

## GENERAL PROFESSIONAL BIOGRAPHY

MITCHELL J. SMALL

Professor

Civil & Environmental Engineering/Engineering & Public Policy  
Carnegie Mellon University  
Pittsburgh, PA 15213

### *Vital Statistics*

Born June 11, 1953, Pittsburgh, Pennsylvania

### *Education*

1975 BS in Civil Engineering/Engineering and Public Affairs, Carnegie-Mellon University

1979 MS in Environmental and Water Resources Engineering, University of Michigan

1982 Ph.D. in Environmental and Water Resources Engineering, University of Michigan

### *Current and Previous Positions*

Carnegie Mellon University

Departments of Civil & Environmental Engineering and Engineering & Public Policy

- H. John Heinz III Professor of Environmental Engineering, 2001 - present
- Professor, 1991 - present
- Associate Professor, 1987-1991
- Assistant Professor, 1982-1987
  
- Associate Department Head for Graduate Education,  
Engineering & Public Policy, 1992 - present.
  
- Acting Department Head,  
Engineering & Public Policy, January 1997 - July 1997.

University of Pittsburgh

Department of Environmental and Occupational Health, Graduate School of Public Health

- Adjunct Professor, 1995 - present.

Teaching and Research Assistantships, University of Michigan, 1979-1982.

Engineer, Hydrosience, Inc., 1975-1978.

Research Intern, Allegheny County Health Department, Division of Water Quality, Summer 1974.

*Professional and Honorary Society Memberships*

American Geophysical Union  
 American Society of Civil Engineers  
 Association of Environmental Engineering & Science Professors  
 Chi Epsilon (Civil Engineering Honor Society)  
 International Society of Exposure Analysis  
 International Society for Industrial Ecology  
 Sigma Xi (Research Honorary Society)  
 Society for Risk Analysis

*Recent Professional Activities*

US EPA Science Advisory Board (SAB)

Member, Environmental Engineering Committee, 1985- 1991  
 Consultant to SAB, 1991-present  
 Chair of SAB Environmental Models Subcommittee, 1999-2003.

US EPA ORD Board of Scientific Counselors (BOOSC), 1996 – 2002

Member, EPA ORD Ecosystems Research Division Peer Review Panel

US EPA External Review Panel for ORD National Exposure Research Laboratory, Ecological Research Division, 2007.

Member of National Research Council Committees:

- Hazardous Wastes in Highway Rights-of-Way, 1990-1993
- Remediation Priorities for Hazardous Waste Sites, 1991-1994
- USGS Water Resources Research, 1993-1996.
- Risk Characterization, 1994-1996.
- Environmental Remediation at Naval Facilities, 2000-2002.
- Changes in New Source Review Programs for Stationary Sources of Air Pollutants, 2004-2006.
- Review of Department of Homeland Security's Approach to Risk Analysis, 2008-

Associate Editor, *Environmental Science & Technology*, 1995-present.

Elected Councilor, Society for Risk Analysis (SRA), 1999-2002.

Planning Committee for First World Congress on Risk, Brussels, Belgium, June 2003.

Elected Secretary, 2005-2009.

Chair of DOE Independent Peer Review Committee for Multimedia Models for Use in Programmatic Environmental Impact Statement Risk Assessment, 1994.

Panelist for EPA Risk Assessment Forum review on Selecting Input Distributions for Exposure Assessment, 1997, 1998.

Review Panel Member for NIEHS Superfund Basic Research Program, Subchair for one of nine proposals, 1999.

Scientific Advisory Committee, Harvard EPA Center on Ambient Particle Health Effects, 2000-

EPA Peer Review Committee review of draft *Risk Assessment Guidance for Superfund (RAGS) Volume 3A*, 2000.

Member of EPA Science Advisory Board Review Panel for selection of EPA employees to receive Scientific and Technological Achievement Awards (STAA), 2001.

Member of Review Panel for EPA Superfund Minority Institutions Program on Hazardous Substance Research, 2002.

Member of Jury Panel for the Annual Heinz Award in Technology, the Economy and Employment, 2001, 2002, 2003.

Member of External Peer Review Panel for Evaluation of US Army Corps of Engineers (COE) Risk-Informed Decision Framework for the Louisiana Coastal Protection and Restoration Project (LaCPR), 2006 - .

Independent Third Party Administrator for Peer Consultation Panel on EPA-DuPont PFOA Site Related Environmental Assessment Program, 2008-2009.

Academic Advisory Panels:

University of North Carolina, Department of Environmental Science & Engineering, Graduate Program Review, April 2000.

Member of Review Panel for Helmholtz Gemeinschaft Research Programme in Earth and Environment: Sustainable Use of Landscapes, Leipzig-Halle, Federal Republic of Germany, June 2003.

Chair of Advisory Board for Cranfield University (UK) Research Council/Defra Collaborative Centre of Excellence in Understanding and Managing Natural and Environmental Risks, 2009-.

*Awards and Fellowships*

Appointed as board-certified member of the American Academy of Environmental Engineers (AAEE) by eminence, December 2006.

Elected Fellow of the Society for Risk Analysis (SRA), December 2003.

2003 American Water Works Association (AWWA) Award for the Best Paper in the Small Systems Division, and the 2003 AWWA Publications Award (selected from the divisional winners), for the *Journal of the American Water Works Association* paper, "Point-of-use treatment and the revised arsenic MCL."

Frank Wilcoxon Prize, 1992, American Society for Quality Control – for best practical applications paper in the journal *Technometrics*, "Modeling lake-chemistry distributions: Bayesian methods for estimating a finite-mixture model."

National Science Foundation Presidential Young Investigator Award, 1986-1991.

The Universities Council on Water Resources, Inc., 1982 Award for the Outstanding Water Resources Thesis in the Field of Environmental and Water Resource Engineering.

Horner Award, 1980, American Society of Civil Engineers – for outstanding urban hydrology paper, "Stormwater interception and storage."

College of Engineering Fellowship, University of Michigan, 1978-1979.

Rackham Pre-Doctoral Fellowship, University of Michigan, 1980-1981.

### *Research Interests*

Mathematical modeling of environmental quality: statistical methods and uncertainty analysis; human exposure modeling; indoor air pollution; human risk perception and decision making; integrated assessment models for acid deposition, global climate and sea-level change; ground water and soil pollution monitoring, site remediation, drinking water regulation and risk communication.

## **PUBLICATIONS**

### **Books**

McDaniels, T.L. and M.J. Small (eds). 2004. *Risk Analysis and Society: An Interdisciplinary Characterization of the Field*. Cambridge University Press, Cambridge, UK.

Ramaswami, A., J.A. Milford and M.J. Small. 2005. *Integrated Environmental Modeling: Pollutant Transport, Fate and Risk in the Environment*. John Wiley & Sons, New York.

### **Journal Articles with Peer Review**

Small, M.J. and W.P. Darby. 1976. Evaluating water quality impacts of small streams on major urban rivers. *J. Boston Society of Civil Eng., ASCE, 63*: 101-122.

Darby, W.P. and M.J. Small. 1976. Identifying urban flash flooding problems. *J. Wat. Res. Planning Mgt. Div., ASCE, 102*: 349-363.

Di Toro, D.M. and M.J. Small. 1977. Discussion of "Theory of storage and treatment plant overflows". *J. Env. Eng. Div., ASCE, 103*: 517-520.

Di Toro, D.M. and M.J. Small. 1979. Stormwater interception and storage. *J. Env. Eng. Div., ASCE, 105*: 43-54.

Small, M.J. and D.M. Di Toro. 1979. Stormwater treatment systems. *J. Env. Eng. Div., ASCE, 105*: 557-569.

Small, M.J. and P.J. Samson. 1983. Stochastic simulation of atmospheric trajectories. *J. Clim. & Appl. Meteor., 22*: 266-277.

Rhue, L.G. and M.J. Small. 1986. Application of a low-flow assessment model for the Monongahela River Basin. *Water Resources Bulletin, 22*: 121-127.

- Small, M.J. and M.C. Sutton. 1986. A regional pH-alkalinity relationship. *Water Research*, 20: 335-343.
- Small, M.J. and D.J. Morgan. 1986. The relationship between a continuous time renewal model and a discrete Markov chain model of precipitation occurrence. *Water Resources Research*, 22: 1422-1430.
- Small, M.J. and M.C. Sutton. 1986. A direct distribution model for regional aquatic acidification. *Water Resources Research*, 22: 1749-1758.
- Small, M.J. and J.R. Mular. 1987. Long-term pollutant degradation in the unsaturated zone with stochastic rainfall-infiltration. *Water Resources Research*, 23: 2246-2256.
- Small, M.J., M.C. Sutton and M.W. Milke. 1988. Parametric distributions of regional lake chemistry: Fitted and derived. *Environmental Science and Technology*, 22: 196-204.
- Small, M.J. and C.A. Peters. 1988. Public policy model for the indoor radon problem. *Mathematical Computer Modelling*, 10: 349-358.
- Davidson, C.I., J.R. Harrington, M.J. Stephenson, M.J. Small, F.P. Boscoe and R.E. Gandley, 1989. Seasonal variations in sulfate, nitrate and chloride in the Greenland ice sheet: Relation to atmospheric concentrations. *Atmospheric Environment*, 23: 2483-2493.
- Small, M.J. and P.J. Samson. 1989. Stochastic simulation of meteorological variability for long-range atmospheric transport: 1. Dynamic Lagrangian models. *Atmospheric Environment*, 23: 2813-2824.
- Small, M.J., C. Boyd, G. Keeler and R.J. Marnicio. 1989. Stochastic simulation of meteorological variability for long-range atmospheric transport: 2. Long-term statistical models. *Atmospheric Environment*, 23: 2825-2840.
- Luthy, R.G. and M.J. Small. 1990. Environmental research: A clearer focus over a broader horizon. *Environmental Science & Technology*, 24(11): 1620-1623.
- Sullivan, T.J., D.L. Kugler, M.J. Small, C.B. Johnson, D.H. Landers, B.J. Rosenbaum, W.S. Overton, W.A. Kretser, J. Gallagher. 1990. Variation in Adirondack, New York, lakewater chemistry a function of surface area. *Water Resources Bulletin*, 26: 167-176.
- Rubin, E.S., M.J. Small, C.N. Boyd and M. Henrion. 1992. An integrated assessment of acid deposition effects on lake acidification. *Journal of Environmental Engineering, ASCE*, 118: 120-134.
- Borrazzo, J.E., C.I. Davidson and M.J. Small. 1992. A stochastic model for diurnal variations of CO, NO, and NO<sub>2</sub> concentrations in occupied residences. *Atmospheric Environment* 26B: 369 -377.
- Crawford, S.L., M.H. DeGroot, J.B. Kadane and M.J. Small. 1992. Modeling lake chemistry distributions: Bayesian methods for estimating a finite-mixture model. *Technometrics*, 34: 441-453.
- Levy, K.O. and M.J. Small. 1992. Radon risk assessment: The effect of voluntary sampling distributions and bias. *Environmental Monitoring and Assessment*, 22: 153-168.
- Patwardhan, A. and M.J. Small. 1992. Bayesian methods for model uncertainty with application to future sea level rise. *Risk Analysis*, 12: 513-523.

- Julien, B., S.J. Fenves and M.J. Small. 1992. Knowledge acquisition methods for environmental evaluation. *AI Applications*, 6: 1-20.
- Julien, B., S.J. Fenves and M.J. Small, 1992. An environmental impact identification system. *Journal of Environmental Management*, 36: 167-184.
- Wilkes, C.R., M.J. Small, J.B. Andelman, N.J. Giardino and J. Marshall. 1992. Inhalation exposure model for volatile chemicals from indoor uses of water. *Atmospheric Environment*, 26A: 2227-2236.
- Giardino, N.J., E. Gumerman, N.A. Esmen, J.B. Andelman, C.R. Wilkes, C.I. Davidson and M.J. Small. 1992. Shower volatilization exposures in homes using tap water contaminated with trichloroethylene. *Journal of Exposure Analysis and Environmental Epidemiology*, Suppl. 1, 147-158.
- Merz, J., M.J. Small and P. Fischbeck. 1992. Measuring decision sensitivity: A combined Monte Carlo-logistic regression approach. *Medical Decision Making*, 12: 189-196.
- Ramaswami, A. and M.J. Small. 1994. Modeling the spatial variability of natural trace element concentrations in groundwater. *Water Resources Research*, 30: 269-282.
- Dakins, M.E., J.E. Toll and M.J. Small. 1994. Risk-based environmental remediation: Decision framework and role of uncertainty. *Environmental Toxicology & Chemistry*, 13: 1907-1915.
- Small, M.J., B.J. Cosby, R.J. Marnicio and M. Henrion. 1995. Joint application of an empirical and mechanistic model for regional lake acidification. *Environmental Monitoring & Assessment*, 35: 113-136.
- Small, M.J., A.B. Nunn, III, B.L. Forslund and D.A. Daily. 1995. Source attribution of elevated residential soil lead near a battery recycling site. *Environmental Science & Technology*, 24(4): 883-895.
- Siegel, E., H. Dowlatabadi and M.J. Small. 1995. Sensitivity and uncertainty analysis of an individual plant model and performance of its reduced form versions: A case study of TREGRO. *Journal of Biogeography*, 22: 689-694.
- Siegel, E., H. Dowlatabadi and M.J. Small. 1995. A probabilistic model of ecosystem prevalence. *Journal of Biogeography*, 22: 875-879.
- Brand, K.P. and M.J. Small. 1995. Updating uncertainty in an integrated risk assessment: Conceptual framework and methods. *Risk Analysis*, 15(6): 719-731.
- Dakins, M.E., J.E. Toll, M.J. Small and K.P. Brand. 1996. Risk-based environmental remediation: Bayesian Monte Carlo analysis and the expected value of sample information. *Risk Analysis*, 16(1): 67-79.
- Wolfson, L.J., J.B. Kadane and M.J. Small. 1996. Bayesian environmental policy decisions: Two case studies. *Ecological Applications*, 6(4): 1056-1066.
- Wilkes, C.R., M.J. Small, C.I. Davidson and J.B. Andelman. 1996. Modeling the effects of water usage and co-behavior on inhalation exposures to contaminants volatilized from household water. *Journal of Exposure Analysis and Environmental Epidemiology*, 6(4): 393-412.

Kovacs, D.C., M.J. Small, C.I. Davidson and B. Fischhoff. 1997. Behavioral factors affecting exposure potential for household cleaning products. *Journal of Exposure Analysis and Environmental Epidemiology*, 7(4): 505-520.

Small, M.J. 1997. Groundwater detection monitoring using combined information from multiple constituents. *Water Resources Research*, 33(5): 957-969.

Small, M.J. 1997. Show me the data. *Journal of Industrial Ecology*, 1(4), 9-12. Invited column on Systems Modeling and the Environment.

Amekudzi, A., P. Fischbeck, J. Garrett, Jr., H. Koutsopoulos, S. McNeil and M. Small. 1998. Computer tools to facilitate brownfield development. *Public Works Management & Policy*, 2(3): 231-242.

Gross, L.J. and Small, M.J. 1998. River and floodplain process simulation for subsurface characterization. *Water Resources Research*, 34(9): 2365-2376.

Sinha, R., M.J. Small, P.F. Ryan, T.J. Sullivan and B.J. Cosby. 1998. Reduced-form modelling of surface water and soil chemistry for the tracking and analysis framework. *Water, Air and Soil Pollution*, 105: 617-642.

Stiber, N.A., M.J. Small and P.S. Fischbeck. 1998. The relationship between historic industrial site use and environmental contamination. *J. Air & Waste Management Association*, 48: 809-818.

Fischhoff, B., D. Riley, D.C. Kovacs and M. Small. 1998. What information belongs in a warning? *Psychology and Marketing*, 15(7): 663-686.

Diwekar, U. and M.J. Small. 1998. Industrial ecology and process optimization. *Journal of Industrial Ecology*, 2(3), 11-13. Invited column on Systems Modeling and the Environment.

Sohn, M.D. and M.J. Small. 1999. Parameter estimation of unknown air exchange rates and effective mixing volumes from tracer gas measurements for complex multi-zone indoor air models. *Building and Environment*, 34: 293-303.

Small, M.J. and P.S. Fischbeck. 1999. False precision in Bayesian updating with incomplete models. *Human and Ecological Risk Assessment*, 5(2): 291-304.

Stiber, N.A., M. Pantazidou and M.J. Small. 1999. Expert system methodology for evaluating reductive dechlorination at TCE sites. *Environmental Science & Technology*, 33(17): 3012-3020.

Farrow, R.S., C.B. Goldberg and M.J. Small. 2000. Economic valuation and the environment: A special issue. *Environmental Science & Technology*, 34(8): 1381-1383.

Fischhoff, B. and M.J. Small. 2000. Human behavior in industrial ecology modeling. *Journal of Industrial Ecology*, 3(2&3): 4-7. Invited column on Systems Modeling and the Environment.

Casman, E.A., B. Fischhoff, C. Palmgren, M.J. Small and F. Wu. 2000. An integrated risk model of a drinking-water-borne cryptosporidiosis outbreak. *Risk Analysis*, 20(4): 495-511.

- Sohn, M.D., M.J. Small and M. Pantazidou. 2000. Reducing uncertainty in groundwater site characterization using Bayes Monte Carlo methods. *Journal of Environmental Engineering*, 126(10): 893-902.
- Riley, D.M., M.J. Small and B. Fischhoff. 2000. Modeling methylene chloride exposure-reduction options for home paint-stripper users. *Journal of Exposure Analysis and Environmental Epidemiology*, 10 (3): 240-250.
- West, J.J., M.J. Small and H. Dowlatabadi. 2001. Storms, investor decisions, and the economic impacts of sea level rise. *Climatic Change*, 48: 317-342.
- Matthews, H.S. and M.J. Small. 2001. Extending the boundaries of life-cycle assessment through environmental economic input-output models. *Journal of Industrial Ecology*, 4(3): 7-10. Invited column on Systems Modeling and the Environment.
- Riley, D.M., B. Fischhoff, M.J. Small and P. Fischbeck. 2001. Evaluating the effectiveness of risk-reduction strategies for consumer chemical products. *Risk Analysis*, 21, 357-369.
- Casman, E., B. Fischhoff, M. Small, H. Dowlatabadi, J. Rose and M. G. Morgan. 2001. Climate change and cryptosporidiosis: A qualitative analysis. *Climatic Change*, 50: 219-249.
- Kovacs, D.C., B. Fischhoff and M.J. Small. 2001. Perceptions of PCE use by dry cleaners and dry cleaning customers. *Journal of Risk Research*, 4(4): 353-375.
- Gurian, P.L., M.J. Small, J.R. Lockwood III and M.J. Schervish. 2001. Benefit-cost estimation for alternative drinking water maximum contaminant levels. *Water Resources Research*, 37(9): 2213-2226.
- Gurian, P.L., M.J. Small, J.R. Lockwood III and M.J. Schervish. 2001. Addressing uncertainty and conflicting cost estimates in revising the arsenic MCL. *Environmental Science & Technology*, 35(22): 4414-4420.
- Lockwood, J.R., M.J. Schervish, P. Gurian and M.J. Small. 2001. Characterization of arsenic occurrence in source waters of US community water systems. *Journal of the American Statistical Association*, 96(456): 1184-1193.
- Gurian, P.L. and M.J. Small. 2002. Point-of-use treatment and the revised arsenic MCL. *Journal American Water Works Association*, 94(3): 101-108.
- Reichert, P., M. Schervish and M.J. Small. 2002. An efficient sampling technique for Bayesian inference with computationally demanding models. *Technometrics*, 44(4): 318-327.
- Axtell, R.L., C.J. Andrews and M.J. Small. 2002. Agent-based modeling and industrial ecology. *Journal of Industrial Ecology*, 5(4): 10-13. Invited column on Systems Modeling and the Environment.
- DeKay, M.L., M.J. Small, P.S. Fischbeck, R.S. Farrow, A. Cullen, J.B. Kadane, L. Lave, M.G. Morgan and K. Takemura. 2002. Risk-based decision analysis in support of precautionary policies. *Journal of Risk Research*, 5(4): 391-417.
- Yeh, S. and M.J. Small. 2002. Incorporating exposure models in probabilistic assessment of the risks of premature mortality from particulate matter. *Journal of Exposure Analysis and Environmental Epidemiology*, 12(6): 389-403.

- Mihelcic, J.R., J.C. Crittenden, M.J. Small, D.R. Shonnard, D.R. Hokanson, Q. Zhang, H. Chen, S.A. Sorby, V.U. James, J.W. Sutherland and J.L. Schnoor. 2003. Sustainability science and engineering: The emergence of a new metadiscipline. *Environmental Science & Technology*, 37(23): 5314-5324.
- Frey, H.C. and M.J. Small. 2003. Integrated environmental assessment, Part 1: Estimating emissions. *Journal of Industrial Ecology*, 7(1): 9-11.
- Ailamaki, A., C Faloutsos, P.S. Fischbeck, M.J. Small, J. VanBriesen. 2003. An environmental sensor network to determine drinking water quality and security. *SIGMOD Record*, 32(4): 47-52.
- Schultz, M.T., M.J. Small, R.S. Farrow and P.S. Fischbeck. 2004 State water pollution control policy insights from a reduced-form model. *Journal of Water Resources Planning and Management*, 130(2): 150-159.
- Stiber, N.A., M. Pantazidou and M.J. Small. 2004. Embedding expert knowledge in a decision model: Evaluating natural attenuation at TCE sites. *Journal of Hazardous Materials*, 110(1-3): 151-160.
- Gurian, P.L, M.J. Small, J.R. Lockwood and M.J. Schervish. 2004. Benefit-cost implications of multicontaminant drinking water standards. *Journal American Water Works Association*, 96(3): 70-83.
- Lockwood, J.R., M.J. Schervish, P. Gurian and M.J. Small. 2004. Analysis of contaminant co-occurrence in community water systems. *Journal of the American Statistical Association*, 99(465): 45-56.
- Boccelli, D.L., M.J. Small and U.M. Diwekar. 2004. Treatment plant design for particulate removal: Effects of flow rate and particle characteristics. *Journal of American Water Works Association*, 96(11): 77-90.
- Karcher, S.C., M.J. Small and J.M. VanBriesen. 2004. Statistical method to evaluate the occurrence of PCB transformations in river sediments with application to Hudson River data. *Environmental Science & Technology*, 38(24): 6760 -6766.
- Krayer von Krauss, M.P., E.A. Casman and M.J. Small. 2004. Elicitation of expert judgments of uncertainty in the risk assessment of herbicide tolerant oilseed crops. *Risk Analysis*, 24(6): 1515-1527.
- Stiber, N.A., M.J. Small and M. Pantazidou. 2004. Site-specific updating and aggregation of Bayesian Belief Network models for multiple experts. *Risk Analysis*, 24(6): 1529-1538.
- Ramaswami, A., J.B. Milford and M.J.Small. 2004. Integrated environmental assessment, Part II: Modeling fate and transport. *Journal of Industrial Ecology*, 8(3): 11-13.
- Goyal, A., M.J. Small, K. von Stackelberg, D. Burmistrov and N. Jones. 2005. Estimation of fugitive lead emission rates from secondary lead facilities using hierarchical Bayesian models. *Environmental Science & Technology*, 39(13): 4929-4937.
- Boccelli, D. L.; Small, M. J.; Dzombak, D. A. 2005. Enhanced coagulation for satisfying the arsenic maximum contaminant level under variable and uncertain conditions. *Environmental Science & Technology*, 39(17): 6501-6507.
- MacDonald, J. and M.J. Small. 2005. Assessing sites contaminated with unexploded ordnance: Statistical modeling of ordnance spatial distribution. *Environmental Science & Technology*, 40(3): 931-938.

- Weber, C.L., J.M. VanBriesen and M.J. Small. 2006. A stochastic regression approach to analyzing thermodynamic uncertainty in chemical speciation models. *Environmental Science & Technology*, 40(12): 3872-3878.
- Boccelli, D., M.J. Small and D.A. Dzombak. 2006. Effects of water quality and model structure on arsenic removal simulation: An optimization study. *Environmental Engineering Science*, 23(5): 835-850.
- Schultz, M.T., M.J. Small, P.S. Fischbeck and R.S. Farrow. 2006. Evaluating response surface designs for uncertainty analysis and prescriptive applications of a large-scale water quality model. *Environmental Modeling and Assessment*, 11(4):345-359.
- Bushey, J.T., M.J. Small, D.A. Dzombak and S.D. Ebbs. 2006. Parameter estimation of a plant uptake model for cyanide: Application to hydroponic data. *International Journal of Phytoremediation*. 8(1): 45-62.
- McKone, T.E. and M.J. Small. 2007. Integrated environmental assessment, Part III: Exposure assessment. *Journal of Industrial Ecology*, 11(1): 4-7.
- Karcher, S.C., J.M. VanBriesen and M.J. Small. 2007. Numerical method to elucidate likely target positions of chlorine removal in anaerobic sediments undergoing polychlorinated biphenyl dechlorination. *Journal of Environmental Engineering*. 133(3): 278-286.
- Boccelli, D., M.J. Small and U. Diwekar. 2007. Drinking water treatment plant design incorporating variability and uncertainty. *Journal of Environmental Engineering*, 133(3): 303-312.
- Higgins, C.J., H.S. Matthews, C.T. Hendrickson and M.J. Small. 2007. Lead demand of future vehicle technologies. *Transportation Research Part D: Transport and Environment*, 12(2): 103-114.
- Gilau, A.M., R. Van Buskirk and M.J. Small. 2007. Enabling optimal energy options under the Clean Development Mechanism. *Energy Policy*, 35(11): 5526-5534.
- Gilau, A.M. and M.J. Small. 2008. Designing cost-effective seawater reverse osmosis under optimal energy options. *Renewable Energy*. 33(4): 617-630.
- Xu, J., P.S. Fischbeck, M.J. Small, J.M. VanBriesen and E. Casman. 2008. Identifying sets of key nodes for placing sensors in dynamic water distribution networks. *Journal of Water Resources Planning and Management*, 134(4): 378-385.
- Ryker, S.J. and M.J. Small. 2008. Combining occurrence and toxicity information to identify priorities for drinking-water mixture research. *Risk Analysis*, 28(3): 653-666.
- Choi, T., M. J. Schervish, K. A. Schmitt and M. J. Small. 2008. A Bayesian approach to a logistic regression model with incomplete information. *Biometrics*, 64(2): 424-430.
- Brusick, D., M.J. Small, E.L. Cavalieri, D. Chakravarti, X. Ding, D.G. Longfellow, J. Nakamura, E.C. Rogan and J.A. Swenberg. 2008. Possible genotoxic modes of action for naphthalene. *Regulatory Toxicology and Pharmacology*, 51(2), Supplement 1(Naphthalene State of Science Symposium): 43-50.
- MacDonald, J., M.J. Small and M.G. Morgan. 2008. Explosion probability of unexploded ordnance: Expert beliefs. *Risk Analysis*, 28(4): 825-841.

Small, M.J. 2008. Methods for assessing uncertainty in fundamental assumptions and associated models for cancer risk assessment. *Risk Analysis*, 28(5): 1289-1307.

Ostfeld, A., J.G. Uber, E. Salomons, J.W. Berry, W.E. Hart, C.A. Phillips, J-P. Watson, G. Dorini, P. Jonkergouw, Z. Kapelan, F. di Pierro, S-T. Khu, D. Savic, D. Eliades, M. Polycarpou, S.R. Ghimire, B.D. Barkdoll, R. Gueli; J.J. Huang, E.A. McBean, W. James; A. Krause, J. Leskovec, S. Isovitsch, J. Xu, C. Guestrin, J. VanBriesen, M. Small, P. Fischbeck, A. Preis, M. Propato, O. Piller, G.B. Trachtman, Z.Y. Wu and T. Walski. 2008. The Battle of the Water Sensor Networks (BWSN): A design challenge for engineers and algorithms. *Journal of Water Resources Planning and Management*, 134(6): 556-568.

MacDonald, J. and M.J. Small. 2009. Statistical analysis of metallic anomaly patterns at former Air Force bombing ranges. *Stochastic Environmental Research and Risk Assessment*, 23(2): 203-214.

MacDonald, J., M.J. Small and M.G. Morgan. 2009. Quantifying the risks of unexploded ordnance at closed military bases. *Environmental Science & Technology*, 43(2):259-265.

Green, S.T., M.J. Small and E.A. Casman. 2009. Determinants of national diarrheal disease burden. *Environmental Science & Technology*, 43(4): 993-999.

Attari, S., M. Schoen, C. Davidson, M.L. DeKay, W. Bruine de Bruin, R. Dawes, and M. Small. 2009. Preferences for change: Do individuals prefer voluntary actions, soft regulations, or hard regulations to decrease fossil fuel consumption? *Ecological Economics*, 68: 1701-1710.

***Current Submissions:***

Choi, T., M. J. Schervish, K. A. Schmitt and M. J. Small. 2008. Bayesian hierarchical analysis for multiple health endpoints in a toxicity study. *Journal of Agricultural, Biological, and Environmental Statistics*, Accepted for publication.

Xu, J. M.J. Small, P.S. Fischbeck and J.M. VanBriesen. 2008. Integrating location models with Bayesian analysis to inform decision making: a case study in deploying sensors in water supply systems. *Journal of Water Resources Planning and Management*, Accepted for publication.

### Edited or Reviewed Conference Proceedings and Book Chapters

- Small, M.J. and P.J. Samson. 1982. Mathematical simulation of Lagrangian precipitation and associated sulfur wet deposition. Proceedings of Specialty Conference on Atmospheric Deposition, Detroit, MI, November 7-10, 1982, *Air Pollution Control Association*, Pittsburgh, PA., pp. 273-285.
- Samson, P.J. and M.J. Small. 1984. Atmospheric trajectory models for diagnosing the sources of acid precipitation. Acid Precipitation, Vol. 9: *Modeling of Total Acid Precipitation Impacts*, Ed. J.L. Schnoor, Ann Arbor Science, Butterworth Publishers, Boston, 1-23.
- Keeler, G.J., P.J. Samson and M.J. Small. 1984. Representativeness of precipitation data in regional-scale acid deposition modeling. Proceedings of Specialty Conference on Meteorology of Acid Deposition, Hartford, CT, *Air Pollution Control Association*, Pittsburgh, PA, 225-240.
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The CMU report provides information and decision tools designed to enable citizens and decision makers to better understand the linkage between climate change, land-use change, and specific resources that they are concerned about and manage. The resource domains where significant research and tool development were achieved include: water resources; ecological resources; energy use; human health; and coastal storm impacts. CMU contributions are included as part of the principal deliverable from the CARA project, the CARA web site: <http://www.cara.psu.edu/>. See especially: <http://www.cara.psu.edu/tools/tools.asp>.

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