mine Spill
Diné Exposure Project

RESULTS

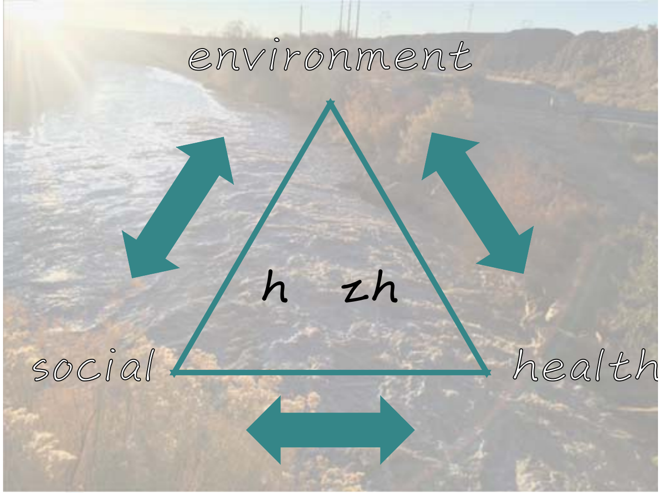
Gold King Mine Spill
Diné Exposure Project

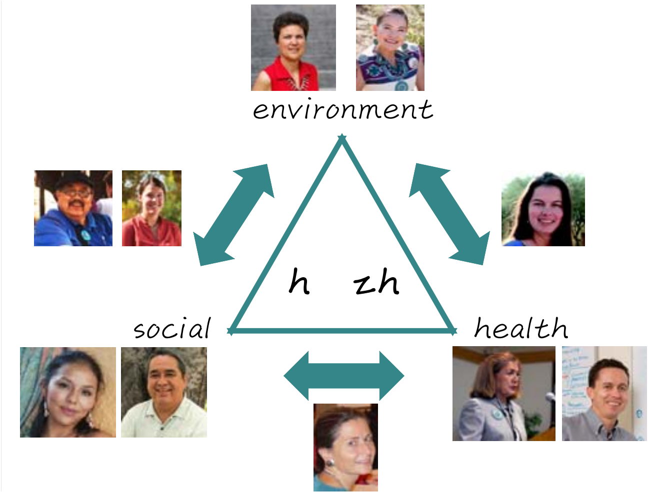
HAURY PROJECT

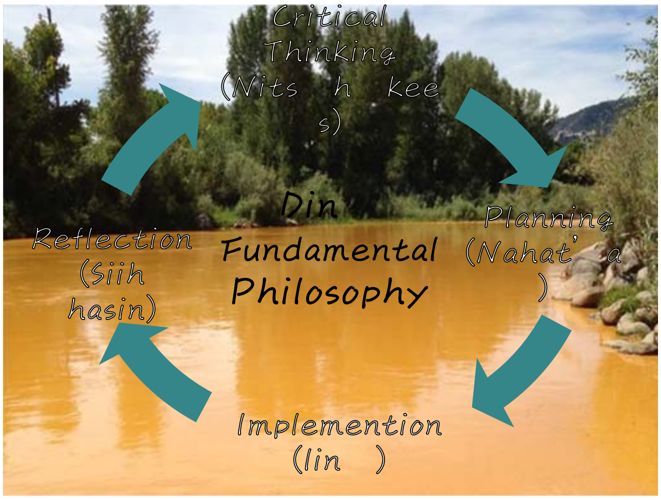
KARLETTA CHIEF, PALOMA BEAMER, JANI INGRAM, DEAN BILLHEIMER, MAE-GILENE BEGAY, MANLEY BEGAY, NICOLETTE TEUFEL-SHONE, PERRY CHARLEY, REBECCA CLAUSEN, AND JANENE YAZZIE

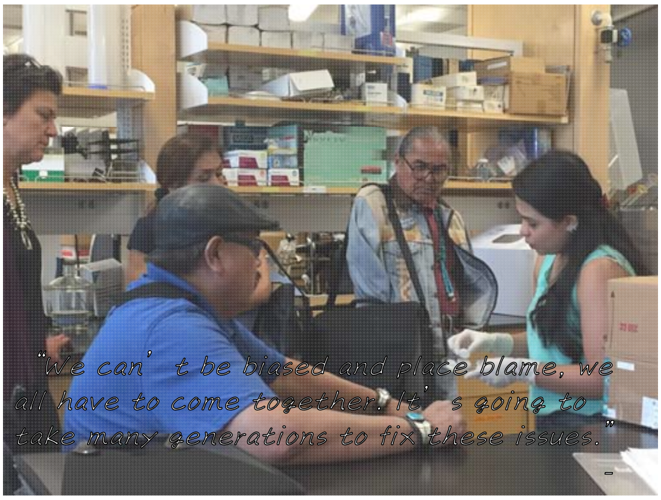
Partnerships:

Funded By: NIH National Institute of Environmental Health Sciences
Agnese Nelms Haury Program in Environment and Social Justice









"We can't be biased and place blame, we all have to come together. It's going to take many generations to fix these issues."

–

FUNDING ACKNOWLEDGEMENT

NIH National Institute of Environmental Health Sciences

1R21ES026948-01

The University of Arizona

Agnese Nelms Haury Program in Environment and Social Justice

Superfund Research Program The University of Arizona

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SOUTHWEST ENVIRONMENTAL HEALTH SCIENCES CENTER

SWEHSC Grant Number - P30 ES006694

Training Grant Number - T32 ES007091

1P20MD006872

CAIR Center for American Indian Resilience

ject

Center for Indigenous Environmental Health Research (CIEHR)

5P50ES026089-02