The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Data-Informed Societies Achieving Sustainability:
Tasks for the Global Scientific, Engineering, and Medical Communities

September 9-10, 2021
(All times are U.S. Eastern Time)

Meeting Goals:
- Explore how the global scientific, engineering, and medical communities can better facilitate the effective use of data to advance sustainability in the context of the United Nations Sustainable Development Goals.
- Discuss crosscutting issues, such as strengthening the engagement of scientific, engineering, and medical communities in efforts to shape the post-2030 agenda on data-related issues, addressing disparities in the ability of societies to utilize data, and highlighting insights and lessons learned from global experience with the COVID-19 pandemic.

Thursday, September 9, 2021

10:00 am   **Welcome from the National Academies of Sciences, Engineering, and Medicine**
Tom Arrison, National Academies of Sciences, Engineering, and Medicine
Franklin Carrero-Martínez, National Academies of Sciences, Engineering, and Medicine

10:05 am   **Goals for the Workshop**
Nebojsa Nakicenovic, International Institute for Applied Systems Analysis (IIASA) and Workshop Chair

10:15 am   **Framing Remarks**
Moderator: Nebojsa Nakicenovic, IIASA and Workshop Chair
- Philip Bourne, University of Virginia
- Claire Melamed, Global Partnership for Sustainable Development Data

Session I: Big Data, Digitization, and COVID-19

11:00 am   **Panel 1: COVID-19, Big Data, and Digitalization: Lessons Learned and Ways Forward**
Moderator: Barend Mons, Leiden University Medical Center
Panelists:
- Sheldon Himelfarb, PeaceTech Lab
- Carly Kind, Ada Lovelace Institute
- Francisca Onaolapo Oladipo, Federal University Lokoja and VODAN Africa
- Wayne Koff, Human Vaccines Project

Discussion points: This panel will focus on big data and digitalization in the context of COVID-19 response and management, including privacy issues, the role of artificial intelligence and machine learning, and a need for transformational thinking for effective response and management. Speakers will describe their experiences relating to public trust in government, different cultural attitudes toward privacy, and the role of volunteer driven efforts to address data infrastructures, data sources, and data collection issues and processes. The panel will also discuss the emerging issues of a "data paradox" and data collection architecture for big data to transform sustainability issues from health to poverty to the environment. The balance between "too much information" but in the wrong format and not trustworthy and the access to potentially relevant real world-real time observations will also be addressed.

12:20 pm   BREAK

12:40 pm   **Panel 2: Big Data and Digitalization for promoting Equity and Equality in Sustainability Efforts**
Moderator: Luis Bettencourt, University of Chicago
Panelists:
- Heide Hackmann, International Science Council
- Sheela Patel, Society for the Promotion of Area Resource Centers
- Joshua Blumenstock, University of California, Berkeley
- Richard Heeks, University of Manchester

Discussion points: This panel will focus on the roles of (big) data and digitalization for promoting greater equity—across its many dimensions—in processes of sustainable development. Beyond criticizing current systems, participants will discuss the specification of indicators, the kind of policy frameworks, and multi-stakeholder incentives that can lead to technology assisted people-centric approaches to sustainable development across communities within nations and internationally. The panel will also discuss potential solutions to close the "digital divide," the need for effective partnerships to address present inequities and power imbalances, and the role of data and information technologies to act as "equalizers" and enablers of social and civic inclusive innovation.

2:00 pm   Adjourn

Friday, September 10, 2021

10:00 am   **Welcome and Re-Cap from Previous Day**
Nebojsa Nakicenovic, IIASA and Workshop Chair
Tom Arrison, National Academies of Sciences, Engineering, and Medicine
Franklin Carrero-Martínez, National Academies of Sciences, Engineering, and Medicine

Session II: Big Data, Digitization, and the Sustainable Development Goals

10:05 am   **Panel 3: Digitalization, Science, Technology, and Innovation (STI), and the SDGs: What should be measured and how?**
Moderator: Aleksandra Berditchevskaia, Nesta
Panelists:
- Sarah West, Stockholm Environment Institute
- Joy Bonaguro, State of California
- Miguel Luengo-Oroz, United Nations Global Pulse
- Alexandre Caldas, United Nations Environment Programme

Discussion points: This session will focus on the role of non-traditional data sources, emerging methods like citizen science and crowdsourcing and digital technologies like AI and data platforms are helping to fill vital data gaps and make better use of data to make progress on the SDGs. It will explore what is needed to sustain and integrate these approaches as well as understanding their limits and how they can complement more traditional datasets to drive policy, collective action and behavioral change. The session will also consider the challenge of monitoring the SDGs from a systems perspective, discussing how to better map the connections and feedback loops between the goals as well as bridging between sustainability initiatives at the planetary level to more disaggregated scales (e.g. neighborhoods, cities, regions) to build a global picture.

11:25 am   BREAK

11:45 am   **Panel 4: Role of Big Data in Our Digital Future**
                   Moderator: Jeanne Holm, City of Los Angeles
                   Panelists:
- Himla Soodyall, Academy of Science of South Africa
- Huadong Guo, Chinese Academy of Sciences
- Pedro Conceição, United Nations Development Programme
- Jennifer Pahlka, Code for America

Discussion points: This final panel will address the role of big data in digital transformation and the future of collective intelligence for sustainable development, including open data, human settlements, education, and enhancing human capacities, etc. Discussions will include emerging models of data sharing in Africa, China, and the United States through public-private partnerships, data collaboratives, data trusts, and other opportunities. The session will also explore crosscutting issues, such as strengthening the engagement of scientific, engineering, and medical communities in efforts to shape the post-2030 agenda on data-related issues.

1:05 pm   **Summary Remarks**
                Solomon Hsiang, University of California, Berkeley

1:15 pm   **Next Steps and Closing Remarks**
                Nebojsa Nakicenovic, IIASA and Workshop Chair

1:20 pm   **Workshop Conclusion**

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Biographies of Speakers and Moderators

FRAMING REMARKS

NEBOJSA NAKICENOVIC (Workshop Chair and Moderator) is the Executive Director of The World In 2050 (www.TWI2050.org). He is one of seven Chief Scientific Advisors to the European Commission, was the Deputy and Acting Director General of the International Institute for Applies Systems Analyses and tenured Professor of Energy Economics at Vienna Technology University. Among other positions, Dr. Nakicenovic has been a member of the Earth League; Earth Commission of the Global Commons Alliance; Multi-stakeholder Technical Group of Advisors on Sustainable Development Goal 7; Scientific Advisory Boards of the Potsdam Institute from Climate Impact Research; Fondazione Eni Enrico Mattei; Japanese Institute of Environmental Studies; German Aerospace Center; Renewable Energy Policy Network for the 21st Century; OMV Advisory Group on Sustainability; and Climate Change Centre Austria. He has also been a Technology and Innovation Advisor to the Government of Montenegro. He serves on many Editorial Boards of peer-reviewed journals, including *Technological Forecasting and Social Change*; *Climate Policy, Energy Policy, Institution of Civil Engineers*; *Current Opinion in Environmental Sustainability*; *Energy Sector Management*; *Ecosystem Health and Sustainability*; *Scientific World Journal*; *Environmental Innovation and Societal Transitions*; and the *Energy Strategy Reviews*. Dr. Nakicenovic's research interests include the long-term patterns of technological change, economic development and response to climate change and, in particular, the evolution of energy, mobility, digital technologies. Dr. Nakicenovic holds bachelors and master's degrees in economics and computer science from Princeton University and the University of Vienna, where he also completed his Ph.D. He also holds Honoris Causa Ph.D. degree in engineering from the Russian Academy of Sciences.

PHILIP BOURNE is the Founding Dean of the School of Data Science and Professor of Biomedical Engineering at the University of Virginia. Dr. Bourne leads a range of initiatives to encourage and facilitate the use of big data in large-scale research across the scientific and technological disciplines, with special emphasis on structural bioinformatics and systems pharmacology. Prior to his time at the University of Virginia, Dr. Bourne was the Associate Director for Data Science at the National Institutes of Health (NIH). In this role he led the Big Data to Knowledge Program, coordinating access to and analyzing biomedical research from across the globe and making it available to scientists and researchers. While there, he was also responsible for governance and strategic planning activities for data and knowledge management, and established multiple trainings in data science. He has done exceptional work to make biomedical research accessible, as well as to advance the field of data science. Prior to his time at the NIH, Dr. Bourne spent 20 years on the faculty at the University of California-San Diego, eventually becoming Associate Vice Chancellor of Innovation and Industrial Alliances. Dr. Bourne earned his Ph.D. in Chemistry from Flinders University.

CLAIRE MELAMED is the Chief Executive Officer of the Global Partnership for Sustainable Development Data. This growing network brings together over 300 members—governments, private sector, and civil society—to harness and leverage data and data technology towards achieving the Sustainable Development Goals. Dr. Melamed was previously Managing Director of the Overseas Development Institute, and in 2014, she worked in the office of the United Nations Secretary General, writing the report of the Independent Expert Advisory Group on the Data Revolution, "A World That Counts." She is based in London and is an Affiliated Researcher at the Bennett Institute for Public Policy at the University of Cambridge and serves on a number of Boards and advisory groups for institutions including the UK Office of National Statistics Data Science Campus, the Overseas Development Institute Human Mobility Initiative, and Mo Ibrahim Foundation Governance Index. Dr. Melamed earned her Ph.D. in Development Studies from the University of London.

SESSION I: BIG DATA, DIGITIZATION, AND COVID-19

Panel 1: COVID-19, Big Data, and Digitalization: Lessons Learned and Ways Forward

BAREND MONS (Moderator) is a molecular biologist by training and a leading FAIR data specialist. The first decade of his scientific career he spent on fundamental research on malaria parasites and later on translational research for malaria vaccines. In the year 2000 he switched to advanced data stewardship and (biological) systems analytics. He is currently a professor in Leiden and most known for innovations in scholarly collaboration, especially nanopublications, knowledge graph based discovery and most recently the FAIR data initiative and GO FAIR. Since 2012 he is Professor in biosemantics in the Department of Human Genetics at the Leiden University Medical Center (LUMC) in The Netherlands. In 2015 Dr. Mons was appointed chair of the High Level Expert Group on the European Open Science Cloud. Since 2017 Dr. Mons is heading the International Support and Coordination office of the GO FAIR initiative. He is also the elected president of CODATA, the standing committee on research data related issues of the International Science Council. Dr. Mons is a member of the Netherlands Academy of Technology and Innovation (ACTI). He is also the European representative in the Board on Research Data and Information (BRDI) of the National Academies of Science, Engineering and Medicine in the USA. Dr. Mons is a frequent keynote speaker about FAIR and open science around the world, and participates in various scientific advisory boards of international research projects.

SHELDON HIMELFARB is the President and Chief Executive Officer (CEO) of PeaceTech Lab. Dr. Himelfarb joined the United States Institute of Peace (USIP) from The Corporate Executive Board, where he was on the Technology Practice Leadership Team, working with chief information officers from governments, universities, and multi-national corporations. Prior to this, he served as foreign policy adviser to a member of the Senate Foreign Relations Committee, the head of North American Documentary Development for Yorkshire TV, and the CEO/Executive Producer for Common Ground Productions, the media division of Search for Common Ground. He is an award-winning filmmaker, former commentator for National Public Radio (Sunday Morning Edition) and author of numerous articles on politics, popular culture, and conflict. He has managed peacebuilding programs in numerous conflicts, including Bosnia, Iraq, Angola, Liberia, Macedonia, and Burundi and received the Capitol Area Peace Maker award from American University. Dr. Himelfarb has held visiting or guest scholar positions at the Brookings Institution, Harvard University and the Paul H. Nitze School of Advanced International Studies at Johns Hopkins University. He holds a doctorate from Oxford University.

CARLY KIND is the Director of the Ada Lovelace Institute, an independent research and deliberative body with a mission to ensure data and AI work for people and society. Ms. Kind is a human rights lawyer and leading authority on the intersection of technology policy and human rights. She has advised industry, government and non-profit organizations on digital rights, privacy and data protection, and corporate accountability in the technology sphere. Since 2015 Ms. Kind has worked with the European Commission, the Council of Europe, numerous United Nations bodies and a range of civil society organizations. She was formerly Legal Director of Privacy International, an nongovernmental organization dedicated to promoting data rights and governance. Ms. Kind holds a Master's of Science in International Relations from the London School of Economics and Political Science.

FRANCISCA ONAOLAPO OLADIPO is a Professor of Computer Science at Federal University Lokoja, Nigeria. She is also the pioneer Director for Research, Innovations and International Relations at Kampala International University, Uganda. In 2018, she was elected a member of the Federal University Lokoja Governing Council and became the first female to hold this position. Presently, she is the Executive Coordinator of the Virus Outbreak Data Africa & Asia Network (VODAN Africa &Asia), a research initiative consisting of researchers, students and doctors from Uganda, Kenya, Ethiopia, Nigeria, Zimbabwe, Tunisia, Kazakhstan, Indonesia, Japan and China. The team is deploying a network of COVID-19 FAIR Data Points in these countries as part of the efforts to fight the pandemic using artificial intelligence. As part of her contributions to taking scientific education to-hard-to-reach women and children in parts of Africa, Dr. Oladipo is presently leading the International Projects Synergy and Support of the NUFFIC 1 and Regional Projects for Africa and Dutch Partners. The two-part project involves strengthening peace through rule of law and employment, facilitated by education in Tigray and regional E-learning in the Horn (specifically in Somalia, Sudan and South Sudan, and Ethiopia) under the Dutch Orange Knowledge Programme (OKP) Initiative. Dr. Oladipo obtained a Ph.D. in Computer Science and was a 2014 Spring Postdoctoral Fellow at the Department of Electronics and Computer Science of the Massachusetts Institute of Technology (MIT), under the TOTAL-MIT Empowering the Teachers Initiative.

WAYNE KOFF is the founding president and CEO of the Human Vaccines Project, a nonprofit global research consortium focused on decoding the human immune system to accelerate vaccine and theraepeutic development, and Adjunct Professor of Epidemiology at the Harvard T.H. Chan School of Public Health. Prior to joining the Human Vaccines Project, Dr. Koff served as chief scientific officer and senior vice president of research and development at the International AIDS Vaccine Initiative (IAVI) in New York City, leading IAVI's research and development program. At IAVI, his accomplishments included developing multiple HIV vaccines through clinical trials; establishing state-of-the-art laboratories in the U.S., Europe, India and Africa; conducting the first HIV vaccine trials in India, Kenya and Rwanda; establishing the Neutralizing Antibody Consortium, which identified new, broad and potent neutralizing antibodies against HIV that led to the discovery of novel targets for vaccine design; and establishing a clinical research network in Africa that has conducted seminal studies on HIV pathogenesis, incidence and acute infection. Dr. Koff earned his Ph.D. from Baylor College of Medicine

Panel 2: Big Data and Digitalization for promoting Equity and Equality in Sustainability Efforts

LUIS BETTENCOURT (Moderator) is the Inaugural Director of the Mansueto Institute for Urban Innovation and Professor of Ecology and Evolution and the College at the University of Chicago, as well as an External Professor at the Santa Fe Institute. He was trained as a theoretical physicist and obtained his undergraduate degree from Instituto Superior Técnico (Lisbon, Portugal) and his Ph.D. from Imperial College (University of London, UK) for research in statistical and high-energy physics models of the early Universe. He has held postdoctoral positions at the University of Heidelberg (Germany), Los Alamos National Laboratory (Director's Fellow and Slansky Fellow) and at Massachusetts Institute of

Technology (Center for Theoretical Physics). He has worked extensively on complex systems theory and applications and on cities and urbanization, in particular. His research emphasizes the creation of new interdisciplinary synthesis to describe cities in quantitative and predictive ways, informed by classical theory from various disciplines and the growing availability of empirical data worldwide. He is the author of over 120 scientific papers and several edited books. His research has been featured in leading media venues, including the New York Times, Science, Nature, PNAS, Wired, New Scientist, and the Smithsonian.

HEIDE HACKMANN is the chief executive officer of the International Science Council, having previously been the Executive Director of the International Council for Science (ICSU). Before joining ICSU, Dr. Hackmann served as Executive Director of the International Social Science Council (ISSC). She has worked as a science policy maker, researcher and consultant in the Netherlands, Germany, the United Kingdom and South Africa. She is a former member and co-chair the United Nation's 10-member group supporting the Technology Facilitation Mechanism (TFM) on the Sustainable Development Goals, and was a member of the World Economic Forum's Global Future Councils. Dr. Hackmann holds membership of several international advisory committees and boards including distinguished visiting fellow at the International Institute for Applied Systems Analysis (IIASA); member of the Expert Advisory Board of the Mercator Research Institute on Global Commons and Climate Change; member of the Advisory Council of the African Open Science Platform supported by the South African Department of Science and Technology, National Research Foundation and South African Academy of Sciences; member of the Scientific Advisory Board of the Potsdam Institute for Climate Impact Research; and member of the Excellence, Impact and Engagement Committee of the Ocean Frontier Institute. Dr. Hackmann earned her Ph.D. in science and technology studies from the University of Twente in the Netherlands.

SHEELA PATEL is the founding Director of the Society for Promotion of Area Resource Centres (SPARC), an NGO that has been working since 1984 to support community organizations of the urban poor in their efforts to access secure housing and basic amenities and seek their right to the city. Patel is widely recognized—nationally and internationally—for seeking urgent attention to the issues of urban poverty, housing, and infrastructure onto the radar of governments, bilateral and international agencies, foundations and other organizations. She is a founder amongst many of Slum Dwellers International a transnational social movement of the urban poor. In 2000, she received the United Nations Habitat Award, 2006 she received Outstanding Contribution towards Mumbai Vision 2015 by Observer Research Foundation. 2009, she received David Rockefeller Bridging Leadership Award, 2011; she was conferred with the prestigious award of Padmashree.

JOSHUA BLUMENSTOCK is an associate professor at the University of California, Berkeley School of Information and the Goldman School of Public Policy, the director of the Data-Intensive Development Lab, and the faculty co-director of the Center for Effective Global Action. His research lies at the intersection of machine learning and empirical economics, and focuses on using novel data and methods to better understand the causes and consequences of global poverty. He is a recipient of the National Science Foundation's Faculty Early Career Development Program (CAREER) award, the Intel Faculty Early Career Honor, a Gates Millennium Grand Challenge award, a Google Faculty Research Award, and the University of California, Berkeley Chancellor's Award for Public Service.

RICHARD HEEKS is Professor of Digital Development in the Global Development Institute, part of the School of Environment, Education and Development at The University of Manchester. He is Director of the University's Centre for Digital Development. He is one of the pre-eminent and highly-cited academics in the emerging sub-discipline of digital development/ICT4D (information and communication technologies for international development), and has written six books, more than 60 refereed articles, and over 150 other papers and reports. He has acted as an external degree examiner in the ICT4D field at

universities in Europe, Africa and Asia; and as a research assessor for bodies such as the U.S. National Science Foundation, MacArthur Foundation, British Academy, EPSRC (Engineering and Physical Sciences Research Council), ESRC (Economic and Social Research Council), and Nuffield and Leverhulme. Dr. Heeks has been project leader on nine major international research contracts, coordinating the work of partner organizations in Africa, Asia and Latin America. Dr. Heeks earned his Ph.D. in Development Informatics from The Open University.

SESSION II: BIG DATA, DIGITIZATION, AND THE SUSTAINABLE DEVELOPMENT GOALS

Panel 3: Digitalization, Science, Technology, and Innovation (STI), and the SDGs: What should be measured and how?

ALEKSANDRA BERDITCHEVSKAIA (Moderator) is a Principal Researcher for the Centre for Collective Intelligence Design (CCID) at Nesta, the United Kingdom's social innovation foundation. She leads the development and delivery of the research agenda for CCID focusing on how artificial intelligence can enhance and scale collective human intelligence, data justice and participatory AI methods. She is interested in designing systems that make the most of combining data, technology and distributed human intelligence for solving societal challenges. She co-authored 'The Future of Minds & Machines,' a report on AI and collective intelligence, and the 'Playbook for Collective Intelligence Design,' the CCID's flagship toolkit for creating projects that mobilise collective intelligence, which was used to train over 370 staff of the United Nations Development Programme as part of their Accelerator Lab network for sustainable development. Prior to Nesta, Dr. Berditchevskaia worked in European science policy and knowledge transfer for participatory innovation methods such as citizen and DIY science. She has also worked at the Science Policy Centre at the Royal Society, focusing on emerging technologies and the societal and ethical implications of machine learning. She holds a Ph.D. in Neuroscience from Imperial College London, where she researched the role of motivation in behaviour.

SARAH WEST is Centre Director for Stockholm Environment Institute (SEI) York. She has been designing, running, evaluating and researching citizen science projects for over a decade, initially on the OPAL (Open Air Laboratoriess) project which aimed to engage people from all backgrounds in science and nature through environmental surveys. Whilst working on this project, Dr. West completed her Ph.D. in the Department of Environment and Geography on the Evaluation of Environmental Education at the University of York. Since then, she has been expanding the topics and locations in which citizen science approaches are used, including through work with Parenting Science Gang, a parent-led citizen science project, developing methods to monitor air pollution in informal settlements in Nairobi, and exploring how citizen science can support the Sustainable Development Goals. She also worked on the Living at Derwenthorpe project led by the Centre for Housing Policy at the University of York, evaluating the success of this new "sustainable community" of houses in York.

JOY BONAGURO is Chief Data Officer for the State of California with an overarching goal to improve government use of data. Ms. Bonaguro has spent her career working at the nexus of data, technology, design and policy. Prior to her state role, she was responsible for scaling internal systems, data, and information security at Corelight, a high-growth cybersecurity startup funded by Accel and General Catalyst. Prior to Corelight, she served as the first Chief Data Officer for the City and County of San Francisco, where she pioneered multiple initiatives to streamline data access, improve data management and governance, and boost capacity to use data through training and data science. Before that, Ms. Bonaguro developed technology, cyber and privacy policy across the Department of Energy's National Laboratory System. Her career started in New Orleans with seven years designing and managing the development of information systems to support planning and decision-making for local governments and

nonprofits. Ms. Bonaguro earned her Master's degree from University of California, Berkeley's Goldman School of Public Policy and her Bachelor's in Mathematics and Philosophy from Tulane University.

MIGUEL LUENGO-OROZ is the Chief Data Scientist at United Nations Global Pulse, an innovation initiative of the United Nations Secretary-General. He is the head of the data science teams across the network of Pulse labs in New York, Jakarta & Kampala. Over the last decade, Dr. Luengo-Oroz has built and directed teams bringing AI to operations and policy through innovation with international orgs, governments, private sector & academia. He has worked in multiple domains including poverty, food security, refugees and migrants, conflict prevention, human rights, economic indicators, gender, hate speech, privacy and climate change. Dr. Luengo-Oroz is the inventor of the collaborative diagnosis platform Malariaspot.org, the founder of the internet-of-medical-things startup Spotlab, and researcher affiliated with the Universidad Politecnica de Madrid. Dr. Luengo-Oroz has been awarded with the Ashoka fellowship, MIT TR35 (Technology Review's prestigious TR35 awards at Massachusetts Institute of Technology), WIPO (World Intellectual Property Organization) AI leader, European Union's Responsible Innovation award, La Caixa fellowship, and Singularity University GSP10 (graduate studies program). He holds a Ph.D. and MSc.Eng from the Universidad Politecnica de Madrid and a MSc from the Ecole des Hautes Etudes en Sciences Sociales de Paris.

ALEXANDRE CALDAS is Chief of Country Outreach, Technology and Innovation Branch in the Science Division of the United Nations Environment Programme (UNEP). He has more than 25 years of experience in science and technology policy across Academia, Industry, Government, and International Organizations. He has worked for the European Union, the African Union, a dozen of national Governments worldwide including 6 years as the Chief of eGovernment nominated by the Portuguese Prime Minister as well as director of innovation in the private sector for the Portuguese Industrial Association and Chamber of Commerce. Dr. Caldas is Associate Professor of Information Science and Technology Policy (ULHT). He was a Faculty Fellow at Oxford University, the Oxford Internet Institute (2004-2005) and has been for more than 13 years a Research Associate of Oxford University. He was a professor and researcher at the London School of Economics and Political Science (2005-2006) and the Science Policy Research Unit, in the United Kingdom (2000-2004). His most recent book is *Science and Time* (2015) and *Science and Space* (2017).

Panel 4: Role of Big Data in Our Digital Future

JEANNE HOLM (Moderator) is the deputy mayor of the City of Los Angeles. Prior to this appointment, Dr. Holm was a chief data officer of the City of Los Angeles, working on issues ranging from homelessness to predictive analytics. She works at the cross-section of innovation, open data, and education. As a senior consultant with the World Bank, she worked with governments throughout the world to build robust open data ecosystems and ensure transparency. She was the evangelist for Data.Gov for the U.S. White House, leading collaboration and building communities with the public, educators, developers, and international and state governments in using open government data. She was the chief knowledge architect at the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory, driving innovation through social media, virtual worlds, gaming, and collaborative systems, including the award-winning NASA public portal. She is a fellow of the United Nations International Academy of Astronautics and Distinguished Instructor at University of California, Los Angeles (UCLA), leads several high-tech startups, and has more than 130 publications on information systems, knowledge management, and innovation. Her research and courses focus on data science, knowledge management, and civic innovation. Her honors include the NASA Exceptional Service Medal for leadership (twice), top 50 Women in Tech, NASA Achievement Award for her work on the Galileo and Voyager spacecraft, three Webby's from The International Academy of Digital Arts and Sciences, and she led NASA to an unprecedented three global Most Admired Knowledge Enterprise awards. Dr. Holm received her Ph.D. in Management of Information Systems from Claremont Graduate University and her B.A. from UCLA.

HIMLA SOODYALL is the Executive Officer of the Academy of Science of South Africa (ASSAf). She is a Research Professor in Human Genetics at the University of the Witwatersrand (Wits) and was Principal Medical Scientist at the National Health Laboratory Service (NHLS) previously. Dr. Soodyal has done ground-breaking genetic research into the peoples of sub-Saharan Africa in which her studies have identified some of the oldest DNA found in living people today, adding weight to the theory that modern humans evolved in the area now known as southern Africa. She obtained an MSc in biotechnology and a Ph.D. in human population and evolutionary genetics from the University of the Witwatersrand (Johannesburg). Dr. Soodyall spent 4 years at Pennsylvania State University doing postdoctoral research with Mark Stoneking, one of the first researchers to advance the 'Out of Africa' hypothesis on human origins. In 1966, she returned to South Africa to set up her own laboratory at the South African Institute for Medical Research, conducting population and evolutionary genetics research within the Department of Human Genetics.

HUADONG GUO is a Professor of the Chinese Academy of Sciences (CAS) Institute of Remote Sensing and Digital Earth, an Academician of CAS, a Foreign Member of the Russian Academy of Sciences, a Foreign Member of the Finnish Society of Sciences and Letters, and a Fellow of TWAS. He presently serves as President of the International Society for Digital Earth, Director of the International Center on Space Technologies for Natural and Cultural Heritage under the Auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO), Chairman of the International Committee on Remote Sensing of Environment, and Editor-in-Chief of the International Journal of Digital Earth and Big Earth Data. He served as President of ICSU (International Council for Science) Committee on Data for Science and Technology. He has over 30 years of experience in Earth observation, specializing in radar remote sensing and Digital Earth science. He has been Principle Investigator for over 30 major national projects in China, and Principle Investigator for 7 international radar remote sensing projects. Dr. Guo has published more than 600 papers and sixteen books, and is the principal awardee of sixteen domestic and international prizes.

PEDRO CONCEIÇÃO has been Director of the Human Development Report Office and lead author of the Human Development Report at the United Nations Development Programme (UNDP). Prior to this, Dr. Conceição served as Director, Strategic Policy, at the Bureau for Policy and Programme Support, and Chief Economist and Head of the Strategic Advisory Unit at the Regional Bureau for Africa. Before that, he was Director of the Office of Development Studies (ODS) from 2007 to 2009, and Deputy Director of ODS from 2001 to 2007. His work on financing for development and on global public goods was published by Oxford University Press in books he co-edited (The New Public Finance: Responding to Global Challenges, 2006; Providing Global Public Goods: Managing Globalization, 2003). He has published on inequality, the economics of innovation and technological change, and development. Prior to coming to UNDP, he was an Assistant Professor at the Instituto Superior Técnico, Technical University of Lisbon, Portugal, teaching and researching on science, technology and innovation policy. He has degrees in Physics from Instituto Superior Técnico and in Economics from the Technical University of Lisbon and a Ph. D. in Public Policy from the Lyndon B. Johnson School of Public Affairs at the University of Texas at Austin, where he studied with a Fulbright scholarship.

JENNIFER PAHLKA is the founder and former executive director of Code for America and served as the U.S. Deputy Chief Technology Officer in the White House Office of Science and Technology Policy from 2013 through 2014, where she founded the United States Digital Service. She received the Skoll Award for Social Entrepreneurship and was named by Wired as one of the 25 people who has most shaped the past 25 years. She currently serves on the Defense Innovation Board and the board of the Tech Talent Project and holds additional fellowships at the Ashoka and the National Academy of Public Administration. Most recently, Ms. Pahlka has played an instrumental role in forming and mobilizing the US Digital Response during the current coronavirus pandemic. This groundbreaking program pairs certified technological experts with immediate state and local government needs. Ms. Pahlka is also

currently working on a book about reimagining public service in the digital age and using technology to achieve better outcomes to our health, our wealth, and the well-being of our society. Ms. Pahlka is a graduate of Yale University.

SUMMARY REMARKS

SOLOMON HSIANG is currently the Chancellor's Professor of Public Policy at the University of California, Berkeley, a Co-Director at the Climate Impact Lab, Research Associate at the National Bureau of Economic Research (NBER), a National Geographic Explorer, and an Andrew Carnegie Fellow. Dr. Hsiang also directs the Global Policy Laboratory at University of California, Berkeley, where his team is integrating econometrics, spatial data science, and machine learning to answer questions that are central to rationally managing planetary resources--such as the economic value of the global climate, how the United Nations can fight wildlife poaching, the effectiveness of treaties governing the oceans, and whether satellites and Artificial Intelligence can be combined to monitor the entire planet in real time. Dr. Hsiang earned a B.S. in Earth, Atmospheric and Planetary Science and a B.S. in Urban Studies and Planning from the Massachusetts Institute of Technology, and he received a Ph.D. in Sustainable Development from Columbia University. He was a Post-Doctoral Fellow in Applied Econometrics at NBER and a Post-Doctoral Fellow in Science, Technology and Environmental Policy at Princeton University.