



NATIONAL ACADEMY OF SCIENCES
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**Workshop on Sustainability Science:
Can Earth's and Society's Systems Meet the Needs of 10 Billion People?**

Monday, 30 September – Tuesday, 1 October, 2013

Room 120
National Academy of Sciences
2101 Constitution Ave
Washington DC 20418

Sponsored by the

Presidents' Committee of the National Academies

Organized under the auspices of

Board on Environmental Change and Society (DBASSE)
Committee on Population (DBASSE)
Board on Life Sciences (DELS)

by the

**National Research Council Committee on
Preparing for Ten Billion on the Planet: Workshop on Sustainability Science**

William Rouse (NAE), chair, Stevens Institute of Technology
John Bongaarts (NAS), The Population Council
F. Stuart (Terry) Chapin (NAS), University of Alaska
W. G. Ernst (NAS), Stanford University
Henry C. Harpending (NAS), University of Utah
Stephen Polasky (NAS), University of Minnesota
B. L. Turner II (NAS), Arizona State University
Meredith A. Lane, project director, National Research Council

Monday, 30 September 2013

Time	Ses- sion	Title / Topic	Session Chair or Speaker
0830		WELCOME TO WORKSHOP; logistics and housekeeping items	<i>BECS Board Director</i>
0835	I.	Introduction to the workshop	<i>Session Chair: William Rouse</i>
0845		Earth as a system <u>abstract</u> <u>PPT</u>	William Rouse
0930		Understanding population in human-environment relationships: Science shaped by world-views or evidence? <u>abstract</u> <u>PPT</u>	B. L. Turner II
1015	DISCUSSION		
1045	BREAK		
1100	II.	Challenges to the Earth system presented by 10 billion people (What do we know and not know about these challenges? Discussion of degree of certainty of the projections of population, migration, and rising aspirations and what they portend for land and resource pressures)	
		A. Character and magnitude of the challenges in 2050	<i>Session Chair: W. G. Ernst</i>
1105		Demographic trends and their consequences <u>abstract</u> <u>PPT</u>	John Bongaarts
1135		Demographic and economic drivers of consumption and environmental change <u>abstract</u> <u>PPT</u>	Andrew Jorgenson and Juliet Schor
1205		Urbanization in the 21st century: Challenges and opportunities for environmental sustainability <u>abstract</u> <u>PPT</u>	Peter Marcotullio and Karen Seto
1235	DISCUSSION		
1300	LUNCH ON YOUR OWN		

1400	B.	Consequences for the Earth system		<i>Session Chair: Henry Harpending</i>
1405		Biodiversity and ecosystem services in a world of 10 billion	abstract PPT	Steve Polasky
1435		Future demand and supply pressures on water: Implications for agriculture and other sectors	abstract PPT	Siwa Msangi
1505		Energy, land, and water on a 10 billion person planet: An integrated perspective	abstract PPT	James A (Jae) Edmonds
1535	BREAK			
1550	DISCUSSION			
1700	RECEPTION			
1800	SPECIAL PRESENTATION	Introduction		<i>Session Chair: William Rouse</i>
		X-Events and human progress (or, why the trend is not your friend)	abstract PPT	John Casti
1900		Adjourn workshop for the day		

Tuesday, 1 October 2013

- 0830 **III. Conundrum:** Global consumption has risen, but so has the Gini coefficient within most countries – how can we approach a more equitable distribution of resources? What do we know, and what do we not know, about our capacity for moving toward equitability, especially under the challenges of population growth?
- Session Chair:*
B. L. Turner II
- 0835 **Global income inequality: Historical trends and policy implications for the future** [abstract](#) [PPT](#) Branko Milanović
- 0905 **Population, internal inequality and conspicuous consumption in Africa: Trends and implications for sustainability** [abstract](#) [PPT](#) Parfait Eloundou-Enyegue
- 0935 **Intergenerational tradeoffs, demographic metabolism, and the long term benefits of equitable empowerment in the near term**
- [abstract](#) [PPT](#)
- 1005 **DISCUSSION**
- 1045 **BREAK**
- 1100 **IV. Wicked problems:** Understanding regional-to-global interactions and feedbacks that create unintended consequences (what do we know and not know about the interactions between the Earth systems and the societal system?)
- Session Chair:*
Terry Chapin
- 1105 **The distribution of population health and consumption risk in low, middle and high income countries: The Rose paradigm revisited** abstract [PPT](#) Lisa Berkman
- 1135 **Demography and climate change: Current understanding, future directions**
- abstract [PPT](#)
- 1205 **DISCUSSION**
- 1240 **Instructions regarding group discussion** *BECS Board Director*
- 1245 **LUNCH ON YOUR OWN**

1345 V. Plenary Discussion: Interdisciplinary research agenda and NAS project development

Session Chair:
William Rouse

Among the many things that we need to learn, what are some priority interdisciplinary questions for study? Of all the topic areas covered in this workshop, which one(s) should be the subject(s) of future NAS / NRC activities? What sponsor(s) might be interested in those activities?

1515 ADJOURN WORKSHOP

AUTHOR BIOGRAPHICAL INFORMATION



Lisa Berkman is Thomas D. Cabot Professor of Public Policy and of Epidemiology and Director of the Harvard Center for Population and Development Studies. Prior to becoming Director, Dr. Berkman was Chair of the Department of Society, Human Development and Health at the Harvard School of Public Health from 1995 – 2008. She is also the former head of the Division of Chronic Disease Epidemiology at Yale University. She is an internationally-recognized social epidemiologist whose work focuses extensively on social and policy influences on health outcomes. Her research has been oriented towards understanding inequalities in health related to socioeconomic status, different racial and ethnic groups, and social networks, support and isolation. The majority of her work is devoted to identifying the role of social networks and support in predicting declines in physical and cognitive functioning, and onset of disease and mortality, especially related to cardiovascular or cerebrovascular disease. In addition, she has devoted much of her work to understanding determinants of population health by comparing European countries with the U. S. She is currently a member of the Conseil Scientifique de l'Institut de Recherche en Sante Publique (IReSP) in France and a member of IOM. Dr. Berkman is the author of several books and over 200 publications; she co-edited *Social Epidemiology*, the first textbook on the topic, plus *Neighborhoods and Health* (both with Ichiro Kawachi). A B.A. in Sociology from Northwestern University was followed by an M.S. and Ph.D. in Epidemiology from the University of California, Berkeley.



John Bongaarts is a Population Council vice president and distinguished scholar and has worked at the Council since 1973. His research focuses on the determinants of fertility, population–environment relationships, the demographic impact of the AIDS epidemic, population aging, and population policy options in the developing world. His studies on AIDS in the late 1980s and early 1990s tracked the spread of the epidemic and its effects on mortality. His research on fertility issues, a prevailing interest throughout his 30-year career, has helped developing countries construct population policy options. His statistical analyses have shown how such diverse factors as malnutrition, the availability of birth control, the duration of breastfeeding, and the accessibility of abortion have affected global and local birth patterns. This research has laid the foundation for effective population forecasts that have galvanized population policy in several countries, including China and developing nations in sub-Saharan Africa. Dr. Bongaarts serves as chairman of the Panel on Population Projections of the National Academy of Sciences, National Research Council. He is a member of the Royal Dutch Academy of Sciences, the US National Academy of Sciences, and a fellow of the American Association for the Advancement of Science. He received the Robert J. Lapham Award (1997) and the

Mindel Sheps Award (1986) from the Population Association of America and the Research Career Development Award from the National Institutes of Health (1980). Dr. Bongaarts has a master's degree in systems analysis from the Eindhoven Institute of Technology, Netherlands, and a Ph.D. in physiology and biomedical engineering from the University of Illinois.



John L. Casti is a Research Scholar at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, where he heads an initiative for the study of Extreme Events in Human Society and is Director of The Kenos Circle, a Vienna-based society of fellows devoted to exploration of the future. He has worked at the RAND Corporation in Santa Monica, CA, and served on the faculties of the University of Arizona, NYU and Princeton before becoming one of the first members of the research staff at IIASA. In 1986, he left IIASA to take up a position as a Professor of Operations Research and System Theory at the Technical University of Vienna. He also served as a member of the External Faculty of the Santa Fe Institute in Santa Fe, New Mexico, USA, from 1992-2002, where he worked extensively on the application of biological metaphors

to the mathematical modeling of problems in economics, finance and road-traffic networks, as well as on large-scale computer simulations for the study of such networks. In 2000, he formed two companies in Santa Fe and London--Qforma, Inc. and SimWorld, Ltd--devoted to the employment of tools and concepts from modern system theory for the solution of problems in business and finance. Dr. Casti's research interests have recently shifted somewhat to the exploration of questions in the social and behavioral realm and the relationship between social "moods" and their consequent social actions and behaviors. In early 2005 he returned to Vienna where he co-founded The Kenos Circle, a professional society that aims to make use of complexity science in order to gain a deeper insight into the future than that offered by more conventional statistical tools. Professor Casti has written a numerous articles and seven technical monographs and textbooks on mathematical modeling. In addition, he is the editor of the journals *Applied Mathematics & Computation* and *Complexity*. In 1989 his text/reference work *Alternate Realities: Mathematical Models of Nature and Man* was awarded a prize by the Association of American Publishers; and in 1992, he published *Reality Rules*, a two-volume text on mathematical modeling. In addition to these technical volumes, he has written several popular books on science, including *X-Events: Complexity Overload and the Collapse of Everything* (2012). Dr. Casti received his Ph.D. in mathematics at the University of Southern California in 1970.



James E. (Jae) Edmonds is a Chief Scientist and Battelle Laboratory Fellow at the Pacific Northwest National Laboratory's (PNNL) Joint Global Change Research Institute, and Adjunct Professor of Public Policy at the University of Maryland at College Dr. Edmonds is the principal investigator for the Global Energy Technology Strategy Program to Address Climate Change, an international, public-private research collaboration. His research in the areas of long-term, global, energy, economy, and climate change spans three decades, during which time he published several books, numerous scientific papers and made countless presentations. His most recent book, *Global Energy Technology Strategy, Addressing Climate Change*, distills

more than a decade of research on the role of technology in addressing climate change. Dr. Edmonds has served in the capacity of Lead Author on every major IPCC assessment to date and presently serves on the IPCC Steering Committee on "New Integrated Scenarios". He serves on numerous panels and advisory boards related to energy, technology, the economy and climate change. His received his Ph.D. in Economics from Duke University.



Parfait Eloundou-Enyegue is an Associate Professor in the Department of Development Sociology in the College of Agriculture and Life Sciences at Cornell University. His research areas include the sociology of education, social change, and the demography of inequality; with a major focus on refining existing frameworks for estimation of the effects of demographic change on the formation of human capital. Sub-Saharan Africa is the geographic center of his research and outreach efforts, and he seeks to support institutions that conduct demographic research and analysis in francophone Africa. Dr. Eloundou-Enyegue carries these interests into his teaching of courses on education and inequality and the empirics of global inequality. He is a member of the International Advisory Board for the World Family Map Project, a member of the board of trustees of the U.S. Population Reference Bureau, a panel chair for the International Union for the Scientific Study of Population, and serves as an adjunct professor for the Korea University Summer School. Dr. Eloundou-Enyegue's B.Sc. is from the National College of Agricultural Sciences UCD, Cameroon, and his M.Sc. and Ph.D. are from the Pennsylvania State University.



Andrew Jorgenson serves as the director of graduate studies of the Sociology Department at the University of Utah. He is also a member of the American Sociological Association's Task Force on Sociology and Global Climate Change and affiliated with the Scholars Strategy Network. Dr. Jorgenson is a new consulting editor for the American Journal of Sociology, he serves on the editorial boards for the International Journal of Comparative Sociology and Human Ecology Review, he is the former editor of the Journal of World-Systems Research (the official journal of the Political Economy of the World-System Section of the American Sociological Association), and he is an elected council member for the Sociology of Development Section of the American Sociological Association. He currently teaches graduate seminars in Introductory Regression Models and Longitudinal Data Analysis, as well as an undergraduate course in Challenges to Global Sustainability. Every year, Dr. Jorgenson teaches a 2 week intensive seminar in Applied Statistics in the Medical School and an intensive 3 day seminar in Global Social Change at Vilnius University, located in Vilnius, Lithuania. His B.S. is from the University of Utah, and M.A. and Ph.D. from the University of California, Riverside.



Wolfgang Lutz is leader of the World Population Program of the International Institute for Applied Systems Analysis (IIASA), director of the Vienna Institute of Demography (VID) of the Austrian Academy of Sciences, Professor of Applied Statistics at the WU-Vienna and Professorial Research Fellow at the Oxford Institute of Ageing. He is Co-Principal Investigator of the Asian MetaCentre for Population and Sustainable Development and serves on the Board of Directors of PRB (Population Reference Bureau), the Berlin Institute for Population and Development and is member of the US National Academy of Sciences Committee on Population. Dr. Lutz has served as chair of the scientific program committee of the African Population and Health Research Centre (APHRC) in Nairobi and as Secretary General of the IUSSP (International Union for the Scientific Study of Population). He is the only expert in population and development to receive the European Research Council (ERC) Advanced Investigator Grant. In 2009 he received the prestigious Mattei Dogan Award of the IUSSP. He has written/edited 22 scientific books and published over 200 articles in scientific journals (including seven in *Science* and *Nature*, two in *Philosophical Transactions* and 21 in *Population and Development Review*). Prof. Lutz holds a PhD in Demography from the University of Pennsylvania and a second doctorate (Habilitation) in Statistics from the University of Vienna.



Peter Marcotullio is Associate Professor in the Department of Geography, Hunter College, City University of New York (CUNY). Dr. Marcotullio moved into this full-time position from a Hunter College Distinguished Lectureship (2007 – 2009), where he taught in the Department of Urban Affairs and Planning, the Department of Geography and in the CUNY Macaulay Honors College. He is also co-Director of the Environmental Studies Program at Hunter College and the co-Deputy Director of the CUNY Institute for Sustainable Cities. His research interests include development and urban environmental change with a regional focus on East and South-east Asia, urbanization and the environment and urban and regional environmental planning. Prior to returning to New York City, he was Professor of Urban Planning, Urban Engineering Department,

University of Tokyo (1998-2006), and held several positions at the United Nations University, Japan (1997-2008). From 2001-2005, Dr. Marcotullio participated in the Millennium Ecosystem Assessment as the co- Coordinating Lead Author of the urban systems chapter and is currently Program Associate with the International Human Dimensions Program's Urbanization and Global Environmental Change project and Council Member of IntEcopolis, the International Council on Ecopolis Development, which is an international urban development project that evolved from the ISCU Scientific Committee on Problems of the Environment (SCOPE) Eco-cities project. Prof. Marcotullio holds a MA in Biology from the University of Pennsylvania and an MA in Geography and a PhD in Urban Planning from Columbia University.



Branko Milanović is a lead economist in the World Bank's research department, where he has been working on the topics of income inequality and globalization. Previously, he was a World Bank country economist for Poland and a research fellow at the Institute of Economic Sciences in Belgrade. Since 1996, Milanović has also served as a visiting professor teaching the economics of transition at the Johns Hopkins University's School for Advanced International Studies. As a senior associate on a two-year assignment with the Carnegie Endowment for International Peace's Global Policy Program, Milanović focused his research on globalization and world income distribution, as well as the

interaction between politics, reform, and inequality in transition countries. He remained an adjunct scholar with the Endowment until early 2010. Milanović's publications in book form include *The Haves and Have Nots: A Brief and Idiosyncratic History of Global Inequality* (2012); *Worlds Apart: Measuring International and Global Inequality* (2005); *Income and Influence: Social Policy in Emerging Economies*, with Ethan Kapstein (2002); and *Inequality and Poverty During the Transition From Market Economy* (1998). He received his Ph.D. in economics in 1987 from Belgrade University.



Siwa Msangi, a citizen of Tanzania, is Senior Research Fellow within the Environment and Production Technology Division and leads the International Food Policy Research Institute (IFPRI) research theme on Global Food and Natural Resources. His work focuses on the major socio-economic and bio-physical drivers affecting agricultural production and trade, and their impacts on nutrition, poverty and the environment. Siwa manages a research portfolio that includes the economic and environmental dimensions of sustainable intensification of agriculture, aquaculture and livestock, biofuels and the bioeconomy, climate change impacts on agriculture and climate adaptation, as well as

resource management of surface and groundwater. Dr. Msangi's PhD is from the University of California, Davis.



Brian O'Neill leads the Integrated Assessment Modeling group within the Climate Change Research section at the National Center for Atmospheric Research (NCAR). He worked previously at the Environmental Defense Fund, and on the faculty of the Watson Institute for International Studies at Brown University. In addition, he founded and led from 2005 to 2009 the Population and Climate Change Program of the International Institute for Applied Systems Analysis (IIASA). He is the lead author, with Landis MacKellar and Wolfgang Lutz, of *Population and Climate Change*, published by Cambridge University Press. Dr. O'Neill works to bridge the physical science of climate change with research into population demographics and other socioeconomic issues. His specialty, known as integrated assessment modeling, addresses such questions as whether an aging population will naturally tend to engage in activities that emit fewer greenhouse gases and the extent to which emissions are likely to increase because of the increasing urbanization of developing countries. He also studies the challenges faced by policy makers in addressing climate change when some of the impacts of global warming are long term and uncertain. Dr. O'Neill's Ph.D. is from New York University in Earth Systems Science.



Stephen Polasky is the Fesler-Lampert Professor of Ecological / Environmental Economics at the University of Minnesota. He previously held faculty positions in the Department of Agricultural and Resource Economics at Oregon State University (1993-1999) and the Department of Economics at Boston College (1986-1993). Dr. Polasky was the senior staff economist for environment and resources for the President's Council of Economic Advisers 1998-1999. He was elected into the National Academy of Sciences in 2010, as a Fellow of the American Academy of Arts and Sciences in 2009, and as a Fellow of the American Association for the Advancement of Science in 2007. His research interests include ecosystem services, natural capital, biodiversity conservation, endangered species policy, integrating ecological and economic analysis, renewable energy, environmental regulation, and common property resources. His papers have been published in *Biological Conservation*, *Ecological Applications*, *Journal of Economics Perspectives*, *Journal of Environmental Economics and Management*, *International Economic Review*, *Land Economics*, *Nature*, *Proceedings of the National Academy of Sciences*, *Science* and other journals. He has served as co-editor and associate editor for the *Journal of Environmental Economics and Management*, as associate editor for *International Journal of Business and Economics*, and is currently serving as an associate editor for *Conservation Letters*, *Ecology and Society* and *Ecology Letters*. Dr. Polasky received his Ph.D. in economics from the University of Michigan.



William B. Rouse is a researcher, educator, author and entrepreneur. His current positions include Alexander Crombie Humphreys Chair in Economics of Engineering in the School of Systems and Enterprises at Stevens Institute of Technology, and Professor Emeritus in the School of Industrial and Systems Engineering at the Georgia Institute of Technology. His earlier positions include Executive Director of the university-wide Tennenbaum Institute, Chair of the School of Industrial and Systems Engineering, CEO of two innovative software companies – Enterprise Support Systems and Search Technology – and earlier faculty positions at Georgia Tech, University of Illinois, Delft University of Technology, and Tufts University. His expertise includes individual and organizational decision making and problem solving, as well as design of organizations and information systems. His current research focuses on understanding and managing complex public-private systems such as healthcare, energy, and defense, with emphasis on mathematical and computational modeling of these systems for the purpose of policy design and analysis. Among many advisory roles, he has served as Chair

of the Committee on Human Factors of the National Research Council, a member of the U.S. Air Force Scientific Advisory Board, and a member of the DoD Senior Advisory Group on Modeling and Simulation. He has been designated a lifetime National Associate of the National Research Council and National Academies. Rouse received his B.S. from the University of Rhode Island, and his S.M. and Ph.D. from the Massachusetts Institute of Technology.



Juliet Schor is Professor of Sociology at Boston College. Before joining Boston College, she taught at Harvard University for 17 years, in the Department of Economics and the Committee on Degrees in Women's Studies. A graduate of Wesleyan University, Schor received her Ph.D. in economics at the University of Massachusetts. Her most recent book is *Plenitude: The New Economics of True Wealth* (The Penguin Press 2010). She is also author of the national best-seller, *The Overworked American: The Unexpected Decline of Leisure* (Basic Books, 1992) and *The Overspent American: Why We Want What We Don't Need* (Basic Books, 1998), as well as a number of other books. Schor is currently working on issues of environmental sustainability and their relation to

Americans' lifestyles and the economy and the emergence of a conscious consumption movement. Schor is a co-founder of the Center for a New American Dream, a national sustainability organization; of the South End Press; and of the Center for Popular Economics. She has been a fellow at the John Simon Guggenheim Memorial Foundation, and received the Leontief Prize for expanding the frontiers of economic thought. She has lectured widely throughout the United States, Europe, and Japan to a variety of civic, business, labor and academic group, and appears frequently on national and international media. Dr. Schor received her B.A. magna cum laude from Wesleyan University and her Ph.D. in Economics from the University of Massachusetts.



Karen Seto is an established leader in the area of urbanization and global environmental change. She is Co-Chair of the Urbanization and Global Environmental Change Project (UGEC) of the International Human Dimensions Programme on Global Environmental Change (IHDP), and a Coordinating Lead Author for Working Group III of the IPCC Fifth Assessment Report. She also serves on the National Research Council Committee to Advise the U.S. Global Change Research Program (USGCRP), the National Research Council Geographical Sciences Committee, the National Research Council Committee on Needs and Research Requirements for Land-Change Modeling, and the U.S. Carbon Cycle Science Steering Group. From 2002

to 2008, she was the Global Thematic Leader for Ecosystem Management Tools for the Commission on Ecosystem Management of the International Union for Conservation of Nature (IUCN). She is the Executive Producer of "10,000 Shovels: Rapid Urban Growth in China," a documentary film that integrates satellite imagery, historical photographs, and contemporary film footage to highlight the urban changes occurring in China. Professor Seto is a recipient of a NASA New Investigator Program Award, a NSF Career Award, and a National Geographic Research Grant. She was named an Aldo Leopold Leadership Fellow in 2009. Seto's research is on the human transformation of land and the links between urbanization, global change, and sustainability. A geographer by training, her research integrates remote sensing, field interviews, and modeling methods to study land change and urbanization, forecast urban growth, and examine the environmental consequences of urban expansion. Her B.A. is from the University of California, Santa Barbara, and her M.A. and Ph.D. were earned at Boston University.



B. L. Turner II is Gilbert F. White Professor of Environment and Society in the School of Geographical Sciences and Urban Planning at Arizona State University. Turner came to ASU after 28 years in the Graduate School of Geography, Clark University, where he was Higgins Professor of Environment and Society, served as Director of that School for more than decade, and helped to create and administer the George Perkins Marsh Institute, which engages a range of human-environment problems. He previously held appointments at the University of Oklahoma and the University of Maryland, Baltimore County. Professor Turner is currently engaged in land change science focused especially on deforestation and sustainability in the southern Yucatán. Turner is a recipient of Distinguished Research Honors from the Association of American Geographers (1995) and the Centenary Medal, Royal Scottish Geographical Society (1996), among other honors. He is former Guggenheim Fellow (1981) and Fellow of the Center for Advanced Studies in the Behavioral Sciences (1994). He was elected to the National Academy of Sciences in 1995, the American Academy of Arts and Sciences in 1998, and the inaugural class of the Massachusetts Academy of Sciences in 2008. B. L. Turner II took his B.A. and M.A. degrees from the University of Texas at Austin, and his Ph.D. in geography from the University of Wisconsin-Madison.