BIOGRAPHICAL SKETCH

NAME: **SMITH, Kirk**

POSITION TITLE: Professor, Global Environmental Health, University of California, Berkeley

EDUCATION/TRAINING:

INSTITUTION AND LOCATION	DEGREE	COMPLETION DATE	FIELD OF STUDY
University of California Berkeley	BA	12/1968	Physics and Astronomy
University of California Berkeley	MPH	06/1972	Environmental Health Sciences
University of California Berkeley	PhD	12/1977	Biomedical and Environmental Health: Energy & Environment

A. PERSONAL STATEMENT

I run the oldest research group in the world on the health and climate impacts of household energy. My current work includes field studies in India, Nepal, China, Laos, Paraguay, and Mongolia focused on household air pollution (HAP) from fuel use. At these sites, we have done pollution measurements related to heath and climate impacts, developed new monitoring technologies, and conducted epidemiologic investigations of the relation between HAP and child pneumonia, tuberculosis, chronic obstructive pulmonary disease, heart disease risk factors, low birth weight, cataracts, cognitive deficit, and several biomarkers (selected below). I was PI of the first randomized controlled trial of an air pollution intervention in a normal population– chimney stoves in highland Guatemala with child pneumonia as the primary outcome. Currently most work is focused on India because of the large-scale intervention (350 million people) underway introducing clean fuels. I have also participated as senior contributor to a number of global scientific assessments including the Intergovernmental Panel on Climate Change, the Global Energy Assessment, and the Global Burden of Disease and developed and elaborated new quantitative concepts and measurement metrics in both environmental health and climate science policy. In addition to my research I have successfully mentored graduate students, postdocs and visiting scholars, including nine visiting young scholars from India who were forming the faculty of the first MPH program in the country in environmental and occupational health at Sri Ramachandra University. Currently, I am focused on developing and evaluating policy options for reducing air pollution exposures for household and ambient pollution in India.

B. POSITIONS AND HONORS (selected)

1977 - 1985	Founder and Leader, Energy Program in East-West Center, Honolulu
1986 - 1995	Head, Environmental Risk and Development Program, East-West Center
1998	Visiting Professor, London School of Hygiene and Tropical Medicine
2013 - 14	Fulbright-Nehru Distinguished Chair, Indian Institute of Technology, Delhi; Visiting Professor, Peking University
1997 - 2017	Founder/Director Graduate Program in Global Health and Environment
2014 - 2017	Chair of the Graduate in Environmental Health Sciences
Current	Director of the Collaborative Clean Air Policy Centre Delhi; Associate Director for International Programs, Center for Occupational and Environmental Health, UC Berkeley/Davis/San Francisco

C. COMMITTEE

(past 10 years)

Health Ministry Steering Committee on Air Pollution, Gov of India Chair, NRC/NAS

Committee on Exposure Science for the 21st Century, NRC/NAS Board of Atmospheric Studies and Climate

Chair, Monograph #95, Intern'l Agency for Research on Cancer, WHO, Lyon Strategic Advis Group, WHO/UNICEF

Program for Water Supply and Sanitation WHO Steering Committee for Global Air Quality Guidelines,

US Member, Interna Sci Committee on Problems of the Environment (SCOPE) Internat Sci Com., Health Impacts of Air Pollution in Asia,

Health Effects Institute NRC/NAS

Board on Environmental Studies and Toxicology.

D. HONORS (selected)

1997	Elected Member of the US National Academy of Sciences
1999	Wesolowski Award, International Society for Exposure Analysis 2007
2007	Extensively shared Nobel Peace Prize for contribution to IPCC 2008
2008	UCB Chancellor's Award for Research in the Public Interest
2009	Heinz Prize in Environment
2009	Lifetime Achievement Award, Mrigendra-Samjhana Medical Trust, Nepal
2010	Vodafone Innovation Co on: Leader of First Prize Team
2010	Distinguished Visiting Professor, Sri Ramachandra University, Chennai, India
2012	Tyler Prize for Environmental Achievement

E. CONTRIBUTIONS TO SCIENCE (selected mostly early pubs in each category)

1. First identification of household air pollution as a major health risk

Beginning with field measurements in India in the early 1980s, I was the first to identify and then quantify the pollution exposures and consequent health impacts that result in about half the world's households because of use of solid fuels for cooking. Household air pollution (HAP) as it is now termed, has been recognized in all major international assessments in the last decade as the single largest environmental health risk in the world and one of the top handful of health risks of all kinds, being ranked first in many poor countries. More than 200 hundred published studies have followed by me along with colleagues to date and many studies are underway.

a. **Smith KR,** A.L. Aggarwal, & R.M. Dave, (1983) Air pollution and rural biomass fuels in developing countries: A pilot village study in India and implications for research and policy, Atmospheric Environment, 17(11):2343-2362.

b. DeKoning, H.W., **KR Smith**, & J.M. Last, (1984) Biomass Fuel Combustion and Health, EFP/84.64, WHO.

c. **Smith KR**, (1987) Biofuels, Air Pollution, and Health: A Global Review, Plenum Publishing, NY.

d. **Smith KR.** (1993) Fuel Combustion, Air Pollution Exposure, and Health: the Situation in Developing Countries, Annual Review of Energy and Environment, 18: 529-566.

e. McCracken JM, **Smith KR**, Mittleman M, Diaz A, Schwartz J, (2007) Chimney stove intervention to reduce long-term woodsmoke exposure lowers blood pressure among Guatemala women, Environ Health Perspect. 115 (7): 996-1001. PMCID: PMC1913602

f. **Smith KR,** McCracken JM, Weber MW, Hubbard H, Jenny A, Thompson L, Balmes J, Diaz A, Arana B, Bruce N, (2011) RESPIRE: A Randomised Controlled Trial of the impact of reducing household air pollution on childhood pneumonia in Guatemala, Lancet 378: 1717–26.

g. Thompson LM, Bruce N, Eskenazi B, Diaz A, Pope D, **Smith KR**, (2011) Impact of reduced maternal exposures to woodsmoke from an introduced chimney stove on newborn birth weight in rural Guatemala, Environ Health Perspectives, 119(10): 1489-94. PMCID: PMC3230429

h. Dix-Cooper L, Eskenazi B, Romero C, Balmes J, **Smith KR**, (2012) Neurodevelopmental performance among school age children in rural Guatemala is associated with prenatal and postnatal exposure to carbon monoxide, a marker for exposure to woodsmoke. J of NeuroToxicology, 33: 246–254.

2. Earliest developer of small, smart, fast, cheap exposure monitoring devices for rural household environments

As commercial research instruments are too expensive, sensitive, large, power-hungry, or otherwise unsuited to use in rugged developing-country rural settings, in the late 1990s, I began developing and validating in the published literature what are now a range of microchip devices for exposure assessment. To date, these include inexpensive particle monitors, stove-use monitors, time-activity monitors, and ventilation rate monitors. The first two are now widely used by many groups around the world and have revolutionized the way field studies are done in household air pollution. In addition, I adapted instrumentation used in industrial hygiene to conduct the first and still only published personal PM monitoring for infants.

a. Litton CD, **Smith KR**, Edwards R, Allen T (2004), Combined optical and ionization measurement techniques for inexpensive characterization of micrometer and submicrometer aerosols, Aerosol Science and Technology, 38(11): 1054-1062.

b. Allen-Piccolo G, Rogers JV, Edwards R, Clark MC, Allen TT, Ruiz-Mercado I, Shields KN, Canuz E, **Smith, KR** (2009) An ultrasound personal locator for time-activity assessment, Intern'l Jof Occup and Environ Health, 15 (2): 122-132.

c. **Smith KR**, McCracken JM, Thompson L, Edwards R, Shields KN, Canuz E, Bruce N, (2010) Personal child and mother carbon monoxide exposures and kitchen levels: Methods and results from a randomized trial of woodfired chimney cookstoves in Guatemala (RESPIRE), J of Expos Sci and Environ Epi, 20: 406–416. PMCID: PMC4575221.

d. Ruiz-Mercado I, Canuz E, **Smith KR** (2012) Temperature dataloggers as Stove Use Monitors (SUMs): Field methods and signal analysis. Biomass and Bioenergy, 47: 459-468. PMCID: PMC4163042.

e. Pillarisetti A, Allen T, Ruiz-Mercado I, Edwards R, Chowdhury Z, Garland C, Hill LD, Johnson M, Litton CD, Lam NL, Pennise D, **Smith KR**, 2017, Small, smart, fast, and cheap: Microchip-based sensors to estimate air pollution. Sensors 17, 1879,doi:10.3390/s17081879

3. First identification of intake fraction as a useful metric for evaluating and controlling air pollution exposures

In the mid-1980s, I proposed the concept of exposure efficiency as a particularly powerful means to evaluate and prioritize the control of air pollution exposures from disparate sources. This concept has now become well established in the environmental health field under the name, intake fraction

a. **Smith KR** (1988), Total Exposure Assessment: Implications for the U.S and Developing Countries., Environment, 30(8): 10-15; 33-38, 30(10): 16-20; 28-3 (two parts)

b. Wang X and **Smith KR** (1999) Near-term benefits of greenhouse gas reductions: Health impacts in China. Environ Sci and Technol, 33 (18): 3056-3061

c. Evans J, S Wolff, K Phonboon, J Levy, **KR Smith**, (2002) Exposure efficiency: an idea whose time has come?, Chemosphere, 49(9): 1075-1091.

d. Bennett DH, TE McKone, JS Evans, WW Nazaroff, MD Margni, O Jolliet, **KR Smith,** (2002) Defining intake fraction, Environ Sci and Technol, 36:207A-211A.

4. Use of total exposure concepts for air pollution control policy

Air pollution has traditionally been monitored and controlled by location (indoors, outdoors, etc), but I was a pioneer in developing the concept of exposure management using total exposure and its use in more efficient control of the health impacts of air pollution. This work has most recently culminated in recommended changes in the way the government of India monitors and regulates air pollution to reduce ill-health.

a. Roumasset, J.A. & **K.R. Smith** (1990) Exposure Trading: An Approach to More Efficient Air Pollution Control, Journal of Environmental Economics and Management 18: 276-291.

b. **Smith KR**, (2001) Place makes the poison, J Exposure Anal and Environ Epidemiol. 12: 167-171..

c. **Smith KR** (Chair) and many others, Exposure Science in the 21st Century: A vision and a strategy,
National Research Council, National Academy of Sciences, Washington DC,2012

d. Sagar A, Reddy S, et al. (including **KR Smith**) Report of the Steering Committee on Air Pollution and Health-Related Issues, Ministry of Health and Family Welfare, Government of India, New Delhi, 2015,
http://www.mohfw.nic.in/showfile.php?lid=3650.

e. Sagar A, et al (including **Smith KR**). India Leads the Way: A Health-Centered Strategy for Air Pollution. Environ Health Perspect. 2016 Jul 1;124(7):A116-7. PMID:274799915.

5. Impact of household fuels on ambient air pollution, which is important in a number of countries. *This is an ongoing research effort in India, China, and Mongolia*

a. Chafe Z, Brauer M, Klimont Z, Van Dingenen R, Mehta S, Rao S, Riahi K, Dentener F, **Smith KR**, 2014, Household Cooking with Solid Fuels Contributes to Ambient PM2.5 Air Pollution and the Burden of Disease, Environmental Health Perspectives, 122: 1314-1320

b. Liu J, Mauzerall DL, Chen Q, Zhang Q, Song Y, Peng W, Klimont Z, Qiu X, Zhang S, Hu M, **Smith KR**, Zhu T, 2016, Air pollutant emissions from Chinese households: A major and underappreciated ambient pollution source, Proc Nat Acad of Sci, 113(28):7756-61.

c. Qin Y, Wagner F, Scovronick N, Peng, W, Zhu T, **Smith KR**, Mauzerall DL, 2017, Air quality, health and climate implications of China's synthetic natural gas development, Proc Nat Acad of Sci 114 (19) 4887–4892.

d. Lauren T. Fleming, Peng Lin, Alexander Laskin, Julia Laskin, Robert Weltman, Rufus D.Edwards, Narendra K. Arora, Ankit Yadav, Simone Meinardi, Donald R. Blake, Ajay Pillarisetti, **Kirk R. Smith**, Sergey A. Nizkorodov, 2017, Molecular composition of particulate matter emissions from dung and brushwood burning in household cookstoves in Haryana, India, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-784

e. Hill LD, Edwards R, Turner JR, Argo YD, Olkhanud PB, Odsuren M, Guttikunda S, Ochir C, **Smith KR**, 2017, Health assessment of future PM2.5 exposures from indoor, outdoor, and secondhand tobacco smoke concentrations under alternative policy pathways in Ulaanbaatar, Mongolia. PLoS ONE12 (10): e0186834. https://doi.org/10.1371/journal.pone.0186834

6. Global Assessments

a. **Smith, KR**, (2000) National burden of disease in India from indoor air pollution, PNAS, 97(24): 13286-93. PMCID: PMC27217.

b. **Smith KR**, Balakrishnan K, Butler CD, Chafe Z, Fairlie I, Kinney P, Kjellstrom T, Mauzerall DL, McKone TE, McMichael AJ, Schneider M, Wilkinson P,(2012) Chapter 4 - Energy and Health. In Global Energy Assessment - Toward a Sustainable Future, Cambridge University Press Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria, pp. 255-324.

c. **Smith KR**, Woodward A, Campbell-Lendrum D, Chadee D, Honda Y, Liu Q, Olwoch J, Revich B, Sauerborn R,(2014) Human Health: Impacts, Adaptation, and Co-benefits. Ch 11 in Climate Change 2014: Impacts, Adaptation, and Vulnerability. Vol I: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, D.J.Dokken, et al. (eds.)]. Cambridge Univ Press, Cambridge, UK and NYC, pp. 709-754.

d. **Smith KR**, Bruce N, Balakrishnan K, Adair-Rohani H, Balmes J, Chafe Z, Dherani M, Hosgood HD, Mehta S, Pope D, Rehfuess E, and others in the HAP CRA Expert Group, (2014) Millions dead: how do we know and what does it mean? Methods used in the Comparative Risk Assessment of

e. **Smith KR**, Woodward A, Lemke B, Otto M, Chang CJ, Mance AA, Balmes J, Kjellstrom T, 2016, The Last Summer Olympics? Climate Change, Health, and Work Outdoors, Lancet 388: 642-644.

e. Landrigan et al. (including **KR Smith**) 2017, Report of the Lancet Commission on Pollution and Health, the Lancet, http://dx.doi.org/10.1016/S0140-6736(17)32345-0

7. National Intervention in India

I have interacted with major government agencies and am conducting field assessments of the massive new LPG intervention underway in India

a. **Smith KR**, Sagar A, 2014, Making the clean available: Escaping India's chulha trap, Energy Policy 75: 410–414.

b. Tripathi A, Sagar AD, **Smith KR**, 2015, Promoting clean and affordable cooking: Smarter subsidies for LPG, Economic & Political Weekly, 50(48): 81-84.

c. **Smith KR**, AD Sagar, 2016, LPG subsidy: Give it Up, if you haven't, Finan Times of India, 1/29.

d. **Smith KR**, 2017, The Indian LPG Programmes: Globally Pioneering Initiatives, in A. Ganguly & B Debroy (eds) The Modi Years, Vol 3, Dr. Syama Prasad Mookerjee Research Found., Delhi.

e. Goldemberg J, Martinez-Gomez J, Sagar A, **Smith KR**, 2018, Household air pollution, health, and climate change – clearing the air, Editorial, Environmental Research Letters