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Progress, Challenges, and Opportunities for Sustainability Science: A Workshop
November 30-December 2, 2020

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2. Folke, C et al. 2020. Our Future in the Anthropocene Biosphere: Global sustainability and resilient societies. *Beijer Discussion Paper Series 272*. http://beijer.kva.se/publication/our-future-in-the-anthropocene-biosphere-global-sustainability-and-resilient-societies

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Progress, Challenges, and Opportunities for Sustainability Science: A Workshop

November 30-December 2, 2020

(All times are North American Eastern Standard Time / UTC-5)

AGENDA

Meeting Goals:

- Examine scientific progress and gaps in six cross-cutting themes that are relevant to almost all research and innovation efforts for sustainability and that have the potential to improve the efficacy of those efforts.
- Provide scientific input to the discussions of the National Academy of Sciences (NAS) Grand Challenges in Science and the Nobel Prize Summit science session in Spring 2021.

Monday, November 30, 2020

8:00 am **Welcome from the National Academy of Sciences**
Marcia McNutt (NAS), National Academy of Sciences

8:05 am **Goals for the Workshop and Framing Remarks**
Pamela Matson (NAS), Stanford University, Workshop Co-Chair
William Clark (NAS), Harvard University, Workshop Co-Chair

8:30 am **Panel I: Measuring Progress Toward Sustainable Development**
A major challenge in sustainability science is empirically measuring progress towards sustainable development. Much work to date has focused on multiple indicators of past trends, which is part of the picture, but does not address what is likely to happen in the future (prediction) nor provide an evaluation of tradeoffs among indicators (valuation). This panel will feature recent advances in measurement that incorporate: (1) forward-looking models; (2) uncertainty including potential tipping points; (3) valuation of components of sustainable development; (4) inequalities in the distribution of benefits and risks; and (5) connections among places (e.g. trade patterns, externalities).

Moderator: **Stephen Polasky** (NAS), University of Minnesota
Panelists:

- **Shunsuke Managi**, Kyushu University
  Measuring sustainable progress: global outlook
- **Eli Fenichel**, Yale University
  What to measure, not how to measure it
- **Marshall Burke**, Stanford University
  Using satellite imagery to understand and promote sustainable development
- **Elena Irwin**, Ohio State University
  Downscaling sustainability theory and measurement to subnational regional scales: Conceptual and empirical challenges

Discussant: **Catherine Kling** (NAS), Cornell University

10:00 am BREAK

10:15 am **Panel II: Promoting Equity and Justice in Sustainability Efforts**

Sustainability science has made extraordinary progress to advance knowledge and identified models for greater wellbeing and environmental conservation—even if progress on environmental goals remains uncertain and patchy. But the practical realization of greater environmental equity and social justice—despite decades of calls by researchers and practitioners alike—requires far more attention. Limited progress on equity threatens future achievement of all other sustainability goals—indeed, equity, justice, and sustainability can no longer be seen as separable, if ever they were! Participants in our panel will collectively contribute to a more transparent understanding of the role of power, learning, networks, and institutions for building the alliances that durably support more equitable and just outcomes for sustainability in its multiple dimensions and at cascading societal levels.

Moderator: **Arun Agrawal** (NAS), University of Michigan
Panelists:

- **Melissa Leach**, University of Sussex
  Equity and sustainability: reflecting on the interactions
- **Laura Pulido**, University of Oregon
  White Supremacy as Roadblock to Sustainability
- **Jaboury Ghazoul**, Swiss Federal Institute of Technology
  Leveling the landscape management playing field
- **Flor Avelino**, Erasmus University
  Power in transition? Power perspectives on transformative social innovation

Discussant: **Yadvinder Malhi**, Oxford University

11:45 am **Adjourn**

Tuesday, December 1, 2020

8:00 am **Welcome and Re-Cap from Previous Day**
Pamela Matson (NAS), Stanford University, Workshop Co-Chair
William Clark (NAS), Harvard University, Workshop Co-Chair

8:15 am **Panel III: Adapting to Shocks and Surprise**

Adaptation concerns not only the dynamic interplay of people, communities, societies, cultures but also the coevolution of people and nature as part of the biosphere and now also at global levels. The panel will focus on capacities for dealing with shocks and surprises as part of strategies for learning and developing with change and what this implies for living in the more turbulent times of the Anthropocene. Panelists will present and discuss findings in relation to climate change, biodiversity loss, inequality, technological change and biosphere stewardship and in the context of just and sustainable futures.

Moderator: **Carl Folke** (NAS), Royal Swedish Academy of Sciences
Panelists:

- **Victor Galaz**, Stockholm University
  Anthropocene risks: connectivity, shocks and surprise
- **Christina Hicks**, Lancaster University
  Adaptive capacities from a local context: knowledge, agency, and voice
- **Marty Anderies**, Arizona State University
  Surprises from within: navigating variability across scales in social-ecological system dynamics

- **Belinda Reyers**, University of Pretoria
  Resilience capacities and sustainable development in intertwined social-ecological systems

Discussant: **Neil Adger**, University of Exeter

9:45 am BREAK

10:00 am **Panel IV: Fostering Innovation for Transformational Change**

A critical challenge for sustainability is to identify key leverage points to foster positive "game-changing" transformations towards green energy systems, sustainable land and resource management, environmentally- and socially-friendly corporate practice, equitable economic development, and other goals. The session examines advances in understanding the behavior of complex adaptive systems and the dynamics that either prevent or promote transformations towards sustainability across varying scales and types of human organization and socio-ecological systems. Research on transformations aims to inform policies, management, and technological development to promote positive, large-scale shifts towards sustainability.

Moderator: **Ruth DeFries** (NAS), Columbia University
Panelists:

- **Frank Geels**, The University of Manchester
  A socio-technical transitions perspective on sustainability transformations
- **Reinette (Oonsie) Biggs**, Stellenbosch University
  Seeds of good Anthropocenes: fostering transformational change toward sustainable futures
- **Garry Peterson**, Stockholm University
  Resilience, collapse, & transformation: strategies for navigating turbulent times
- **Harini Nagendra**, Azim Premji University
  Through education, research and practice: seeking new imaginations of transformation from the global south

Discussant: **Stephen Carpenter** (NAS), University of Wisconsin-Madison

11:30 am **Adjourn**

Wednesday, December 2, 2020

8:00 am **Welcome and Re-Cap from Previous Day**
Pamela Matson (NAS), Stanford University, Workshop Co-Chair
William Clark (NAS), Harvard University, Workshop Co-Chair

8:15 am **Panel V: Linking Knowledge with Action**

This panel will discuss successes and lessons from social science research on linking knowledge to action in the sustainability sciences, especially for the cases of climate and biodiversity, including actors such as universities, think tanks, governments, business and nongovernmental organizations and through concepts that include co-production, boundary work, and climate and ecosystem services.

Moderator: **Diana Liverman** (NAS), University of Arizona
Panelists:

- **Maria Carmen Lemos**, University of Michigan
  Scaling up user engagement: increasing participation, actionable knowledge, and impact

- **Esther Turnhout**, Wageninen University
  Transforming global environmental science to become more responsive to diverse user needs
- **Meaghan Daly**, University of New England
  The role of power in producing actionable knowledge: examining the case of climate services
- **Sarah Burch**, University of Waterloo
  Deepening community-based sustainability transformations: the case for capacity-building in small business ecosystems

Discussant: **Lorrae Van Kerkhoff**, The Australian National University

9:45 am BREAK

10:00 am **Panel VI: Managing and Governing Complex Nature-Society Systems**

We conceptualize "governance" as the process of devising institutions and following practices for making and implementing collective decisions for a set of human beings. Our focus is on sustainable development as defined by the statement for the workshop. We will discuss what has been learned through scientific research about governing complex nature-society systems in a way consistent with sustainable development; and about promising directions for future scientific research. We will be particularly attentive to issues of power, distributional conflict, path-dependence, and equity. We will focus on three specific nature-society systems, on all of which efforts at governance have been made: climate change, pandemics, and cities.

Moderator: **Robert O. Keohane** (NAS), Princeton University
Panelists:

- **Michael Osterholm** (NAM), University of Minnesota
  Responding to COVID-19 with science
- **Harriet Bulkeley**, Durham University
  Governing cities for climate and Nature
- **Leah Stokes**, University of California, Santa Barbara
  Understanding climate action in the United States

Discussant: **Chukwumerije Okereke**, Alex-Ekwueme Federal University

11:30 am BREAK

11:45 am **Workshop Synthesis: Challenges and Opportunities for Sustainability Science**

Moderator: **William Clark** (NAS), Harvard University, Workshop Co-Chair
Key Themes from Each Panel:

- **Stephen Polasky** (NAS), University of Minnesota
- **Arun Agrawal** (NAS), University of Michigan
- **Carl Folke** (NAS), Royal Swedish Academy of Sciences
- **Ruth DeFries** (NAS), Columbia University
- **Diana Liverman** (NAS), University of Arizona
- **Robert O. Keohane** (NAS), Princeton University

12:30 pm **Sustainability Science as a Growing Field of Scholarship**
B. L. Turner II (NAS), Arizona State University

12:45 pm **Sustainability Science as a Guide to the Pursuit of Sustainability**
Pamela Matson (NAS), Stanford University, Workshop Co-Chair

1:00 pm **Workshop Conclusion**

Progress, Challenges, and Opportunities for Sustainability Science: A Workshop

Statement of Task
An expert committee of the National Academies of Sciences, Engineering, and Medicine will organize a virtual workshop to explore critical areas of sustainability science that can help societies meet the goals of sustainable development. Presentations by speakers and discussions with participants will clarify what has been learned through scientific research about six cross-cutting issues of importance to sustainability progress in any sector, and what more is needed to make that knowledge most useful to decision making. Major objectives of the workshop will include:

- To explore scientific progress and gaps in six cross-cutting areas, such as (1) measuring progress toward sustainable development; (2) promoting equity and justice in sustainability efforts; (3) adapting to shocks; (4) linking knowledge and action; (5) fostering innovation for transformational change; and (6) managing and governing complex social-environmental systems;
- To discuss opportunities for scientific efforts that could contribute to research-based knowledge around sustainable development and sustainability, and the use of such knowledge in decision making; and
- To provide scientific input to the discussions of the National Academy of Sciences Grand Challenges in Science and the Nobel Prize Summit science session in Spring 2021.

The workshop will include participants from academic and non-academic research institutions as well as practitioners from government, the private sector, and non-governmental sector who are concerned with linking knowledge with decision making in the pursuit of sustainability. A Proceedings of a Workshop—in Brief will be prepared by a designated rapporteur in accordance with institutional guidelines and distributed broadly to interested parties, including those involved in the Nobel Prize Summit.

Selected Background Readings

- Clark, W. C., and A. G. Harley. 2020. Sustainability Science: Toward a Synthesis. *Annual Review of Environment and Resources* 45(1):331-386. https://doi.org/10.1146/annurev-environ-012420-043621
- Folke, C et al. 2020. Our Future in the Anthropocene Biosphere: Global sustainability and resilient societies. *Beijer Discussion Paper Series 272*. http://beijer.kva.se/publication/our-future-in-the-anthropocene-biosphere-global-sustainability-and-resilient-societies

Committee Membership Information
Pamela Matson (NAS) (Co-Chair), Richard and Rhoda Goldman Professor in Environmental Studies; Director, Change Leadership for Sustainability; and Senior Fellow, Woods Institute for the Environment, Stanford University
William C. Clark (NAS) (Co-Chair), Harvey Brooks Professor of International Science, Public Policy and Human Development, Kennedy School of Government, Harvard University
Arun Agrawal (NAS), Samuel Trask Dana Professor, School of Natural Resources and Environment, University of Michigan
Partha Dasgupta (NAS), Frank Ramsey Professor Emeritus, Faculty of Economics, University of Cambridge
Ruth Defries (NAS), Professor of Ecology and Sustainable Development, Columbia University
Carl Folke (NAS), Director, The Beijer Institute of Ecological Economics, Royal Swedish Academy of Sciences
Robert Keohane (NAS), Professor of International Affairs, Emeritus, Woodrow Wilson School of Public and International Affairs, Princeton University
Diana Liverman (NAS), Regents Professor, School of Geography, Development and Environment, University of Arizona
Stephen Polasky (NAS), Regents Professor & Fesler-Lampert Professor of Ecological/Environmental Economics, University of Minnesota

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Background Readings
(* for featured readings)

Workshop Overview

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*Folke, C et al. 2020. Our Future in the Anthropocene Biosphere: Global sustainability and resilient societies. *Beijer Discussion Paper Series 272*. http://beijer.kva.se/publication/our-future-in-the-anthropocene-biosphere-global-sustainability-and-resilient-societies

Panel I: Measuring Progress toward Sustainable Development

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Panel II: Promoting Equity and Justice in Sustainability Efforts

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Panel III: Adapting to Shocks and Surprise

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Panel IV: Fostering Innovation for Transformational Change

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Panel V: Linking Knowledge with Action

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Progress, Challenges, and Opportunities for Sustainability Science: A Workshop
November 30-December 2, 2020

Moderator and Speaker Biographical Information

PAMELA MATSON (NAS) (Steering Committee Co-Chair) is the Richard and Rhoda Goldman Professor of Environmental Studies, Director of the Change Leadership for Sustainability, and Senior Fellow at the Woods Institute for the Environment at Stanford University. Dr. Matson served as dean of Stanford University's School of Earth, Energy and Environmental Sciences from 2002-2017, building interdisciplinary departments and educational programs focused on resources, environment and sustainability, as well as co-leading university-wide interdisciplinary initiatives. Her research addresses a range of environment and sustainability issues, including sustainability of agricultural systems, vulnerability and resilience of particular people and places to climate change, and characteristics of science that can contribute to sustainability transitions at scale. Dr. Matson serves as chair of the board of the World Wildlife Fund-US and as a board member of the World Wildlife Fund-International and several university advisory boards. She is a past President of the Ecological Society of America. Her recent publications (among around 200) include *Seeds of Sustainability: Lessons from the Birthplace of the Green Revolution in Agriculture* (2012) and *Pursuing Sustainability: A Guide to the Science and Practice* (2016). Dr. Matson is an elected member of the National Academy of Science and the American Academy of Arts and Sciences, and is an American Association for the Advancement of Science Fellow. She received a MacArthur Foundation Award, contributed to the award of the Nobel Prize to the Intergovernmental Panel on Climate Change, among other awards and recognitions, and is an Einstein Fellow of the Chinese Academy of Sciences. Dr. Matson holds a Bachelor of Science degree with double majors in Biology and Literature from the University of Wisconsin (Eau Claire), a Master degree in Environmental Science and Policy from Indiana University's School of Public and Environmental Affairs, a Doctorate in Forest Ecology from Oregon State University, and honorary doctorates from Princeton, McGill and Arizona State Universities.

WILLIAM C. CLARK (NAS) (Steering Committee Co-Chair) is the Harvey Brooks Professor of International Science, Public Policy and Human Development at Harvard University's John F. Kennedy School of Government. Trained as an ecologist, his research focuses on sustainability science: understanding the interactions of nature and society with a view toward advancing the goals of sustainable development. He is particularly interested in how institutional arrangements affect the linkage between knowledge and action in the sustainability arena. At Harvard University, he serves as Area Chair for the program in International and Global Affairs and co-directs the Sustainability Science Program. He is co-author of *Sustainability Science: Toward a synthesis* (ARER, 2020), *Pursuing sustainability: A guide to the science and practice* (Princeton, 2016), *Adaptive environmental assessment and management* (Wiley, 1978), and *Redesigning rural development* (Hopkins, 1982); editor of the *Carbon dioxide review* (Oxford, 1982); coeditor of *Sustainable development of the biosphere* (Cambridge, 1986), *The earth transformed by human action* (Cambridge, 1990*), Learning to manage global environmental risks* (MIT, 2001), *Global Environmental Assessments* (MIT, 2006) and *The global health system: Institutions in a time of transition* (Harvard, 2010); and co-chair of the U.S. National Research Council's study *Our Common Journey: A Transition Toward Sustainability* (National Academies Press, 1999). He serves on the editorial board of the *Proceedings of the National Academy of Science*. Dr. Clark is a member of the National Academy of Sciences and a Fellow of the American Association for the Advancement of Science. He is a recipient of the MacArthur Prize, the Humboldt Prize, the Kennedy School's Carballo Award for excellence in teaching, and the Harvard College Phi Beta Kappa Prize for Excellence in Teaching. Dr. Clark received his Ph.D. in Ecology from University of British Columbia and his B.S. from Yale University.

NEIL ADGER is Professor of Human Geography at University of Exeter. He teaches, supervises graduate students, and researches in the areas of environmental geography, ecological and institutional economics, and global environmental change. Dr. Adger is a ISI Highly Cited Researcher in the Social Sciences in 2015, 2016 and 2017, one of the few geographers whose work is widely cited across the disciplines. He led the chapter on Human Security and was a member of the core writing team for the Summary for Policy Makers for the Intergovernmental Panel on Climate Change Fifth Assessment Report Working Group 2 published in final form in 2014. He previously served as a Convening Lead Author for the 2007 Fourth Assessment Report of the Intergovernmental Panel of Climate Change and in the Third Assessment Report in 2001. He also served as a Lead Author in the Millennium Ecosystem Assessment and continues to work extensively on ecosystem services and well-being. In 2015 Dr. Adger acted as a Commissioner and author of the Lancet Commission Climate Health Commission, publishing "'Climate Change and Health 2015: Policy Responses to Protect Public Health" arguing for urgent action on climate change to maintain and enhance well-being. He is Chair of the Board of Directors of the Beijer Institute of Ecological Economics at the Royal Swedish Academy of Sciences and serves on the International Scientific Advisory Committee of the Basque Centre for Climate Change in Bilbao. He is on the Editorial Board of Global Environmental Change, having served as Editor from 2004-2013, Global Sustainability, Ambio and Ecology and Society. Dr. Adger received his M.A. in Economics from University of Edinburgh, a M.S.c. in Agricultural Economics from Wye College, University of London, and a Ph.D. from the School of Environmental Sciences at University of East Anglia.

ARUN AGRAWAL (NAS) (Steering Committee Member) is a Samuel Trask Dana Professor at the School of Natural Resources and Environment at the University of Michigan. His research and teaching emphasize the politics of international development, institutional change, and environmental conservation. He has written critically on indigenous knowledge, community-based conservation, common property, population and resources, and environmental identities. Dr. Agrawal is the coordinator for the International Forestry Resources and Institutions network and is currently carrying out research in central and east Africa as well as in South Asia. Since 2013, Dr. Agrawal has served as the editor-in-chief of *World Development*, and his recent work has appeared in *Science*, *Proceedings of the National Academy of Sciences of the United States of America*, *Conservation Biology*, and *Development and Change*, among other journals. Preceding his work at the University of Michigan, Dr. Agrawal held teaching and research positions at Yale University; University of Florida; McGill University; University of California, Berkeley; and Harvard University, among others. Dr. Agrawal received his Ph.D. in political science (1992) from Duke University.

MARTY ANDERIES is Professor at the School of Sustainability, College of Global Futures at Arizona State University (ASU). His research interests focus on developing an understanding of how ecological, behavioral, social, and institutional factors affect the robustness/vulnerability characteristics of social-ecological systems. His work combines qualitative insights from present-day, historical, and archaeological case studies of social-ecological systems with formal mathematical modeling and experiments with human subjects to study how individual decision-making processes interact with governance regimes to influence social and environmental outcomes. Other areas of interest include economic growth, demographics, and theoretical ecology. He received his Ph.D. and M.S. in Applied Mathematics from the University of British Columbia.

FLOR AVELINO works at the Dutch Research Institute for Transitions, Erasmus University Rotterdam as assistant professor and senior researcher in the politics of sustainability transitions and social innovation. She is specialized in power and empowerment theories, and has a particular interest in translocal networks and innovation movements that aim to tackle social challenges. As scientific coordinator of the TRANSIT project she was one of the initiators of the Transformative Social Innovation Manifesto. As the academic director of the Transition Academy, Dr. Flor strives to co-create new learning environments to challenge people to think and act for radical, transformative change. Dr. Flor received

her Ph.D. in Power and Empowerment in Sustainability Transitions from Erasmus University Rotterdam, M.A. in Political Science from University of Leiden, and B.A. in Social Sciences & Humanities (interdisciplinary) from University of Utrecht.

REINETTE (OONSIE) BIGGS holds a Department of Science and Technology/National Research Foundation (NRF) South African Research Chair (SARChI) in Social-Ecological Systems and Resilience. She is an NRF P-rated researcher, and holds a joint appointment in the School of Public Leadership at Stellenbosch University, and the Stockholm Resilience Centre at Stockholm University in Sweden. Professor Biggs coordinates the Southern African Program on Ecosystem Change and Society (SAPECS), a network of researchers and practitioners working on social-ecological systems in the southern African region (see www.sapecs.org). Professor Biggs' research aims to advance theory and understanding of complex social-ecological systems, specifically how to build resilience to deal with uncertainty, surprise and ongoing environmental and social change. A specific focus of her research are regime shifts—large, often abrupt, long-lasting changes in social-ecological systems that can have dramatic implications for human economies and societies. Through her research, Professor Biggs aims to develop practical theory, methods and insights that can ultimately contribute to facilitating transitions to more sustainable futures in Southern Africa. Professor Biggs received her Ph.D. in Limnology and Marine Science from University of Wisconsin-Madison and her M.S. in Environmental Science from University of the Witwatersrand, Johannesburg, Gauteng, South Africa.

HARRIET BULKELEY holds joint appointments as Professor in the Department of Geography, Durham University, and at the Copernicus Institute of Sustainable Development, Utrecht University. Her research focuses on environmental governance and the politics of climate change, energy and sustainable cities. She has published 8 books, several edited collections and over 60 papers, including An Urban Politics of Climate Change (Routledge 2015) and Accomplishing Climate Governance (CUP 2016). Dr. Bulkeley currently Co-ordinates the H2020 NATURVATION project examining the role of urban innovation with nature based solutions for sustainable development and is a co-investigator on the H2020 REINVENT project examining the political and financial challenges of decarbonisation. She has undertaken commissioned research for the UK Government, European Commission, NGOs, UN-Habitat and the World Bank. In 2014, Dr. Bulkeley was awarded the King Carl XVI Gustaf Professorship in Environmental Science and a Visiting Professorship at Lund University, Sweden and in 2018 was granted the Back Award by the Royal Geographical Society in recognition of the policy impact of her work on climate change. She was elected as a Fellow of the British Academy in 2019. Dr. Bulkeley received her Ph.D. and B.A. in Geography from University of Cambridge.

SARAH BURCH holds a Canada Research Chair in Sustainability Governance and Innovation, and is an Associate Professor in the Department of Geography and Environmental Management, University of Waterloo, Canada. She is an expert in transformative responses to climate change at the community scale, innovative strategies for making progress on sustainability, and the unique contributions that small businesses can make to this solving this complex challenge. She leads the international partnership-based research project *TRANSFORM: Accelerating sustainability entrepreneurship experiments in local spaces*, and is the Director of the Sustainability Policy Research on Urban Transformations (SPROUT) Lab. She is a Lead Author of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (winner of the Nobel Peace Prize in 2007). She was elected to the Royal Society of Canada's College of New Scholars in 2017 and was named one of Canada's Top 40 Under 40^{TM} in 2018. Her most recent book is entitled 'Understanding Climate Change: Science, Policy and Practice,' and she has taught the first Massive Open Online Course on climate change, which reached thousands over students in over 130 countries. Dr. Burch holds a Ph.D. from the University of British Columbia, and held a postdoctoral fellowship at the University of Oxford.

MARSHALL BURKE is an associate professor in the Department of Earth System Science, deputy director at the Center on Food Security and the Environment, and center fellow at the Freeman Spogli Institute for International Studies (FSI) at Stanford University. He is also a faculty research fellow at the National Bureau of Economic Research, and a co-founder of AtlasAI, a remote sensing start-up. His research focuses on social and economic impacts of environmental change and on measuring and understanding economic development in emerging markets. His work has appeared in both economic and scientific journals, including recent publications in Nature, Science, The Quarterly Journal of Economics, and The Lancet. He holds a Ph.D. in agricultural and resource economics from the University of California, Berkeley and a B.A. in international relations from Stanford University.

STEPHEN CARPENTER (NAS) is Emeritus Director and Professor at University of Wisconsin-Madison's Center for Limnology, where he continues his research on social-ecological systems. He is a member of the U.S. National Academy of Sciences, a Fellow of the American Academy of Arts and Sciences, and a foreign member of the Royal Swedish Academy of Sciences. Dr. Carpenter is the 2011 laureate of the Stockholm Water Prize and recipient of the Ramon Margalef Prize in Ecology 2018. His other notable awards include a Pew Fellowship in Conservation and Environment, the G. Evelyn Hutchinson Medal of the American Society of Limnology and Oceanography, the Robert H. MacArthur Award from the Ecological Society of America, the Excellence in Ecology Prize from the Ecology Institute, and the Naumann-Thienemann medal of the International Society for Limnology. Dr. Carpenter studies the resilience of social-ecological dynamics of watersheds and freshwaters. He is especially interested in prediction of lake characteristics from land-water interactions and food web processes, including human effects such as fishing and introduction of exotic species. This research is linked to larger perspectives of resilience through collaborations with the Beijer Institute of Ecological Economics, Stockholm Resilience Center and Resilience Alliance.

MEAGHAN DALY is an Assistant Professor in Environmental Studies at University of New England. Dr. Daly's research focuses on the interactions between science and society, with a specific interest in examining processes of co-production of knowledge to inform climate change decision-making, planning, and policy. She has also investigated relationships between drought response and climate change adaptation, including how these shape long-term adaptive capacities and the dynamics of vulnerability. She has carried out research in East and Southern Africa, South Asia, Europe, and the U.S. She is currently on the editorial board for the journals Climate Services and Frontiers in Climate. Before joining University of New England, Dr. Daly was a Research Fellow at the Centre for Climate Change Economics and Policy at the University of Leeds and a Research Fellow at the Center for International Climate and Environmental Research (CICERO) in Oslo, Norway. She received an M.A. in Climate and Society from Columbia University and a Ph.D. in Environmental Studies from the University of Colorado Boulder.

PARTHA SARATHI DASGUPTA (NAS) (Steering Committee Member) is the Frank Ramsey Professor Emeritus of Economics at the University of Cambridge, United Kingdom; Fellow of St John's College, Cambridge, and Visiting Professor at the New College of the Humanities, London. Dr. Dasgupta made seminal contributions to many fields in economics. He gave an ethical voice to economics through his espousal of social well-being and the effects of economic policies on the poor. Dr. Dasgupta's analyses are widely used to forge optimal policies for extracting exhaustible resources, and also underlie economic development planning. He also brought new ideas to the understanding of optimal population growth, and how competition fosters technological innovation. His memberships include: fellow of the British Academy and the Royal Society; member of the Pontifical Academy of Social Sciences and the American Philosophical Society and Royal Swedish Academy of Science; honorary fellow of the London School of Economics and Trinity College, Cambridge; honorary member of the American Academy of Arts and Sciences; and international member of the U.S. National Academy of Sciences. His honours include: Volvo Environment Prize (2002), John Kenneth Galbraith Prize of the American Agricultural

Economics Association (2007), Zayed International Prize for the Environment (2011), Blue Planet Prize (2015), and Tyler Prize (2016). Dr. Dasgupta obtained a Ph.D. in Economics at Cambridge. He was made Knight Bachelor in 2002, and was awarded an Honorary Doctorate by, among other universities, University of Bologna in 2012 and Harvard University in 2013.

RUTH DEFRIES (NAS) (Steering Committee Member) is a professor of ecology and sustainable development at Columbia University in New York. She uses images from satellites and field surveys to examine how the world's demands for food and other resources are changing land use throughout the tropics. Her research quantifies how these land use changes affect climate, biodiversity and other ecosystem services, as well as human development. She has also developed innovate education programs in sustainable development. Dr. DeFries was elected as a member of the U.S. National Academy of Sciences, received a MacArthur "genius" award, and is the recipient of many other honors for her scientific research. In addition to over 100 scientific papers, she is committed to communicating the nuances and complexities of sustainable development to popular audiences through her books *The Big Ratchet: How Humanity Thrives in the Face of Natural Crisis* and *What Would Nature Do?: A Guide for Our Complex World*. Dr. DeFries is committed to linking science with policy, for example through her involvement with the Environmental Defense Fund, Science for Nature and People, World Wildlife Fund, and reconciling conservation and development in central India. Dr. DeFries received her Ph.D. from the Department of Geography and Environmental Engineering at Johns Hopkins University. She currently serves on the NAS council.

ELI FENICHEL is the Knobloch Family Professor of Natural Resource Economics at the Yale School of the Environment at Yale University. Dr. Fenichel's research approaches natural resource management and sustainability as a portfolio management problem by considering natural resources as a form of capital. He is interested in how people can and do allocate natural resources and natural resource risks through time. This leads to a strong interest in feedbacks among humans, ecosystems, and the management of coupled ecological-economic processes. His research is applied in a wide variety of systems including: natural capital valuation, fisheries, infectious disease, groundwater, tropical forests, and grasslands. Dr. Fenichel has been writing on the economics of social distancing during an epidemic since 2011. He recently published on paper on COVID-19 and childcare for healthcare workers in Lancet Public Health. A graduate of the University of Maine, Dr. Fenichel earned a Ph.D. in fisheries and wildlife at Michigan State University. He began his academic career as an assistant professor of ecological- and bio-economics at Arizona State University before joining the Yale faculty in 2012. Dr. Fenichel has contributed more than 60 peer-reviewed articles to professional journals. His research has been supported by numerous grants from federal agencies, private foundations, and the United Nations. He has been invited to deliver presentations throughout the United States, as well as in China, Canada, Sweden, Turkey, the United Kingdom, and the Netherlands, among other countries.

CARL FOLKE (NAS) (Steering Committee Member) is Professor and Director of the Beijer Institute of Ecological Economics of the Royal Swedish Academy of Sciences, and founder and Chair of the Board of the Stockholm Resilience Centre at Stockholm University. Dr. Folke is a systems thinker in integrative science for sustainability, recognized for his research on social-ecological systems and resilience thinking. Since the mid-1980s he has broken new ground in understanding the dynamic interplay of humans and nature, of economy and ecology, from management and stewardship of ecosystem services in the seas and on the land to global sustainability. Dr. Folke has contributed in fostering a new generation of sustainability science researchers internationally and in Sweden, built internationally leading research centres and institutes, and worked with scholars across the natural and social sciences and the humanities. He is genuinely engaged in the arts-science interface. Dr. Folke has produced some three-hundred publications and is recognized as highly cited researcher. He has received the Gunnerus Award in Sustainability Science (2017), the International Geographical Union's Planet and Humanity Medal (2016), the Sustainability Science Award of the Ecological Society of America (2004), and the Pew

Scholar Award in Conservation and the Environment (1995). He is member of the Royal Swedish Academy of Sciences (2002) and the U.S. National Academy of Sciences (2017). Dr. Folke received his Ph.D. in Ecological Economics/Natural Resource Management from Stockholm University and became full professor of natural resource management at Stockholm University in 1996.

VICTOR GALAZ is deputy director and associate professor at the Stockholm Resilience Centre, Stockholm University. He is also a programme director at the Beijer Institute for its programme Governance and Complexity as well as senior academy fellow at the Royal Swedish Academy of Sciences where he co-leads the programme Global Economic Dynamic and the Biosphere's work on financial systems, and their connection to large-scale environmental change with global non-linear climate repercussions. Dr. Galaz has extensive experience as research leader in interdisciplinary projects exploring various dimensions of complex adaptive systems from his work as research theme leader (years 2006-2015) at the Stockholm Resilience Centre; Deputy Science Director at the Stockholm Resilience Centre; Acting Executive Director (2014-2015) at the Royal Swedish Academy; project leader for the project "Earth system finance" (2016-ongoing); co-lead of the Lancet Commission on Human Health and Climate Change (2013-2015), Researcher and theme leader in the international research consortium Dynamic Drivers of Disease in Africa (DDDAC), together with STEPS Centre (UK), Institute for Development Studies (UK) and others (2012-2016); Member of the Convention on Biological Diversity Liaison Expert group on geo-engineering (2011-2012); and Advisor to the EU High-Level Group on Innovation Policy Management (2017). Among his publications are articles in journals including The Lancet; International Environmental Agreements; Trends in Environment and Evolution; Frontiers in Ecology and the Environment; Global Environmental Change; Ecological Economics; Public Administration; Environmental Politics; Governance; Complexity, Governance and Networks; Nature Climate Change; Science and others. He is also the author of the book *Global Environmental Governance, Technology and Politics - The Anthropocene Gap* (Edward Elgar, 2015). Dr. Galaz participates actively to international and national public discussions about global sustainability, politics and technology, and is a regular writer in Swedish newspaper media, and in international media outlets like The Guardian.

FRANK GEELS is Professor of System Innovation and Sustainability at the Sustainable Consumption Institute, University of Manchester and chairman of the international Sustainability Transitions Research Network. Dr. Geels is a world-leading scholar on socio-technical transitions and has published six books and more than sixty peer- reviewed articles in this area, many of which are highly cited. Dr. Geels has extensive experience in research management, acting as a Principal Investigator on a prestigious ERC (European Research Council)-funded project (Destabilisation of sociotechnical regimes as the key to transitions towards sustainability, 2008-2012), a project funded by the Dutch TransForum programme (Historical and future transitions in agriculture and food, 2007-2008), and a project funded by the Dutch Knowledge Network on System Innovation (Historical Transition Pathways, 2004-2007). Dr. Geels has acted as consultant for the Department for Environment, Food and Rural Affairs (Defra) (two reports on sustainability transitions), The World Wildlife Fund (which has adopted his multi-level perspective to structure their strategic thinking), the Dutch Ministry of Economic Affairs (which adopted transition management in the energy sector), and Dutch practitioners working 'on transition projects. Dr. Geels received his Ph.D. and M.S. from University of Twente.

JABOURY GHAZOUL has been Full Professor for Ecosystem Management at the Department of Environmental Sciences at Swiss Federal Institute of Technology in Zurich (ETH Zurich) since October 2005. Dr. Ghazoul was born in Iraq and moved to the UK in 1980. He received his Ph.D. from the University of St Andrews, Scotland in evolutionary ecology of wasps. Thereafter he spent a year in Vietnam leading biodiversity survey work with the Vietnamese Ministry of Forestry, returning to London to work as a postdoctoral researcher at the Natural History Museum from where he ran a CIFOR (Center for International Forestry Research) project addressing impacts of logging on forest tree reproduction in

Thailand. He was appointed Lecturer in Ecology at Imperial College London in 1998 and to Senior Lecturer in 2003. At Imperial he developed both basic and applied research in ecology and environment at locations throughout the tropics as well as the United Kingdom (UK). His research at ETH Zurich is on plant reproductive processes both in natural and human dominated environments. Elements of this research extend to plant genetics, conservation and human livelihoods. He was Editor-in-Chief of the journal Biotropica between 2006 and 2013. He is currently also a member of the Expert Committee on Forest Science for the UK Forest Commission, and holds the Prince Bernhard Chair of International Nature Conservation at Utrecht University.

CHRISTINA HICKS is a professor within the Political Ecology group at Lancaster University's Environment Centre. Dr. Hicks is an Environmental Social Scientist interested in the relationships individuals and societies form with nature; how these relationships shape people's social, environmental, and health outcomes; and how they create sustainable livelihood choices. Her current research examines small scale fisheries, how they contribute nutritional, cultural, and wellbeing benefits, and their vulnerability to climate change. This research addresses three broad themes: 1) Ensuring socially and ecologically sustainable access to fisheries nutrition; 2) Integrating social theories into ecosystem services research and, 3) Building fisheries governance capacity. She gained her Ph.D. in 2013 from the ARC (Australian Research Council) Centre of Excellence for Coral Reef Studies, James Cook University; after which she held an Early Career Social Science Fellowship at the Center for Ocean Solutions, Stanford University. Dr. Hicks' main source of research funding comes from an ERC (European Research Council) Starting Grant: FAIRFISH, and she was awarded the 2019 Philip Leverhulme Prize for Geography. Dr. Hicks' work is global with particular field sites on the east and west coasts of Africa and in the Pacific.

ELENA IRWIN is a professor of environmental economics in the Department of Agricultural, Environmental, and Development Economics and faculty director of the Sustainability Institute at Ohio State University. Her research addresses the sustainability of human-natural systems at local and regional scales, with a focus on land use, ecosystem services, and integrated models of land-water systems. Her current research includes coupled human-natural systems modeling of agricultural land use and water quality; food, energy, water systems modeling of the Great Lakes regional economy; sustainability theory and assessment; urbanization patterns and ecosystem services; and urban housing markets and redevelopment. She is a member of the U.S. Environmental Protection Agency's Board of Scientific Councilors Sub-Committee for Sustainable and Healthy Communities and is currently serving a three-year term as an elected member of the Agricultural and Applied Economics Association executive board. She has served on multiple national research committees with the National Research Council and National Science Foundation (NSF), including most recently as a member of NSF's Advisory Committee for Environmental Research and Education subcommittee on Sustainable Urban Systems (SUS), which produced a 2018 report on the future research SUS agenda. Dr. Irwin earned an undergraduate degree in German and History from Washington University in St. Louis and her Ph.D. in agricultural and resource economics from the University of Maryland.

ROBERT KEOHANE (NAS) (Steering Committee Member) is Professor of International Affairs at Princeton University. He is the author of *After Hegemony: Cooperation and Discord in the World Political Economy* (1984) and *Power and Governance in a Partially Globalized World* (2002). He is co-author (with Joseph S. Nye, Jr.) of *Power and Interdependence* (third edition 2001), and (with Gary King and Sidney Verba) of *Designing Social Inquiry* (1994). He has served as the editor of the journal *International Organization* and as president of the International Studies Association and the American Political Science Association. Dr. Keohane won the Grawemeyer Award for Ideas Improving World Order, 1989, and the Johan Skytte Prize in Political Science, 2005. He is a member of the American Academy of Arts and Sciences, the American Philosophical Society, and the National Academy of Sciences. He has received honorary degrees from the University of Aarhus, Denmark, and Science Po in Paris, and is the Harold Lasswell Fellow (2007-08) of the American Academy of Political and Social

Science. His recent work has involved political analyses of 'post-Kyoto' climate change architecture. Dr. Keohane earned his B.A. from Shimer College in 1961 and a Ph.D. from Harvard University in 1966.

CATHERINE KLING (NAS) is the Tisch University Professor of Environmental, Energy, and Resource Economics in the Dyson School of Applied Economics at Cornell University and the Faculty Director of the Atkinson Center for a Sustainable Future. She specializes in the economic valuation of ecosystem services and the integrated assessment modeling for water quality modeling. Dr. Kling currently chairs the National Academies of Sciences, Engineering, and Medicine's Water Science and Technology Board and is a member of the PNAS (Proceedings of the National Academy of Sciences of the United States of America) editorial board. She has been a member of nine Academies study committees, including several focused on water resources and agricultural issues. She served as president of the Association of Environmental and Resource Economists, held editorial positions at ten economics journals, and has published over 100 journal articles and book chapters. She is currently the editor of the Review of Environmental Economics and Policy. She is an elected Fellow of the Association of Environmental and Resources Economists, the Agricultural and Applied Economics Association, and the American Association for the Advancement of Science. She is also a University Fellow at Resources for the Future, a member of the National Academy of Sciences, and has served for ten years on U.S. Environmental Protection Agency's Science Advisory Board. Dr. Kling received her B.A. in business and economics from the University of Iowa and Ph.D. in economics from the University of Maryland, College Park.

MELISSA LEACH is the Director of the Institute of Development Studies (IDS) at the University of Sussex. She co-founded and co-directed the ESRC STEPS (Social, Technological and Environmental Pathways to Sustainability) Centre from 2006 to 2014, with its pioneering pathways approach to innovation, sustainability and development issues. As a social anthropologist Dr. Leach has carried out long-term ethnographic fieldwork in West Africa while engaging with scientific, policy and public discourses and debates around health, sustainability and development. She has led numerous interdisciplinary, policy-engaged research programmes in Africa and beyond. Amongst external roles, she was vice-chair of the Science Committee of Future Earth 2012-2017, lead author of the 2016 World Social Science Report 2016 on Challenging Inequalities and the UN Women's World Survey on the Role of Women in Economic Development 2014, and is a member of the International Panel of Experts on Sustainable Food Systems (IPES-Food). She was the lead social scientist in the UK/WHO (World Health Organization) responses to the 2014-2016 Ebola outbreak and co-led the award-winning Ebola Response Anthropology Platform. She is a Fellow of the British Academy and in 2017 was awarded a CBE for Services to Social Science.

MARIA CARMEN LEMOS is Professor at the School for Environment and Sustainability (SEAS) and co-Director of the Great Lakes Sciences and Assessments Center (GLISA) at the University of Michigan, Ann Arbor. Her research focuses on the use of scientific knowledge in environmental public policymaking in Latin America and the U.S., especially related to climate change (adaptation and adaptive capacity building) and the co-production of science and policy. She was a contributing and lead author to the Intergovernmental Panel on Climate Change (IPCC-AR4 and AR5) and has led many research and practice projects focusing on the co-production of climate knowledge with city practitioners, water managers, farmers and businesses in support of adaptation. She has MSc. and Ph.D. degrees in Political Science from the Massachusetts Institute of Technology.

DIANA LIVERMAN (NAS) (Steering Committee Member) is a Regents Professor and the Director of the School of Geography and Development at the University of Arizona. Dr. Liverman's current research focuses on the connections between climate and development, especially the synergies and trade offs between the responses to climate change, poverty alleviation and sustainable development goals. This builds on her long-term interests in understanding how people become vulnerable to climatic changes,

especially in agricultural and food systems, and how climate adaptation, including climate services, can help them cope. She has also studied aspects of environmental governance, including the effectiveness of carbon offsets and the impacts of trade agreements on the U.S.-Mexico border. She uses multiple methods in her research including computer modeling, interviews, social surveys and data analysis. Dr. Liverman was a lead author for the Intergovernmental Panel on Climate Change Special Report on 1.5°C and is part of interdisciplinary teams that have published on planetary boundaries and pathways to a sustainable future. She was awarded the Founders Gold Medal of the Royal Geographical Society and the Association of American Geographers Distinguished Service Honors and Presidential Achievement Award for her contributions and leadership in understanding the human dimensions of global change. Dr. Liverman holds a B.A. from University College London, a M.Sc from the University of Toronto, and a Ph.D. from University of California, Los Angeles. She was elected to the NAS in 2020.

YADVINDER MALHI is Professor of Ecosystem Science at the University of Oxford and Director of the Oxford Centre for Tropical Forests. His work focuses on understanding the ecosystem ecology of tropical forests, and how this will change in the context of global atmospheric change and direct anthropogenic change. His research employs a range of tools from intensive field studies through to satellite monitoring and ecosystem modelling. Much of his work has focused on Amazonia, where he was co-founder of the RAINFOR forest plots network, and the ABERG elevation transect in the Andes. More recently his research has also spread to the forests of Africa and Asia, and he leads the GEM (Global Ecosystems Monitoring) network of intensive forest monitoring sites across the tropics. More generally, he is interested in understanding how we can maximize the resilience and viability of the tropical forest biome in the context of the Anthropocene, and in building the scientific capacity of tropical forest nations. He is a Fellow of the Royal Society and in 2018 is President of the Association for Tropical Biology and Conservation. Professor Malhi received his first degree in physics from Queens' College, University of Cambridge, and a Ph.D. in Meteorology from the University of Reading.

SHUNSUKE MANAGI is the Distinguished Professor of Technology and Policy and Director of Urban Institute at the Kyushu University, Japan. He has been awarded several national research grants on topics such as urbanization, transportation, energy, climate change, sustainability, urbanization, and population change. He has received several research fellowships from organizations such as the Helmholtz Association and Cheney Senior Fellowship and has served as an expert on energy and environmental policy. He is an editor of Environmental Economic and Policy Studies and on the editorial board for six journals including Resource and Energy Economics, a lead author for the Intergovernmental Panel on Climate Change, and is the author of "Technology, Natural Resources and Economic Growth: Improving the Environment for a Greener Future," published by Edward Elgar Publishing Ltd, and editor of "The Routledge Handbook of Environmental Economics in Asia." He is the author of 12 books and 140 academic journal papers. He has published in peer reviewed journals such as Global Environmental Change, Journal of Environmental Economics and Management, Journal of Banking and Finance, Journal of Economic Dynamics and Control, Land Economics, Environmental and Resource Economics, Journal of Regulatory Economics, Resource and Energy Economics, The Energy Journal, International Journal of Production Economics, Omega, Energy Economics, Environment and Development Economics, Ecological Economics, Economic Modelling, Agricultural Economics, Journal of Industrial Ecology, Energy Policy, and Physica A. Dr. Managi received his M.Eng in Civil Engineering from Kyushu University and his Ph.D. in Environmental and Natural Resource Economics from University of Rhode Island.

MARCIA MCNUTT (NAS) is a geophysicist and the 22nd president of the National Academy of Sciences. From 2013 to 2016, she was editor-in-chief of *Science* journals. Dr. McNutt was director of the U.S. Geological Survey (USGS) from 2009 to 2013, during which time USGS responded to a number of major disasters, including the Deepwater Horizon oil spill. For her work to help contain that spill, Dr. McNutt was awarded the U.S. Coast Guard's Meritorious Service Medal. She is a fellow of the American

Geophysical Union (AGU), Geological Society of America, the American Association for the Advancement of Science, and the International Association of Geodesy. Dr. McNutt is a member of the American Philosophical Society and the American Academy of Arts and Sciences, and a Foreign Member of the Royal Society, UK, and the Russian Academy of Sciences. In 1998, Dr. McNutt was awarded the AGU's Macelwane Medal for research accomplishments by a young scientist, and she received the Maurice Ewing Medal in 2007 for her contributions to deep-sea exploration. Dr. McNutt received a B.A. in physics from Colorado College and her Ph.D. in Earth sciences from the Scripps Institution of Oceanography.

HARINI NAGENDRA is a Professor of Sustainability at Azim Premji University. Her recent book "Nature in the City: Bengaluru in the Past, Present, and Future" (Oxford University Press India, 2016) examines the transformation of human-nature interactions in Bangalore from the 6th century CE to the present, addressing the implications of such change for the urban sustainability of fast-growing cities in the global South. Professor Nagendra is an ecologist who uses methods from the natural and social sciences—satellite remote sensing, biodiversity studies, archival research, GIS (geographic information system), institutional analysis, and community interviews, to examine the sustainability of forests and cities in the global South. She completed her Ph.D. from the Centre for Ecological Sciences in the Indian Institute of Science in 1998. Since then, she has conducted research and taught at multiple institutions, and was most recently a Hubert H Humphrey Distinguished Visiting Professor at Macalester College, Saint Paul, Minnesota in 2013. She is a recipient of numerous awards for her research, including a 2017 Web of Science 2017 India Research Excellence Award as the most cited Indian researcher in the category of Interdisciplinary Research; a 2013 Elinor Ostrom Senior Scholar award for her research and practice on issues of the urban commons, and a 2009 Cozzarelli Prize from the Proceedings of the National Academy of Sciences USA (with Elinor Ostrom). Professor Nagendra has authored two books, and over 150 peer reviewed publications, including in Nature, Nature Sustainability and Science. She engages with international research on global environmental change as a Steering Committees member of the Future Earth Programme on Ecosystem Change and Society and a former Steering Committee Member of the Global Land Project, Diversitas and a Capacity Building Committee member of the Asia Pacific Network for Global Environmental Change.

CHUKWUMERIJE OKEREKE serves as the Director of Centre for Climate Change and Development at Alex-Ekwueme Federal University in Nigeria. He is also a full professor in Environment and Development at the Department of Geography and Environmental Science, University of Reading and the Director of Postgraduate Research (Human Geography). Previously, he was a Senior Research Fellow and Head of Climate and Development Centre at the Smith School Enterprise and the Environment, University of Oxford. He remains a visiting fellow at the Smith School and Oxford University's Environmental Change Institute (ECI). Dr. Okereke is a renowned policy analysis and development specialist. He is a Lead Author on the IPCC (Intergovernmental Panel on Climate Change) Fifth Assessment Report on Equity and Sustainable Development. His main interest is the governance of climate change and the links with international development. He has been engaged in teaching, research and consultancy activities focusing on climate governance, climate adaptation and low carbon development in developing countries for over 15 years. Dr Okereke has worked and published extensively on climate governance and African development with special focus on policy design, regulations, institutions and private sector involvement. He was the Project Director of the Rwandan National Strategy for Climate and Low Carbon Development project funded jointly by the Climate Development and Knowledge Network (CDKN) and DfID (Department for International Development) Rwanda. Dr Okereke is the Moderator of United Nations Institute for Training and Research (UNITAR) Climate Diplomacy Course and an ad-hoc consultant to the United Nations Development Programme and the World Bank. Dr. Okereke received his Ph.D. from Keele University.

MICHAEL OSTERHOLM (NAM) is Regents Professor, McKnight Presidential Endowed Chair in Public Health, the director of the Center for Infectious Disease Research and Policy (CIDRAP), Distinguished Teaching Professor in the Division of Environmental Health Sciences, School of Public Health, a professor in the Technological Leadership Institute, College of Science and Engineering, and an adjunct professor in the Medical School, all at the University of Minnesota. He is also a member of the National Academy of Medicine (NAM) and the Council of Foreign Relations. In June 2005 Dr. Osterholm was appointed by Michael Leavitt, Secretary of the Department of Health and Human Services (HHS), to the newly established National Science Advisory Board on Biosecurity. In July 2008, he was named to the University of Minnesota Academic Health Center's Academy of Excellence in Health Research. In October 2008, he was appointed to the World Economic Forum Working Group on Pandemics. Between June 2018 to May 2019, Dr. Osterholm served as a Science Envoy for Health Security on behalf of the U.S. Department of State. The author of more than 315 papers and abstracts, including 21 book chapters, Dr. Osterholm also serves on the boards of nine epidemiology and infectious disease journals and is a reviewer for The New England Journal of Medicine. He is a frequent consultant to the World Health Organization, the National Institutes of Health (NIH), the Centers for Disease Control (CDC), a fellow of the American College of Epidemiology and the Infectious Diseases Society of America and has received six major research awards from the NIH and the CDC.

GARRY PETERSON is a professor in environmental sciences with emphasis on resilience and social-ecological systems at Stockholm Resilience Centre, Stockholm University. His research combines three themes: abrupt systemic change, how ecological changes impacts people, and using futures thinking to improve navigating surprising social-ecological change. He is head of subject for the centre's Sustainability Science Ph.D. programme. He has a Bachelor's degree in Systems Design Engineering from the University of Waterloo, and a Ph.D. in Zoology from the University of Florida. He was also a postdoc at the National Center for Ecological Analysis and Synthesis at University of California, Santa Barbara and the Center for Limnology at University of Wisconsin-Madison. Prior to coming to the Stockholm Resilience Centre he was an assistant professor and Canada Research Chair jointly appointed in the department of Geography and the McGill School of the Environment, at McGill University. Dr. Peterson was co-editor of the Artic Council's Arctic Resilience Report. He was a coordinating lead author for the Millennium Ecosystem Assessment's Scenarios Assessment. He was coordinating lead author for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services' (IPBES) scenarios and models assessment, and is currently a review editor for an IPBES regional assessment. He has been a member of the Resilience Alliance, since its founding. He has conducted and contributed to participatory ecosystem management processes in Canada, the USA, and Sweden.

STEPHEN POLASKY (NAS) (Steering Committee Member) is the Regents Professor and Fesler-Lampert Professor of Ecological and Environmental Economics at the University of Minnesota, St. Paul. His research focuses on issues at the intersection of ecology and economics and includes the impacts of land use and land management on the provision and value of ecosystem services and natural capital, biodiversity conservation, sustainability, environmental regulation, renewable energy, and common property resources. Dr. Polasky is a member of the National Academy of Sciences, and he is also a fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, and the Association of Environmental and Resource Economists. He has a B.A. degree from Williams College and a Ph.D. degree in Economics from the University of Michigan.

LAURA PULIDO is Professor and Head of Ethnic Studies and Professor of Geography at the University of Oregon where she currently studies race, landscape, environmental justice, and cultural memory. She is the author of numerous books, including *Environmentalism and Economic Justice: Two Chicano Struggles in the Southwest*; *Black, Brown, Yellow and Left: Radical Activism in Los Angeles*; *A People's Guide to Los Angeles (*with Laura Barraclough and Wendy Cheng), and most recently she worked with Jordan Camp to posthumously complete Clyde Woods's, *Development Drowned and Reborn: The Blues*

and Bourbon Restoration in Post-Katrina New Orleans. She has received numerous honors, including the Presidential Achievement Award from the Association of American Geographers and Ford and Guggenheim fellowships. Most of her research explores the relationship between race, place, and economic processes, through both forms of domination and resistance. Most recently her research has shifted to questions of cultural memory and the various ways and means which the historical role of racism is denied—which is fundamental to its reproduction. Currently, she is studying sites on the National Registrar of Historic Places and how they narrate and represent histories and geographies of foundational white supremacy—the white supremacy implicated in the creation of the U.S. nation, state, and territory. The end goal is to create an historical atlas of white supremacy, which will document both the various forms of white supremacy involved in the creation of the U.S., as well as the degree to which it is erased through practices of historical commemoration. Dr. Pulido received a B.A. in Geography from California State University, Fresno, M.S. in Geography from University of Wisconsin, and Ph.D. in Urban Planning from University of California, Los Angeles.

BELINDA REYERS is a Professor in Sustainability Science at Future Africa, University of Pretoria. She is also a senior advisor on Resilience and Development at Stockholm Resilience Centre, Stockholm University, Sweden and an Extra-ordinary Professor at the University of Stellenbosch. Together with regional and international collaborators from research and practice, Professor Reyers' research explores the contribution of theories, methods and evidence from social-ecological systems research and sustainability science to the development challenges facing Africa. Her work focuses on exploring the role of social-ecological feedbacks, cross-scale dynamics, non-linearities, and resilience capacities in achieving sustainable and equitable futures. She also conducts empirical and conceptual research on the dynamic linkages between sustainability and equity, especially in the context of more complex, connected and uncertain futures. Professor Reyers has played a number of advisory roles to national government and international bodies including: Vice Chair of the Science Committee of Future Earth; Coordinating Lead Author of the Intergovernmental Platform on Biodiversity and Ecosystem Services; Science Committee: DIVERSITAS; Advisory Committee: Sustainable and Healthy Food Systems; and the Bridge Collaborative. Professor Reyers initiated and co-led the Southern African Program on Ecosystem Change and Society, a network of leading social-ecological researchers working in southern Africa to develop new theory and tools and grow capacity in the social-ecological systems field, and one of the core case studies within the Future Earth Program on Ecosystem Change and Society (PECS). Professor Reyers received her Ph.D. from the University of Pretoria, South Africa in 2001.

LEAH STOKES is an Assistant Professor in the Department of Political Science and affiliated with the Bren School of Environmental Science & Management and the Environmental Studies Department at the University of California, Santa Barbara (UCSB). She works on energy, climate and environmental politics. Within American Politics, her work focuses on representation and public opinion; voting behavior; and public policy, particularly at the state level. Within environmental politics, Dr. Stokes researches climate change, renewable energy, water and chemicals policy. Her research has been published in top journals including the American Political Science Review, American Journal of Political Science, British Journal of Political Science, Nature Energy, Energy Policy, and Environmental Science & Technology. She has also published articles in The New York Times, The Washington Post, The Los Angeles Times, Vox, The Guardian, CNN and elsewhere. She is frequently quoted in national media. Dr. Stokes completed her Ph.D. in Public Policy in the Department of Urban Studies and Planning's Environmental Policy & Planning group at the Massachusetts Institute of Technology (MIT). She also received a masters from MIT's Political Science Department and, before that, completed an MPA in Environmental Science & Policy at the School of International & Public Affairs (SIPA) and the Earth Institute at Columbia University. She earned a B.Sc. in Psychology and East Asian Studies from the University of Toronto. Prior to academia, she worked at the Parliament of Canada and Resources for the Future.

B. L. TURNER II (NAS) is a Regents Professor in the School of Sustainability, College of Global Futures and Regents Professor and Gilbert F White Professor of Environment and Society in the School of Geographical Sciences and Urban Planning, College of Liberal Arts and Sciences at Arizona State University. He is a geographer and human-environmental scientist who works on land change from prehistory to present, urban land system design, vulnerability and resilience, and sustainability. He works on deforestation, primarily in Mexico and Central America, and urban design in arid environments, especially the American Southwest. Dr. Turner has been involved in a number of international and national science programs examining global environmental change including those dealing with land systems of the International Geosphere-Biosphere Programme, the International Human Dimensions Programme, DIVERSITAS, and the U.S. National Climate Assessment, and is a senior review editor for Climate Change and Land: An IPCC Special Report. He is also the Associate Editor of the Proceedings of the National Academy of Sciences focused on sustainability. He is a member of the National Academy of Sciences, and American Academy of Arts and Sciences. Dr. Turner received B.A. and M.A. degrees in geography from the University of Austin at Texas and a Ph.D. in geography from the University of Wisconsin at Madison.

ESTHER TURNHOUT is a professor at Wageningen University, The Netherlands. She is an interdisciplinary social scientist and manages a research program in 'The politics of environmental knowledge'. Her research and teaching focuses on biodiversity governance and nature conservation at global to local scales with a specific focus on the relation between science, other knowledge systems, and environmental governance practices. She has published numerous articles on the biodiversity science-policy interface and other topics in high impact journals and she is also the first author of the book Environmental Expertise: Connecting Science, Policy and Society' with Cambridge University Press. She is editor in chief of the interdisciplinary journal Environmental Science & Policy. She plays several active roles in the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) and was an author of the IPBES Global Assessment of biodiversity and ecosystem services.

LORRAE VAN KERKHOFF is the Director of the Institute for Water Futures, and is Associate Professor and Associate Director Staff Development at the Fenner School of Environment and Society, at the Australian National University. Her research focuses on understanding the role of science in decision-making for complex environmental issues, especially with regard to preparing for uncertain but different futures. She uses qualitative social and institutional research methods to examine how knowledge is generated, shared, applied and governed, within Australia and internationally, and works collaboratively with stakeholders to generate innovative pathways for transition and transformation. Dr. van Kerkhoff leads the Bachelor of Environment and Sustainability program and teaches Sustainable Development and Complex Environmental Problems in Action. Her interests revolve around how science gets used (or not used) in decision-making; how does it fit? What other forms of knowledge come into play and how do the rules decision-makers create and abide by shape the quality of the outcomes that result? How do they help us understand and anticipate the future? These questions become even more critical as the pace of environmental and social change accelerates, and post-truth politics contest evidence-based knowledge. While she has enjoyed the opportunity to explore these questions across three continents around the world, she is excited to bring these ideas, questions and challenges closer to home. The Institute for Water Futures is a unique and timely opportunity to rethink how we imagine and create the future of water in Australia and the Asia-pacific region. She loves the interdisciplinary capability and focuses on collaboration and partnerships.

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Progress, Challenges, and Opportunities for Sustainability Science: A Workshop
November 30-December 2, 2020

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Associate Professor
Chalmers University of Technology

Alessandra Alfieri
Chief, Environmental Economic Accounts Section
United Nations

Bernard Amadei (NAE)
Professor of Civil Engineering
University of Colorado Boulder

Liliana Andonova
Professor
Graduate Institute of International and Development Studies, Geneva

Nicole Ardoin
Associate Professor
Stanford University

Katie Arkema
Lead Scientist, Natural Capital Project
Stanford University

Paul Armsworth
Professor
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Ines Azevedp
Associate Professor
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Xuemei Bai
Distinguished Professor
Australian National University

Patricia Balvanera
Professor
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Edward Barbier
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Christopher Barrett
Stephen B. and Janice G. Ashley Professor of Applied Economics
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Solomon (Solly) Benatar
Emeritus Professor of Medicine and Senior Scholar
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Michele Betsill
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